



**16<sup>th</sup> Annual Congress of the ECSS**

**New horizons from  
a world heritage city**

**6th - 9th July 2011 | Liverpool UK**

# Book of Abstracts



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**16<sup>th</sup> annual Congress of the**  
**EUROPEAN COLLEGE OF SPORT SCIENCE**  
**6-9 July Liverpool 2011 – United Kingdom**  
**BOOK OF ABSTRACTS**

**Edited by:**  
N. Tim Cable, Keith George

Hosted by:  
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# Welcome

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We are delighted, on behalf of the European College of Sport Science and the Research Institute of Sport and Exercise Sciences (RISES) at Liverpool John Moores University, to welcome you to Liverpool for the 16th Annual Congress of the ECSS.

The Congress theme of “New Horizons from a World Heritage City” provides a platform for our internationally renowned Plenary and Invited Speakers to stimulate and promote new research directions in our core Sport Science disciplines. These sessions will be supported, as ever, by the Young Investigator Awards of which we have the largest ever submission of 211 presenters. We are also particularly proud to have attracted 1756 abstracts, which will bring energy, academic rigour and debate to the 74 oral sessions and 120 poster sessions across the 4 days of the Congress. This volume of submitted work reflects the importance of our discipline to the societies in which we live and to the continued development of the College. A particular highlight of the Congress this year will be the presentation of the Tom Reilly Memorial Lecture, by Professor George Brooks, entitled “Three Decades of Research on Lactate Metabolism; A conversation with Tom Reilly”. The programme has been designed to inspire debate and academic exchange and we trust that you will leave the Congress sufficiently challenged and energised to build new horizons for the future.

We are very excited to welcome you to our City of Liverpool, which is well known for its friendliness and fun. We trust that you will take time to network and socialise with friends and colleagues in the many restaurants and bars in the Albert Dock and City Centre that are all within walking distance of the Conference. In addition, we hope you will have time to explore the many cultural opportunities that range from world famous art galleries, to gothic architecture, to theatre, musical and sporting heritage.

On behalf of RISES and the ECSS we thank you for travelling to Liverpool and your continued commitment to ECSS. We trust that you will have a fruitful and pleasant visit to the North West of England.

Best wishes

Tim Cable

*Congress President*



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# Wednesday, July 6th, 2011

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**15:00 - 16:30**

## Invited symposia

### IS-PM01 Sports Nutrition Symposium (sponsored by GSK)

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#### **BEFORE: NEW DEVELOPMENTS IN PRE-EXERCISE NUTRITION**

WALLIS, G.

*GLAXOSMITHKLINE*

For many years athletes have been recommended to follow a diet that provides sufficient energy and is relatively high in carbohydrate in order to meet the demands of training and competition. The emphasis on carbohydrate reflects its critical role as the major fuel source for exercise. Nonetheless, in the context of training, scientists have started to explore roles for carbohydrate beyond simply meeting energy and fuel requirements. Specifically, carbohydrate availability has been manipulated during training as a means to enhance training adaptation. By using diet and exercise interventions to either reduce or increase carbohydrate availability during training it has been possible to induce favourable metabolic adaptations in previously well-trained individuals. It will however be important to understand the long-term consequences for performance (and health) if such practices are to be recommended to competitive sports participants. In terms of competition, it is important that interventions can be shown to be truly beneficial for real-world performance. Recently, we completed a large-scale study to establish the extent to which selected anthropometric and nutritional factors influence field-based marathon running performance. Using multivariate statistical methods it was identified that in addition to gender, body size and training, pre-race carbohydrate intake can significantly and independently influence marathon running performance. Therefore, recent developments are revealing potential additional benefits of manipulating dietary carbohydrate to enhance training adaptations along with providing new perspectives into the real value of pre-competition carbohydrate intake.

#### **CARBOHYDRATE FEEDING DURING EXERCISE - NEW GUIDELINES BASED ON THE LATEST RESEARCH**

JEUKENDRUP, A.

*UNIVERSITY OF BIRMINGHAM*

Carbohydrate feeding during exercise has been shown to enhance endurance performance. During exercise of 2 hours or more, the delivery of carbohydrates to the muscle is a crucial step and appears to be limited by intestinal absorption. This can, at least partly, be overcome by making use of multiple transportable carbohydrates (for example glucose and fructose). Ingestion of these carbohydrates may result in higher intestinal absorption rates, has been shown to result in higher exogenous carbohydrate oxidation rates and better endurance performance. Multiple transportable carbohydrates can also help fluid absorption and have the potential to reduce gastrointestinal discomfort. In addition it seems possible to increase the absorptive capacity of the intestine by adapting to a high carbohydrate diet. During shorter higher intensity exercise of approximately 1 h duration carbohydrate also appears to improve performance but does this through a completely different mechanisms. Even a mouth rinse with a carbohydrate solution can improve performance suggesting central rather than metabolic effects of carbohydrate. The optimal carbohydrate feeding strategy depends on the duration and intensity of exercise. The current knowledge allows for more detailed guidelines to enhance the delivery of carbohydrates and ultimately improve endurance performance. This presentation will present a series of new guidelines for carbohydrate intake during endurance exercise.

#### **AFTER: HOW CAN PROTEIN HELP MUSCLE RECOVERY?**

VAN LOON, L.

*MAASTRICHT UNIVERSITY MEDICAL CENTRE*

Intact protein, protein hydrolysates, and free amino acids are popular ingredients in contemporary sports nutrition, and are suggested to augment post-exercise recovery. Co-ingestion of protein and/or amino acids with carbohydrate can accelerate muscle glycogen repletion during recovery from exhaustive exercise. However, such an effect is only observed when suboptimal amounts of carbohydrate (<1.0 g/kg/h) are being ingested. As it is not always feasible to ingest such large amounts of carbohydrate (>1.2 g/kg/h) it may be more practical to stimulate skeletal muscle glucose uptake by co-ingesting an insulinotropic amino acid/protein mixture. Furthermore, protein and/or amino acid ingestion stimulates skeletal muscle protein synthesis, inhibits protein breakdown and, as such, stimulates muscle protein accretion during and after resistance or endurance type exercise. This has been suggested to lead to a greater skeletal muscle adaptive response to each successive exercise bout, resulting in more effective muscle reconditioning. Despite limited evidence, some basic guidelines can be defined regarding the preferred type and amount of dietary protein and the timing of protein ingestion to allow optimal post-exercise muscle reconditioning. So far, whey protein seems most effective in stimulating muscle protein synthesis during acute post-exercise recovery. This is likely attributed to its rapid digestion and absorption kinetics as well as its specific amino acid composition. Ingestion of approximately 20 g protein during and/or immediately after exercise is sufficient to maximize post-exercise muscle protein synthesis rates. Co-ingestion of a large amount of carbohydrate or additional free leucine is not warranted to further augment post-exercise muscle protein synthesis when ample protein is already ingested. Future research should focus on the relevance of the acute anabolic response following exercise to optimize the skeletal muscle adaptive response to more prolonged exercise training.



## Invited symposia

## IS-PM02 Eccentric Training and Exercise in Sport

## STRUCTURAL AND MOLECULAR DAMAGE WITH ECCENTRIC EXERCISE

RAASTAD, T., PAULSEN, G., OWE, S.G., LAURITZEN, F., HALLEN, J.

NORWEGIAN SCHOOL OF SPORT SCIENCES

Eccentric exercise has been used as a model to study exercise induced muscle damage for more than four decades (1). Generally, the higher potential for tension development combined with tension at long sarcomere lengths make muscle structures more susceptible for mechanical tearing during eccentric actions than during concentric muscle actions. The degree of damage induced by different eccentric exercise protocols varies with the tension developed, range of motion, exercise volume, speed of elongation and the training status of the muscle. The etiology of eccentric exercise induced muscle damage is not fully understood, but it is believed that the initial step is a mechanical tearing of myofibrillar, cytoskeletal and membrane structures. The initial structural damage can thereafter activate proteases like the calpain system and other protein degradation systems (2). Furthermore, in cases of severe damage an inflammatory response with accumulation of leukocytes is initiated and develops the following days (3). The degree of damage might vary from only minor myofibrillar disruptions to severe cell damage causing segmental fiber necrosis (2, 4). Consequently, the recovery of muscle function may vary from a couple of days to several weeks depending on the degree of damage induced by the exercise protocol (2, 4). At the ultrastructural level myofibrillar disruptions are observed as disorganization of myofilaments and loss of Z-disks (2, 4). A close relation between reduction in force-generating capacity and number of fibers with myofibrillar disruptions, especially the days after exercise, indicates that the structural disruptions directly affects the force-generating capacity of the muscle. After moderate myofibrillar disruptions it seems like sarcomere structure and muscle function can be regained within a week, however, if segmental necrosis takes place, the regeneration process may take more than 1-2 months (2, 4). The remodeling process after moderate myofibrillar disruptions involves exchange of myofilaments and intermediate filaments (5), whereas the remodeling process after segmental necrosis involves leukocyte accumulation and later regeneration of fiber segments through satellite cell fusion into connecting myotubes (6). Serial addition of new sarcomeres has been indicated as part of the remodeling process and suggested as one possible mechanism behind the repeated bout effect observed after the first bout of eccentric exercise. A heat shock protein response is also a part of the remodeling process and may also contribute to strengthen myofibrillar structures after the first bout (7). 1 Friden et al. *Experientia* 37 (5):506-507, 1981. 2 Raastad et al. *Med Sci Sports Exerc.* 42 (1):86-95, 2010. 3 Paulsen et al. *Med Sci Sports Exerc.* 42 (1):75-85, 2010. 4 Lauritzen et al. *J Appl Physiol* 107 (6):1923-1934, 2009. 5 Yu et al. *Histochem. Cell Biol.* 119 (5):383-393, 2003. 6 Paulsen et al. *Scand J Med Sci Sports* 20 (1):e195-e207, 2010. 7 Paulsen et al. *J Appl Physiol* 107 (2):570-582, 2009.

## ECCENTRIC EXERCISE TRAINING IN ELITE SKIING

VOGT, M.

UNIVERSITY OF BERN

Introduction: Competitive alpine skiing is very different compared to recreational skiing and other sports. Heart rate and blood lactate measurements during competition show that physical demand during these 45 to 120 seconds tasks is maximal and that the values can even exceed the maximal values measured during appropriate lab performance testing. Moreover, the load on skeletal muscles during competitive alpine skiing is very high. Compared to other competitive sports, muscle recruitment pattern during alpine skiing is special and characterized by a preponderance of eccentric over concentric activity. Methods: In the course of the optimization of training methods which account for high demands on energy turnover and strength during elite alpine skiing, we constructed an eccentric ergometer. The device is software controlled, can deliver a maximum of 5'000 W of power during cyclic exercise, uses a biofeedback system to adjust training loads and allows for quantitative assessment of required vs. applied power (coordination). We have used the eccentric ergometer in various training settings with patients as well as with junior and elite alpine skiers and selected other athletes. In addition to conventional strength training, elite alpine skiers trained on the eccentric ergometer ones or twice per week during their summer preparation period. A typical training session consisted of four 4- to 5-minutes intervals. Results: The summary of selected results from different training groups indicate that maximal isometric strength, jump heights and performance in counter movement jumps can further be increased in elite skiers within six to eight weeks of eccentric exercise training. Without getting muscle soreness elite slalom skiers were able to increase their eccentric training load by over 100% within only 5 exercise sessions. Athletes were able to massively improve coordination of eccentric force development. For slalom skiers we have some indication that the quality of eccentric force development is best in those athletes with the best world rank position. Discussion: Our results indicate that cyclic eccentric exercise further improves maximal and explosive strength and the quality of (eccentric) force development in junior and elite alpine skiers. The mode of muscle action during alpine skiing requires high power generating and stabilizing leg and trunk muscles as well as well developed coordination for eccentric muscle activity. Cyclic eccentric training therefore appears to be a supporting approach to optimize performance and prevent injury in elite alpine skiing. REFERENCES Berg HE, Eiken O. Muscle control in elite alpine skiing. *Med Sci Sports Exerc.* 31(7):1065-7, 1999. Gross M, Luethy F, Kroell J, Mueller E, Hoppeler H, Vogt M, Effects of Eccentric Cycle Ergometry in Alpine Skiers, *Int J Sports Med* 31, 2010. Vogt M, Däpp Ch, Blatter J, Weisskopf R, Sutter G, Hoppeler H. Training zur Optimierung der Dosierung exzentrischer Muskelaktivität. *Schweizerische Zeitschrift für Sportmedizin* 51(4), 2003.

## ECCENTRIC EXERCISE TRAINING AS A NOVEL REHABILITATION MODALITY

MARCUS, R.L., DIBBLE L.E., LASTAYO, P.C.

UNIVERSITY OF UTAH

Overcoming muscular impairments is often one of the primary objectives of rehabilitation following injury or disease. More specifically, the recovery of muscle size, strength, power and mobility are critical goals of rehabilitation. At the very least, rehabilitation professionals seek to minimize these muscle impairments in those where deterioration is inevitable. While eccentric training models have historically been employed to induce muscle damage or improve sport performance, chronic exposure to eccentric muscle contraction is increasingly being employed to overcome muscle impairments in patient populations. Because much greater force (2 to 3 times greater) can be produced eccentrically than either isometrically or concentrically, eccentric training has the capability of "overloading" muscle to a greater extent and enhancing muscle mass, strength and power than concentric exercise. Importantly, these benefits of eccentric training are

achievable with a minimal energetic/exertion cost, making eccentric training ideally suited for patients who are often exercise-intolerant. Our research has focused on the application of eccentric exercise training in adults who suffer from muscle loss and its clinical consequences, including those: recovering from total knee arthroplasty and anterior cruciate ligament reconstruction; living with diabetes, Parkinson disease, and multiple sclerosis; survivors of stroke and cancer; and those who are frail and at high fall risk. This symposium will present data from our laboratory and from the literature that illustrates both the application and impact of eccentric training to mitigate loss of muscle, muscle fatty infiltration and the functional sequelae adversely affecting needy populations, in a rehabilitation setting. References: LaStayo PC, Ewy GA, Pierotti DD, Johns RK, Lindstedt S. (2003) *J of Gerontology* 58A, 419-424 LaStayo PC, Woolf JM, Lewek MD, Snyder-Mackler L, Reich T, Lindstedt SL. (2003) *JOSPT* 33, 557-571. Dibble LE, Hale T, Marcus RL, Droge J, Gerber JP, LaStayo PC (2006) *Movement Disorders* 21, 1444-1452. Gerber JP, Marcus RL, Dibble LE, LaStayo PC (2009) *Sports Health* 1, 31-38. Marcus RL, Smith S, Morrell G, Addison O, Dibble LE, Wahoff-Stice D, LaStayo PC. (2008) *Phys Ther* 88, 1345-1354. LaStayo PC, Meier W, Marcus RL, Mizner R, Dibble L, Peters C. (2009) *Clin Orthop Relat Res* 467, 1493-1500. Mueller M, Breil FA, Vogt M, Steiner R, Lippuner K, Klosner S, Hoppeler H, Dapp C. (2009) *Eur J Appl Physiol* 107, 145-53. Marcus RL, Addison O, Kidde JP, Dibble LE, LaStayo PC. (2010) *J Nutr Health Aging* 14, 362-366. LaStayo PC, Larsen S, Smith S, Dibble L, Marcus RL. (2010) *J of Geri Phys Ther*, 33, 135-140. Marcus R, Yoshida Y, Meier W, Peters CL, LaStayo PC. (2011) *Arthritis*, in press. LaStayo P, Marcus R, Dibble L, Smith S, Beck S. *BMC Geri*, 11, 5. Mueller M, Breil FA, Lurman G, Klossner S, Fluck M, Billeter R, Dapp C, Hoppeler H. (2011) *Gerontology* (online).

## Invited symposia

### IS-PM03 Cardiovascular Imaging in Sport Science: What does the future hold?

#### EXERCISE AS VASCULAR MEDICINE: ULTRASOUND INSIGHTS IN EXERCISE AND HEALTH

GREEN, D.

LIVERPOOL JOHN MOORES UNIVERSITY

In this symposium I will briefly present a history of the study of the circulation, from Harvey's proofs, through the era of plethysmography, to sophisticated contemporary imaging approaches. Conceptually, I will develop an argument that much of the beneficial impact of exercise, in terms of cardiovascular (CV) risk, may relate to direct haemodynamic effects of episodic exercise bouts on the vasculature rather than modulation of traditional CV risk factors, as has been previously thought. Evidence will be presented which illustrates the impact of forces such as vascular shear stress and transmural wall pressure on adaptations in the function and structure of the arterial tree, at conduit, resistance and microvascular levels. The possibility of both anti- and pro-atherosclerotic effects of exercise will be raised. New studies, which follow on from the seminal work of Folkow pertaining to the vascular implications of the Law of Laplace, will also be presented. The concept that exercise training regimes might be devised around optimising haemodynamic signals will be explored. Finally, I will present some ideas about the future directions of in vivo human vascular research, particularly the way in which new technological advances may lead our future understanding of the integrative responses to exercise and adaptations to physical activity and exercise training.

#### CARDIAC MAGNETIC RESONANCE IMAGING IN ATHLETES

SCHARHAG, J.

UNIVERSITY OF POTSDAM

Cardiac magnetic resonance imaging (CMR) is considered as the most exact diagnostic tool to examine the heart non-invasively, and allows detailed analyses of cardiac structures and functions in physiological and pathophysiological altered hearts. Therefore, CMR is considered as the non-invasive gold standard to examine the heart. On the other hand, compared to echocardiography, CMR is more time consuming and expensive, and therefore, less data are available in athletes than for echocardiography. Nevertheless, within the last decade a considerable number of CMR studies has been performed by different scientific groups and examined the heart in athletes. Due to different techniques and different study populations, which usually are small, in some aspects different results have led to different interpretations of cardiac adaptations in the athlete's heart. Whereas adaptive changes in the athlete's left ventricle have been described more or less uniform in endurance athletes presenting an eccentric hypertrophy, only little data are available for strength trained athletes. Based on an own study, anabolic free strength trained athletes only presented a very moderate eccentric, but not concentric, left ventricular hypertrophy when related to the lean body mass and compared to sedentary controls matched for body dimensions. For right ventricular changes in athletes, still only a little number of studies exists. In endurance athletes most study groups report a harmonic eccentric hypertrophy of the left and the right ventricle. Nevertheless, some reports on right ventricular pathologies detected in endurance athletes, which are thought to be induced by repetitive excessive endurance exercise over years, warrant further (multi-centre) studies with higher numbers of athletes and similar CMR techniques to examine this possible maladaptation in the future. Another advantage of CMR is its high sensitivity to detect cardiac abnormalities and pathologies. By the use of special CMR sequences and contrast media, acute myocardial oedema during and chronic scars after myocarditis or myocardial infarction can be detected. In addition, mild maladaptive changes or pathologies can be detected earlier by CMR than by echocardiography, such as hypertrophic cardiomyopathy (especially in the apical region), arrhythmogenic right ventricular cardiomyopathy (ARVC) or left ventricular non-compaction cardiomyopathy (LVNC). Furthermore, it may be possible in the future to allow a better risk stratification for adverse cardiac events or sudden cardiac death in athletes if the above mentioned pathologies are examined systematically in athletes by cMRI. The lecture will give an overview on the present results of CMR studies in athletes and perspectives on future studies.

#### STRAIN AND TORSION MECHANICS BY ECHOCARDIOGRAPHY DURING ACUTE EXERCISE AND IN RESPONSE TO ENDURANCE TRAINING.

OBERT, P.

UNIVERSITY OF AVIGNON

During the cardiac cycle, the myocardium deforms in longitudinal (L), circumferential (C) and radial (R) planes. As a result of obliquely orientated fibers, the left ventricle (LV) twists along its longitudinal axis during systole and rapidly untwists during early diastole. The latter (consequence of both active relaxation and elastic recoil) promotes LV "suction" and filling by increasing intraventricular (base to apex)

and atrio-ventricular gradients. Evaluation of myocardial deformation and torsion by echocardiography (speckle tracking imaging, STI) has been validated against MRI. STI provides sensitive indexes of myocardial relaxation and contractility, relatively independent of loading conditions. Notomi first demonstrated in the transition from rest to exercise an increase in LV torsion (LVT) and untwist rate during early diastole. During a triangular exercise, we reported that L strain rapidly plateaued while LVT and C strain gradually increased. Both studies underlined the key role of untwisting in LV filling. No L strain changes were documented in response to handgrip stress (Stefani et al 2007), demonstrating that certain conditions (eg hemodynamic load,  $\beta$ -adrenergic stimulus,...) have to be fulfilled. Based on conventional echo, previous studies reported « supernormal » LV function in endurance athletes. Whether strain and torsional mechanics change in response to endurance training remains poorly understood. Recent data (Nottin et al. 2008) demonstrated at rest similar LV L, C and R strain/strain rate but reduced LVT in competitive cyclists compared to sedentary controls. Similar results regarding LV torsional dynamics have been obtained by Zocalo et al (2007) in professional soccer players. These results were related to the pronounced resting bradycardia (and probably lower sympathetic drive) and might be indicative of « supernormal functional reserve » in the training state. Very recent findings from our group (unpublished data) have confirmed this hypothesis, as greater LVT reserve (enhanced apical rotations) during effort was demonstrated in trained cyclists. Normal resting LV L, C and R strain/strain rate have also been established in endurance athletes (Teske et al 2010, Galderisi et al 2010). Of note, different strain and torsional profiles at rest have been documented by others. Compared to sedentary controls, Richand et al (2007) reported similar C and R but reduced L strain in soccer players while Simsek et al (2010) demonstrated greater L strain in highly-trained aerobic/anaerobic athletes. Galderisi et al (2010) showed similar LVT in top-level rowers and controls, despite significant bradycardia in the athletes. Finally, recent findings from Weiner et al (2010) highlighted enhanced twist (improved apical rotation)/untwist rate in recreational rowers after an endurance training program. Differences in training state (quantity, quality, and length), methods (STI vs TDI-derived strain, cross-sectional vs longitudinal) might explain these controversial data and further studies will be required.

## Oral presentations

### OP-BN05 Fatigue

#### INTERPOLATED TWITCH TECHNIQUE: INTERESTING TECHNIQUE DURING FATIGUE EXERCISE?

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**Introduction** Muscle fatigue results from an intense and/or prolonged exercise and progressively leads to a reduction in maximal voluntary contraction (MVC) force (Gandevia, 2001). This reduction in MVC force is transient and can be assigned to central and/or peripheral mechanisms. To assess the amount of central fatigue, the interpolated twitch technique (ITT) is commonly used. However, the validity of this technique is discussed in the literature (e.g. Horstman, 2009; Enoka, 2009) and recently Place et al. (2008) demonstrated with mouse intact single fibres that the ITT takes into account peripheral properties of fatigue. The present study was designed to assess the effect of fatigue on the interpolated twitch amplitude applied on repeated tetanic stimulation induced by electromyostimulation (EMS) in human quadriceps muscle. **Methods** Experiments were performed on 9 healthy men. Twitch was evoked on (superimposed twitch) and after (potentiated twitch) each of the 15 repeated tetanic stimulations (6s on - 6s off), performed in isometric condition with a knee angle of 90°. The intensity used for the EMS-induced contractions was set to 20% of MVC and kept constant for the 15 contractions. MVC have been performed before and after the EMS-induced contractions. Twitches amplitudes (superimposed and potentiated ones) and EMS-induced torque were recorded. **Results** The repeated tetanic contractions induced by EMS resulted in a decreased of MVC torque ( $-14.1 \pm 6.9\%$ ;  $P < 0.001$ ). The EMS-induced torque and the potentiated peak twitch were significantly depressed ( $-60.0 \pm 7.3\%$  and  $-10.3 \pm 5.9\%$  respectively;  $P < 0.001$ ), whereas the superimposed twitch amplitude was significantly increased ( $24.6 \pm 13.8\%$ ;  $P < 0.001$ ) at the end of the 15 repeated tetanic stimulations. **Discussion** The results showed a progressive increase in the superimposed twitch amplitude, whereas the EMS-induced torque decrease. This can be interpreted as central fatigue. We also noted a progressive decrease in the potentiated twitch amplitude, evidencing peripheral fatigue. The time course of the increase in the superimposed twitch amplitude combined with the reduction in the potentiated twitch amplitude indicate that the loss of force could mainly be attributed to a reduction in motor unit discharge rate rather than full motor unit derecruitment, and/or to a failure in the excitation-contraction coupling process (Place et al., 2008). **References** Enoka RM. (2009). J Appl Physiol 107: discussion 359-366 Gandevia SC. (2001). Physiol Rev 81: 1725-1789 Horstman AM. (2009). J Appl Physiol 107: discussion 359-366 Place N, Yamada T, Bruton JD, Westerblad H. (2008). J Physiol 586: 2799-2805

#### ACUTE AND DELAYED SSC FATIGUE EFFECTS ON TREADMILL RUNNING: MEANINGFUL INITIAL NEURO-MECHANICAL ADJUSTMENTS

MORIO, C., BARLA, C., MESURE, S., BERTON, E., NICOL, C.

OXYLANE RESEARCH

**ACUTE AND DELAYED SSC FATIGUE EFFECTS ON TREADMILL RUNNING: MEANINGFUL INITIAL NEURO-MECHANICAL ADJUSTMENTS** Morio, C.1,2, Barla, C.1, Mesure, S.2, Berton, E.2, Nicol, C.2 1: Oxylane Research (Lille, France), 2: UMR 6233 (Marseille, France) **Introduction** Stretch-shortening cycle (SSC) defines natural, but challenging forms of ground locomotion (Komi 2000). Due to necessary initial adjustments, the SSC pattern is usually analysed once stabilized. In case of fatigue, however, meaningful compensatory and/or protective neuro-mechanical adjustments are expected to take place in the early exercise. Fatigue induced by exhaustive SSC exercise is of particular interest as it includes acute functional defects, but also delayed ones associated with muscle soreness and potential influence of III and IV muscle afferents on the neural drive (Nicol et al. 2006). This fatigue paradigm was used to compare the neuro-mechanical adjustments observed during the first 3 min of a treadmill run and once stabilized. **Methods** Exhaustive SSC exercise was performed on a sledge apparatus by 8 male healthy subjects who repeated series of 25 bilateral jumps, with inter-series rests of 3 min. Rebound height was set at 80% of maximal rebound height. SSC fatigue was quantified before (PRE), after (POST) and two days (D2) later by a maximal drop jump test. The induced neuro-mechanical changes were examined in the early and stabilized phases (first and third minutes) of a submaximal treadmill run through 3D kinematics and electromyography recordings of 8 major muscles of the right lower limb. Appropriate two-way ANOVA analyses and Tukey post-hoc comparisons were performed with a 0.05 level of significance. **Results** Maximal rebound height decreased similarly by 6% at POST and D2. Muscle soreness was elevated up to day 4. In the treadmill runs, initial neuro-

mechanical adjustments occurred, but they remained similar in trends and amplitude despite fatigue. Comparison of the stabilized running patterns revealed most changes at D2, which presented a  $12 \pm 8\%$  increase in lower limb stiffness, with associated  $7 \pm 23\%$  increased vastii preactivation ( $33 \pm 45\%$  at the first minute), straighter knee at impact and reduced subsequent flexion. This contrasted with larger ankle eversion and midfoot abduction. Discussion In circumstances where DOMS is involved, reduced knee flexion could aim at preventing further muscle pain in vastii muscles (Dutto & Braun 2007), but at the expense of impact shocks that could explain the associated ankle and foot protective kinematic changes. It is noteworthy that the D2 running pattern was modified since its first minute and remained as such. At this expected time of inflammation within the exercised muscles, activation of III and IV muscle afferents might have contributed to the protective neural strategies. References Komi PV (2000). J Biomech, 33, 1197-1206. Nicol C, Avela J, Komi PV (2006). Sports Med, 36, 977-999. Dutto DJ, Braun WA (2004). Med Sci Sports Exerc. 36:560-566.

### **CAN INTERVENTIONAL PAIRED ASSOCIATIVE STIMULATION MODIFY FATIGUE RESISTANCE DURING SUSTAINED ISO-METRIC MAXIMAL VOLUNTARY CONTRACTION?**

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**INTRODUCTION** Interventional paired associative stimulation (IPAS) has been used to study motor learning and utilised in motor control therapies after brain injury (Thickbroom 2007). IPAS includes combination of peripheral nerve stimulation (PNS) and transcranial magnetic stimulation (TMS) at the motor cortex. In central fatigue, muscle force is limited by insufficient central drive to the motor neurons (Gandevia 1998). Because IPAS has potential to increase or decrease motor cortex excitability, the purpose of this study was to examine whether IPAS can modify supraspinal contribution of central fatigue. **METHODS** 30 subjects were randomly divided into two groups separated by the interstimulus interval (ISI) between PNS and TMS (20 ms and 50 ms). IPAS protocol consisted of 200 pairs (0.2 Hz) of PNS to the common tibial nerve and TMS aimed into Soleus motor cortex. Corticospinal and spinal excitability were tested with the TMS and H-reflex, respectively. Fatigue resistance was calculated as the relative force reduction during a 15 second sustained isometric maximal voluntary contraction (MVC). In addition, twitch occlusion technique was used at the end of the contraction to reveal the level of central activation. **RESULTS** ISI50 group demonstrated a significant increase in the average size of the motor evoked potential (MEP) with a value of  $1.92 \pm 0.41$  ( $p=0.019$ ) after IPAS. Conversely, ISI20 group showed a significant reduction in MEP size with a value of  $0.75 \pm 0.12$  ( $p<0.023$ ). In both groups, the H/M ratio as well as M-max remained unchanged. Force decreased significantly at the end of the 15 second sustained MVC (11-13%) before and after IPAS. However, this reduction was not different between the groups. In addition, central activation did not change significantly after IPAS with neither of the groups. However, in both groups significant negative correlations were found between change in fatigue resistance and change in superimposed twitch torque ( $r=-0.61$  and  $-0.58$ ,  $p<0.05$ ). **DISCUSSION** Current results highlight the timing-specificity of the two concurrent stimuli during IPAS targeted to Soleus motor cortex. 15 second sustained MVC failed to induce remarkable central fatigue (only from 1 to 2%). However, because of the unchanged H/M ratio and the aforementioned negative correlation, it could be suggested that IPAS may have potential to modify the supraspinal mechanisms of central fatigue. **REFERENCES** Thickbroom GW. (2007). Exp Brain Res 180(4):583-93. Gandevia SC. (1998). Acta Physiol Scand. 162(3):275-83.

### **NEUROMUSCULAR FATIGUE AFTER TREADMILL SHORT AND LONG SPRINTS**

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Tomazin, K.1,2 Morin, JB.2, Strojnik, V.1, Millet GY.2 1: University of Ljubljana, Faculty of Sport (Ljubljana, Slovenia), 2: Université de Lyon, F-42023, (Lyon, France) and Jean Monet University (Saint-Etienne, France) **Introduction** A slight to substantial decrease in speed characterize single, maximal sprints on Olympic distances (100, 200 and 400-m). Neuromuscular alterations due to high force output demands during sprint support phases are probably one of the main reasons for speed decrements towards the end of a sprint. Although many studies have investigated neuromuscular fatigue after different high-intensity whole body exercises (>60 s) performed in the laboratory conditions (Strojnik and Komi, 1998; Tomazin et al. 2008), very little is known about central and peripheral fatigue during maximal, single sprints. The aim of this study was to compare the aetiology of fatigue following maximal sprints of different Olympic distances. **Methods** Eleven subjects ( $24 \pm 4$  years,  $73 \pm 6$  kg,  $179 \pm 6$  cm) performed 100, 200 and 400-m sprints on a motorized instrumented treadmill (Morin et al. 2010). The neuromuscular function evaluated before (Pre), 30 s (Post) and 30 min after sprints (Post30), consisted in determining maximal voluntary knee extensors torque (MVC), maximal voluntary activation of knee extensors (%AL), single twitch (TW) and doublets low- (10 Hz, Db10) and high-frequency torque (100 Hz, Db100). **Results** MVC was not significantly altered following 100 and 200-m sprints but decreased by  $14 \pm 13\%$  ( $P<0.001$ ) after the 400-m and went back to initial values Post30. Only non-significant decrease in %AL ( $-4 \pm 7\%$ ) was obtained post 400-m. Db100 decreased only Post 200-m ( $-8 \pm 9\%$ ;  $P<0.001$ ) and 400-m ( $-14 \pm 12\%$ ;  $P<0.001$ ) sprints. Tw and ratio Db10/Db100 decreased Post 100-m ( $-9 \pm 10.1\%$ ;  $P<0.05$  and  $-7 \pm 6\%$ ;  $P<0.01$ , respectively), 200 ( $-19 \pm 12\%$ ;  $P<0.001$  and  $-11 \pm 7\%$ ;  $P<0.001$ , respectively) and 400-m ( $-34 \pm 18\%$ ;  $P<0.001$  and  $25 \pm 10\%$ ;  $P<0.001$ , respectively) sprints and were not recovered Post30 after all sprints. **Discussion** Single maximal sprints of 100 to 400-m induce progressive and substantial low-frequency peripheral fatigue. Despite altered single or paired stimulations, MVC strength loss (i.e. conventional definition of fatigue) was detected only after the 400-m sprint. **References** Morin JB, Samozino P, Bonnefoy R, Edouard P, Belli A (2010). J Biomech, 43(10), 1970-1975. Strojnik V, Komi PV (1998). J Appl Physiol, 84(1), 344-350. Tomazin K, Sarabon N, Strojnik V (2008). J Sport Sci Med, 7(2), 242-248.

### **THE EFFECT OF FATIGUE ON THE BIOMECHANICAL PROPERTIES OF OBSTACLE CROSSING**

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1: TEFAA-AUTH, (SERRES, GREECE), 2: TEFAA-AUTH, (THESSALONIKI, GREECE).

**Introduction** Fatigue, as an element of everyday life, physical activity and as a symptom in different pathologies, influences the accuracy of a movement (Welsh and Segal 1996). On the other hand, obstacle crossing is a common task, which is quite challenging for elderly people or people with disabilities. In these cases fatigue could further increase the risk of falling. However, it is still unknown the effect of fatigue on the biomechanical and neuromuscular properties during obstacle crossing. **Methods** Fourteen untrained male volunteers (age:  $23 \pm 5$  years) walked over an obstacle of 10% or 20% of their lower limb length, in random order. Then they were fatigued walking/running on a treadmill until exhaustion using modified Bruce protocol. Immediately and five minutes after, the obstacle crossing was re-evaluated. We captured the vertical ground reaction forces (vGRF), the kinematics of the lower limbs and the electromyogram (EMG) of

the medial gastrocnemius, soleus and tibialis anterior of the trailing foot. A two way ANOVA with repeated measurements was used for statistical analysis ( $p < 0.05$ ). Results The EMG for the three examined muscles of the trailing foot was not affected by the obstacle height and no changes were observed before and after fatigue during obstacle crossing. The hip and knee of the leading limb was more flexed when increasing the obstacle height, but fatigue did not induce any significant change. The trailing limb showed significantly increased knee and ankle joint angles when increasing the obstacle height. The main effect for fatigue and the interaction was not significant for the trailing limb. The distance of the trailing foot from the 10% height obstacle was significantly shorter after fatigue and recovered after 5 minutes. No differentiation was observed for the distance of the leading limb from the obstacle when stepping on the ground after the obstacle. Finally, the vGRF was significantly higher after fatigue independent of the obstacle height and recovered after 5 minutes rest. Discussion Our results suggest that kinematics and EMG properties of the examined muscles during obstacle avoidance of two different heights are not affected by fatigue induced by sustained running until exhaustion. Although the higher vGRF on the support (trailing) foot may increase the risk of falling it can be concluded that at least in healthy young persons, fatigue can only have minor effects on the obstacle avoidance pattern. However, further investigation is required in more sensitive to falls populations and during more challenging obstacle heights. References Welsh DG, Segal SS (1996). *Circulation Research*, 79, 551-559.

## THE EFFECTS OF RUNNING FATIGUE ON OVERGROUND IMPACT ACCELERATION

CLANSEY, A., HANLON, M., WALLACE, E., LAKE, M.

UNIVERSITY OF ULSTER

THE EFFECTS OF RUNNING FATIGUE ON OVERGROUND IMPACT ACCELERATIONS Clansey, A.1, Hanlon, M.1, Wallace, E.1, Lake, M.2 1:UUJ (Belfast, NI), 2: LJMU (Liverpool, UK) Introduction Fatigue can have considerable effects on lower limb mechanics during running and has been linked with the development of overuse injuries (Dierks et al., 2010). It has been reported that as a runner progresses over the course of a run the onset of neuromuscular fatigue causes the protective mechanisms of the muscle to be less effective in coordinating limbs and reducing leg impact accelerations (Mizrahi et al., 2000). However, it is still unknown how different fatigue levels subsequently affect impact accelerations of trained distance runners. The aim of this study was to investigate the effects of different levels of running fatigue on subsequent impact accelerations during overground running. Methods Ten runners ( $32.5 \pm 11$  yrs;  $73 \pm 13$  kg;  $1.77 \pm 9.4$  m;  $13.8 \pm 1.9$  km/h lactate threshold (LT) at 3.5 Mm) performed three tests (Pre, Mid & Post) of 8 acceptable overground running trials at 4.5 m/s ( $\pm 5\%$ ). Between tests each subject ran on a treadmill (HP Cosmed, UK) for 20 min at their LT speed. Ratings of perceived exertion (RPE) were taken at the 3rd and 20th min of the treadmill run. Subjects had two accelerometers (Noraxon, USA) attached to the distal tibia and forehead. For each trial, three seconds of vertical acceleration data was collected at 1500 Hz. A repeated measures ANOVA was used to assess the significance of run duration (3 time levels) on acceleration measures (alpha level of  $p < 0.05$ ). Results Subject RPE scores increased from 11.8 to 15 at the end of the 1st 20-min run and then to a further 18.2 by the end of the second 20-min run. Both peak tibial acceleration (12.4 to 13.4 g) and peak head acceleration (1.4 to 1.7 g) significantly increased from the Pre to Post test. However no significant differences were found in both head and tibial accelerations between pre and mid test. Discussion Results showed that tibial and head accelerations significantly increased with fatigue levels (mean changes of 8% and 21%, respectively). Greater accelerations at the head and tibia with fatigue may be due to a possible reduction in shock attenuation properties of the musculoskeletal system (Mizrahi et al., 2000). Further investigation is still required into possible kinematic factors that may be linked with these fatigue-induced increases in tibial and head accelerations (Dierks et al., 2010). References Derrick, T.R., Dereu, D., Mclean, S (2002) Impacts and kinematic adjustments during an exhaustive run. *Med Sci Sports Exerc.* 34, 998-1002. Dierks, T., Davis, I., Hamill, J (2010). The effects of running in an exerted state on lower extremity kinematics and joint timing. *J Biomech.* 43, 2993-2998 Mizrahi, J., Verbitsky, O., Isakov, E., Dailly, D (2000). Effect of fatigue on leg kinematics and impact acceleration in long distance running. *Hum Movement Sci*, 19, 139-151.

## Oral presentations

### OP-PM04 Health

## EFFECT OF ACUTE EXERCISE INTENSITY ON BRACHIAL ARTERY ENDOTHELIAL FUNCTION IN HUMANS

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Introduction: Whilst the effects of exercise training on vascular function have been well studied, less is known about the influence of acute exercise on conduit artery vasodilator function. Previous data may be confounded by methodological issues such as exercise intensity and the timing of post-exercise measurements. We examined brachial artery flow mediated dilation (FMD) before, immediately after and 1, 2 and 24 hours following 3 bouts of acute exercise at different intensities. Methods: Ten healthy males ( $22 \pm 1$  years) were randomly assigned to undertake 30 min cycling at 50, 70 and 85% maximal heart rate (HRmax). Brachial artery FMD was assessed using high resolution echo-Doppler. We also calculated the shear rate area-under-the-curve (from cuff deflation to peak dilation; SRAUC) as the eliciting stimulus for FMD. Results: Exercise at 50, 70 and 85% HRmax was performed at  $99 \pm 7$ ,  $129 \pm 3$  and  $153 \pm 5$  bpm. Two-way ANOVA demonstrated no change in brachial artery FMD at any time point at 50% HRmax. There was a significant decrease immediately post-exercise at 70% ( $6.7 \pm 2.1$  vs  $4.5 \pm 2.4\%$ ;  $P = 0.016$ ) which then returned to near baseline levels at 1 ( $5.9 \pm 2.7\%$ ), 2 ( $6.4 \pm 2.7\%$ ) and 24hr ( $6.6 \pm 2.5\%$ ). There was also a significant decrease in FMD post-exercise at 85% HRmax ( $6.1 \pm 1.2$  vs  $3.4 \pm 1.2\%$ ;  $P < 0.001$ ) which subsequently normalised (1hr:  $6.8 \pm 2.7\%$ ; 2hr:  $5.6 \pm 2.1\%$ ; 24hr:  $6.1 \pm 2.5\%$ ). No differences were evident in baseline diameter or SRAUC by 2-way ANOVA. Conclusion: These data indicate that the intensity of an acute exercise bout impacts conduit artery vasodilator function in a differential and time-dependent manner. Higher intensities were associated with immediate post-exercise reductions in FMD, which were not due to decreased SR stimulus presentation. Previous studies have suggested that elevated oxidative stress or inflammation associated with intense acute exercise may decrease vasodilator function. All FMD data were normalised by 1 hour post-exercise, suggesting any impairment is transient. These findings of a time and dose-dependent response inform our understanding of the acute stimuli responsible for training-induced arterial adaptations and indicate that care should be taken when interpreting post-exercise data.

## EFFECT OF INTENSE INTERVAL TRAINING ON BLOOD PRESSURE AND HEMODYNAMICS IN SUBJECTS WITH ESSENTIAL HYPERTENSION

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**Introduction** Roughly 1 billion people worldwide suffer from hypertension and extensive work has been done to evaluate pharmacological and non-pharmacological interventions. Regular physical activity of moderate intensity is known to reduce blood pressure but the effect of high intensity intermittent exercise on blood pressure is less clear. Moreover, the mechanisms behind the blood pressure lowering effects of exercise remain unsolved. Nitric oxide (NO) and vasodilator prostanooids (PGs) are potent vasodilators that contribute to blood pressure regulation. The present study examined the effect of intensive interval training on blood pressure and the role of the NO/PG system in this response. **Methods** Ten subjects diagnosed with essential hypertension ( $47 \pm 4$  years,  $171 \pm 11$  cm,  $80 \pm 24$  kg (S.E.)) and ten normotensive control subjects ( $46 \pm 3$  years,  $177 \pm 8$  cm,  $76 \pm 9$  kg), performed 8 weeks of high intensity intermittent exercise training (1 hour cycling sessions 3-4 times per week, ~40% of training time > 80% of heart ratemax). Before and after the training period, the subjects participated in an experiment in which intra-vascular blood pressure and leg hemodynamics were measured at rest and during low, medium and high intensity one-leg knee-extensor exercise. The measurements were performed with and without inhibition of NO and PGs by infusion of L-NMMA and Indomethacin into the femoral artery. **Results** Training increased ( $P < 0.05$ )  $VO_{2max}$  by ~10% in both groups and decreased ( $P < 0.05$ ) mean arterial pressure by 7 mmHg in the hypertensive group only. The reduction in blood pressure was present both at rest and during all exercise intensities. Blocking the NO/PG system fully reversed the training induced reduction in resting and exercising blood pressure. **Discussion** The finding of a reduction in blood pressure in individuals with essential hypertension highlights that high intensity interval training is an efficient non-pharmacological intervention. The finding of full reversal of the blood pressure reduction by NO and PG blockade strongly indicates that one or both of these systems is up regulated with training in hypertensive subjects and contribute to the training-induced reduction in blood pressure. **Funding:** Danish Medical Research Council

## THE EFFECT OF CIRCUIT TRAINING ON RESTING HEART RATE VARIABILITY, CARDIOVASCULAR DISEASE RISK FACTORS AND FITNESS IN HEALTHY UNTRAINED ADULTS

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**THE EFFECT OF CIRCUIT TRAINING ON HEART RATE VARIABILITY, CARDIOVASCULAR DISEASE RISK FACTORS AND FITNESS IN HEALTHY UNTRAINED ADULTS** Vrachimis, A.1,2, Hadjicharalambous, M.2, Tyler, C.1 1: Roehampton University (London, UK), 2: University of Nicosia (Cyprus) **Introduction** Heart rate variability (HRV) is a clinical predictor of cardiovascular disease (CVD) morbidity and mortality (e.g. Tsuji et al., 1994). Studies have shown that aerobic training has a positive effect on resting HRV (e.g. Lee et al., 2003); however, not much is known about the effect of circuit training (CT) on resting HRV. The main purpose of this study was to examine whether CT has a positive effect on resting HRV. The secondary purpose was to investigate the effect of CT on other CVD risk factors and several fitness components. **Methods** Twelve healthy untrained adults (mean (SD) age 23.3 (3.2) years, height 166.9 (8.4) cm, weight 67.6 (16.7) kg) performed 12 bodyweight exercises in a circuit format, 3 d/wk for 6 weeks. In weeks 1 and 2, 3 and 4, and 5 and 6 they had to complete 1, 2, and 3 circuits per session respectively. In weeks 1, 3 and 5 and weeks 2, 4 and 6 the objective was to complete 15 and 20 repetitions respectively for each exercise. Pre and post intervention time- and frequency-domain, and non-linear methods of resting HRV and blood pressure (Systolic: SBP; Diastolic: DBP) were measured. The time-domain measures were heart rate, SD of the RR intervals, number and proportion of adjacent RR intervals more than 50 ms different. The frequency-domain measures were very low, low (LF), and high (HF) frequency power, LF and HF in normalised units, and the ratio of LF to HF. The non-linear measures were the SD calculated on the vertical axis (SD1) and on the horizontal axis (SD2) of the Poincare plot, and the ratio of SD1 to SD2. In addition, body composition, blood lipids, glucose,  $VO_{2max}$ , upper body and abdominal and hip flexor muscular endurance, back and handgrip strength were assessed. Data were analysed using paired t-tests. **Results** There was no effect of CT on any of the measures of resting HRV (all  $P > 0.05$ ). SBP ( $P = 0.04$ ) and DBP ( $P = 0.03$ ) decreased, lean body weight ( $P = 0.03$ ) increased, whereas the other CVD risk factors did not change after CT. Upper body muscular endurance ( $P < 0.001$ ) and back strength ( $P = 0.02$ ) increased, while the rest of the fitness components were not affected. Blood lipids (total cholesterol, lipoproteins, triglycerides) and glucose did not change with CT. **Discussion** The present study suggests that CT involving bodyweight exercises has no effect on resting HRV. These results are concordant with the findings of Liu (2010). However, this type of training may decrease the risk for development of CVD by reducing arterial blood pressure as well as by enhancing muscular strength and endurance. **References** Lee et al. (2003). *Med Sci Sports Exerc*, 35(6), 961-969. Liu (2010). *J Beijing Sport Uni*, 33(4), 52-55. Tsuji et al. (1994). *Circulation*, 90, 878-883.

## PHYSICAL ACTIVITY STATUS AND OXIDISED LOW-DENSITY LIPOPROTEIN CONCENTRATIONS IN OLDER ADULTS

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**Introduction** Although oxidised low-density lipoprotein (LDL), a risk marker for cardiovascular disease (Itabe and Ueda, 2007), increases with age (Cakotay et al., 2008), regular physical activity ameliorates oxidative stress and prevents the accumulation of lipids (Li, 1993). However, it remains unclear whether oxidised LDL concentrations differ with physical activity status in older adults. The purpose of this study was to examine the relationship between the amount of physical activity and oxidised LDL concentrations in older adults. **Methods** A total of 27 older adults (aged  $69.9 \pm 0.8$  years, mean  $\pm$  SEM; 16 females and 11 males) were analysed in a cross-sectional design. Prior to the blood collection, participants were asked to wear an uniaxial accelerometer for 4 consecutive weeks for the determination of physical activity status. After a 48-h period of physical activity avoidance and a 10-h overnight fast, fasting venous blood samples were obtained from each participant. **Results** The amount of moderate to vigorous physical activity determined by the accelerometer was  $173.2 \pm 14.6$  min/week (range; 62.6–312.9 min/week). Fasting plasma oxidised LDL concentrations and plasma monocyte chemoattractant protein-1 concentrations were negatively correlated with the amount of physical activity ( $r = -0.409$ ,  $P = 0.034$ ;  $r = -0.385$ ,  $P = 0.047$ , respectively). The amount of physical activity was significantly correlated with fasting serum triacylglycerol ( $r = -0.415$ ,  $P = 0.031$ ), fasting serum high-density lipoprotein cholesterol ( $r = 0.405$ ,  $P = 0.036$ ) or fasting plasma insulin ( $r = -0.482$ ,  $P = 0.011$ ) concentrations. **Discussion** The present study is the first to examine the relationship between the amount of physical activity and oxidised LDL concentrations in older adults. We demonstrated that lower concentrations of oxidised LDL were associated with higher amount of physical activity in older adults. These findings indicated that the oxidative modification of LDL may be prevented through regular physical activity. Therefore, our

findings may imply that being physically active is important to reduce the potential risk of atherosclerotic cardiovascular disease in older adults if they can maintain such status through daily life. It would be interesting to investigate whether physical activity interventions can be used to slow the progression of atherosclerosis in older adults. Reference Cakalay U, Kayali R, Uzun H. (2008). Clin Exp Med, 8, 51-57. Itabe H, Ueda M. (2007). J Atheroscler Thromb, 14, 1-11. Li LJ. (1993). Med Sci Sports Exerc, 25, 225-231.

### COMBINED IMPACT OF HEALTH BEHAVIOURS ON CARDIOVASCULAR RISK IN CHILDREN: A RANDOMIZED PROSPECTIVE STUDY

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**Introduction** Factors of negative health behaviour are known to be associated with increased cardiovascular risk in children, but their combined impact on a general population of children is not well documented. We aimed therefore to quantify the combined impact of easily assessable health behaviours in randomly selected children on their cardiovascular risk four years later. **Methods** 502/540 randomly selected 6- to 13-year-old Swiss children took part in a baseline health assessment and 232 (64%) of those participated again in the same assessment four years later which included anthropometry, fasting blood samples and a health behaviour questionnaire. A cardiovascular risk score was built by averaging sex- and age-related z-scores of waist circumference, blood pressure, glucose, inverted high density lipoprotein and triglycerides. Participants scored one point for each negative health behaviour: a BMI above the 85th percentile (IOTF), less than 60 min of moderate-vigorous physical activity per day, media use of more than 120 min daily, smoking and/or overweight parents. **Results** After four years of follow up, the age-, sex-, and social class-adjusted odds ratios (95% CI) for having an unfavourable cardiovascular risk score (highest tertile of age- and sex-adjusted z-scores) for children who had no or one (n=91) compared to two (n=77), three (n=39) or three and more (n=54) risk behaviours were respectively 1.44 (0.73 to 2.85, p=ns), 2.27 (1.02 to 5.08, p=0.046) and 2.59 (1.24 to 5.40, p=0.011). **Discussion** Three or more negative health behaviours combined predicted a 2.6-fold higher risk of having an unfavourable cardiovascular risk score four years later. Thus, already in childhood, an accumulation of negative health behaviours is associated with a higher cardiovascular risk four years later in life which underlines the urge of early prevention.

### SARCOPENIC OBESITY AND PHYSICAL FITNESS IN ELDERLY PEOPLE

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**Sarcopenic obesity and physical fitness in elderly people** Gómez-Cabello A1, Pedrero-Chamizo R2, Delgado S3, Hernandez R4, Juez-Bengochea A5, Mata E6, Cañada D2, Aznar S7, Villa G5, Espino L5, Gusi N3, Gonzalez-Gross M2, Vicente-Rodríguez G1, Casajús JA1, Ara I1,6 1 GENUD Research Group, University of Zaragoza, Spain 2 Department of Health and Human Performance, Universidad Politécnica de Madrid, Spain 3 Faculty of Sport Sciences, University of Extremadura, Spain 4 Unit of Sports Medicine, Cabildo of Gran Canaria, Spain 5 Institute of Biomedicine (IBIOMED), University of León, Spain 6 GENUD Toledo Research Group, University of Castilla La Mancha, Spain 7 PAFS Research Group, University of Castilla La Mancha, Spain **Introduction:** sarcopenic obesity (SO) is commonly defined as the presence of reduced muscle mass (sarcopenia) and increased fat mass (obesity) (1). Older adults with both sarcopenia and obesity have worse physical functioning than those with only one of these disorders; thus, both may act synergistically increasing the risk of disability. This study aimed to test whether any of the most widespread adapted physical fitness tests in this population group may be related to the risk of SO. **Material and methods:** 2859 subjects (671 men and 2188 women) aged 72.2±5.3 were evaluated in Spain within the framework of the elderly EXERNET multi-centre study. Anthropometric and body composition (Tanita BC 418-MA; Tokyo, Japan) measurements were performed in all subjects. Four SO groups were created based on the quintile scores for percentage of body fat and relative muscle mass; 1) normal, 2) high fat, 3) low muscle and 4) SO (2). Physical fitness was evaluated using eight different tests modified from the Senior Fitness Test and Eurofit Testing Batteries. Three different categories were created for each test based on the calculated scores. Age-adjusted logistic regression was applied to study the probability to have SO depending on the fitness level. **Results:** among the physical fitness tests studied, balance, lower-body strength and lower-body flexibility were associated to lower risk of suffering SO in the fittest men (highest tertile) by 65.5, 65.4 and 51.0%, respectively (95% CI [(0.180-0.660); (0.185-0.646); (0.275-0.872)]). In women, the risk of suffer SO was lowered by 56.2, 53.6 and 39.1% in those in the highest tertile of balance, lower-body strength and endurance, respectively (95% CI [(0.301-0.639); (0.330-0.652); (0.418-0.887)]). **Conclusion:** to preserve adequate physical fitness levels is of great importance to maintain a good health status and help to reduce the age-related functional decline. **References:** 1. Stenholm S et al. Curr Opin Clin Nutr Metab Care 2008; 11(6):693-700. 2. Davison KK et al. J Am Geriatr Soc 2002; 50(11):1802-9. **Acknowledgments:** supported by Ministerio de Trabajo y Asuntos Sociales (104/07), and University of Zaragoza (UZ 2008-BIO-01). AGC has received a PhD grant from Gobierno de Aragón (B059/09).

## Oral presentations

### OP-PM08 VO2max and O2 Kinetics

#### RIGHT ATRIAL PACING INCREASES MAXIMAL HEART RATE BUT DOES NOT ALTER VO2MAX OR MAXIMAL EXERCISE PERFORMANCE IN HEALTHY HUMANS

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**INTRODUCTION:** Aerobic power (VO2max) and exercise performance is limited by a plateau or decline in cardiac output (Q) during incremental and constant load maximal exercise, but the mechanisms restricting maximal Q remain unknown. The attainment of maximal heart rate (HR) could be a factor limiting Q, but the effect of increasing maximal HR has not been investigated in humans. Therefore, the purpose of this study was to investigate the effect of HR pacing on cardiac output, VO2max and exercise performance during incremental cycling to exhaustion. **METHODS:** We measured systemic (direct Fick) and peripheral (thermodilution) hemodynamics during incremental

(25, 40, 55, 70, 85, 100% of maximal workload (WLmax)) cycling to exhaustion with (pace) and without (control) atrial pacing (15-20 beats/min higher HR than control) in 7 endurance trained cyclists (28±2 years, 181±2 cm, 72±2 kg, 66±1 mlO<sub>2</sub>/min/kg). Data were analyzed by repeated measures two-way ANOVA and Tukey's honestly significant difference (HSD) post hoc procedure. RESULTS: Atrial pacing increased HR during submaximal cycling and peak HR by 16±2 beats/min (HRmax 185±1 and 201±6 beats/min in control and pace, respectively) (P<0.05). However, cardiac output and leg blood flow (LBF) increased similarly in both trials and reached the same peak Q (23.1±0.9 and 24.8±1.4 l/min in control and pace, respectively), LBF (9.7±0.1 and 9.7±0.2 l/min, respectively), VO<sub>2</sub> (4.8±0.1 and 4.7±0.1 l/min, respectively) and exercise performance time (11:33±0.01 and 11:15±0.01 min, respectively). Furthermore, there was no difference in plasma norepinephrine or epinephrine levels between conditions. In both trials, Q increased linearly until 55% of WLmax but then levelled off in parallel to a drop in stroke volume and an increase in central venous, pulmonary arterial and mean arterial pressures (P<0.05). DISCUSSION: The present results demonstrate for the first time that healthy humans can achieve a higher maximal HR during atrial pacing compared to control conditions and that this increase in HR does not alter peak cardiac output, VO<sub>2</sub>max or maximal exercise performance. Supported by Team Denmark

### CONVENTIONAL TESTING METHODS PRODUCE SUB-MAXIMAL VALUES OF MAXIMUM OXYGEN CONSUMPTION .

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Background This study used a novel protocol to test the hypothesis that a plateau in oxygen consumption (VO<sub>2</sub>max) during incremental exercise testing to exhaustion represents the maximal capacity of the cardiovascular system. Methods Twenty six subjects (23 male, 3 female, age 29.5 ± 10.0 years, body mass 73.7 ± 9.8 kg, height 177 ± 6 cm) were randomly divided into two groups matched for their initial VO<sub>2</sub>max. On separate days, the reverse group performed an incremental uphill running test (INC1) followed 15 minutes later by a verification phase test (Day 1), a decremental test (DEC) (Day 2) and a final incremental test (INCF) (Day 3). The decremental test started at 1 km.h<sup>-1</sup> higher than the maximal running speed achieved during INC1 and speed was reduced progressively throughout the test. Before the trials all participants were familiarized with both the incremental and decremental test. The control group performed incremental tests on the same 3 days that the reverse group was tested. Results All but one subject in each group reached a plateau during INC1. VO<sub>2</sub>max remained within 0.6 ml.kg<sup>-1</sup>.min<sup>-1</sup> over the trials for the control group (p = 0.93), but was 4.4% higher during DEC compared to INC1 (63.9 ± 3.8 vs. 61.2 ± 4.8 ml.kg<sup>-1</sup>.min<sup>-1</sup> respectively, p = 0.004) in the reverse group. VO<sub>2</sub>max remained significantly higher during INCF (63.6 ± 3.68 ml.kg<sup>-1</sup>.min<sup>-1</sup>, p = 0.01) in comparison to INC1 for the reverse group, despite an unchanged exercise time. The difference in VO<sub>2</sub>max between INC1 and DEC was on average 2.7 ± 3.2 ml.kg<sup>-1</sup>.min<sup>-1</sup> (~200 ml.min<sup>-1</sup>), 60% higher than the upper threshold for a VO<sub>2</sub> plateau during INC1 (1.7 ml.kg<sup>-1</sup>.min<sup>-1</sup>, 123 ml.min<sup>-1</sup>). The difference in VO<sub>2</sub>max was also beyond the upper limit of the typical error of measurement in VO<sub>2</sub>max calculated for the control group (1.6 ml.kg<sup>-1</sup>.min<sup>-1</sup>, 95% CI 1.3 to 2.1 ml.kg<sup>-1</sup>.min<sup>-1</sup>). The higher values in VO<sub>2</sub>max during the DEC protocol were achieved even though the participants were running at 1.9 km.h<sup>-1</sup> slower during DEC (14.3 ± 1.1 vs. 16.2 ± 0.9 km.h<sup>-1</sup> for DEC and INC1 respectively, p=0.0001). Peak ventilation rate, heart rate, breathing frequency and respiratory exchange ratio were not different between the trials for any of the groups, although peak ventilation rate in the control group fell between INC1 and INCF. Conclusion These findings disprove the concept that a plateau in oxygen consumption during an incremental exercise test represents a systemic limitation to oxygen use. The reasons for a higher VO<sub>2</sub> during the final incremental test following the decremental test remain unclear but suggest the presence of an acute adaptive response probably regulated in the central nervous system.

### LINEARITY OF V'O<sub>2</sub>-KINETICS DURING MODERATE PRBS EXERCISE TESTING

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Introduction Static and dynamic linearity can be a prerequisite for further analysis of oxygen uptake kinetics. Specifically, the combinations of on- and off-step responses which are part of the pseudo random binary sequence-testing (PRBS) rely on this assumption. However, some instances might be in contradiction to the dynamic linearity: 1. In the transition phase the venous return is influenced by the venous blood volume between exercising tissues and lungs, the perfusion rate of the exercising muscles and cardiac output (CO). As a consequence, in the whole transition respiratory V'O<sub>2</sub> (V'O<sub>2</sub>R) is a distorted version of muscular V'O<sub>2</sub> (V'O<sub>2</sub>M). A traditional used method is an exclusion of the first 20s in the transition phase, but neglects the complex interactions of the cardio-vascular parameters. 2. Differences in on- and off-step responses of V'O<sub>2</sub>M are also in contrast to the assumption of dynamic linearity. Frequently reported are asymmetries detected by monoexponential fitting for V'O<sub>2</sub>R may indicate asymmetries in V'O<sub>2</sub>M (Rossiter et al., 2002). The aim of this study is to analyze the assessed V'O<sub>2</sub>R for linearity. Methods 17 volunteers (age: 28 ± 6 years; height: 174 ± 8 cm; weight: 71 ± 12 kg; V'O<sub>2</sub>peak: 3.8 ± 1.0 l•min<sup>-1</sup>) were subjected to two moderate PRBS workload (WL) changes (min: 30 W, max: 80 W, mean: 53.3 W; duration per sequence: 300s), 2 constant WL phases (30 W, 80 W, 200s). Gas exchange was assessed breath-by-breath (ZAN 680, ZAN Messgeräte, Oberthulba, Germany). Averages for 30 W and 80 W, respectively, were calculated from the last 30s of the constant phases for each subject. Expected V'O<sub>2</sub> (V'O<sub>2</sub>(53.3W)) for 53.3 W were interpolated and compared with the averages of the two PRBS separately (V'O<sub>2</sub>(PRBS1), V'O<sub>2</sub>(PRBS2)). ANOVA for repeated measurements was applied. Results V'O<sub>2</sub>(PRBS1) was calculated as 1.087 ± 0.129 l•min<sup>-1</sup>, V'O<sub>2</sub>(PRBS2) as 1.097 ± 0.125 l•min<sup>-1</sup> and V'O<sub>2</sub>(53.3W) as 1.094 ± 0.127 l•min<sup>-1</sup>. ANOVA showed no significant differences (p>0.05; n=17). Discussion The results are in line with the assumptions of static linearity of V'O<sub>2</sub>R. This is in contradiction to reported on-off asymmetries for V'O<sub>2</sub>R. If on-kinetics faster than off-kinetics this would result in higher averages in the PRBS intervals. The influence from CO dynamics and invalidity of monoexponential fitting can explain this result. For further analysis a two compartment model representing the exercising and non-exercising part of the body, considering the cardio dynamic influences, can be applied to estimate V'O<sub>2</sub>M assuming dynamic and static linearity in the transition phases. The study was funded by the DLR (Deutsches Zentrum für Luft- und Raumfahrt), Germany (FKZ 50WB0726). References Rossiter, HB, Ward, SA, Kowalchuk, JM, Howe, FA, Griffiths, JR and Whipp, BJ (2002). J Physiol., 541.3: 991-1002.



**RAT MODELS SELECTIVELY BRED TO DIFFER FOR MAXIMAL AEROBIC CAPACITY DIVIDE FOR AGING AND LONGEVITY**

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Rationale: Low aerobic exercise capacity is a powerful predictor of premature morbidity and mortality. For aged populations, poor performance on treadmill or extended walking tests indicates closer proximity to future health declines. The underlying mechanisms connecting aerobic capacity to survivability, however, are difficult to explore in humans. Objectives: To develop an animal model system that: a) prospectively tests whether aerobic energy capacity associates with complex disease and longevity (aerobic hypothesis) and b) can serve as a more accurate experimental representation for translational studies (1). Methods: Laboratory rats of widely diverse genetic backgrounds (N:NIH stock) were selectively bred across 20 generations (n=7,342 rats) for low or high intrinsic (inborn) treadmill running capacity (2). Cohorts of male and female rats derived from generations 14, 15 and 17 were followed for survivability and evaluated for age-related declines in cardiovascular fitness including maximal oxygen uptake (VO<sub>2</sub>max), myocardial function, endurance performance, and change in body mass. Results: Median lifespan for high exercise capacity rats was 28-45% longer than low capacity rats (hazard ratio, 0.06; P<.001). VO<sub>2</sub>max, measured across adulthood was a reliable predictor of lifespan (P<.001). During progression from adult to old age, left ventricular cardiomyocyte morphology, contractility, and intracellular Ca<sup>2+</sup> handling were less compromised in rats bred for high aerobic capacity. Physical activity levels, energy expenditure (VO<sub>2</sub>), and lean body mass were all better sustained with age in rats bred for high aerobic capacity. Conclusions: These data from a contrasting rat model system provide strong evidence that genetic segregation for aerobic exercise capacity can be linked with longevity. References: (1) Wisloff U, Najjar SM, Ellingsen O, Haram PM, Swoap S, Al-Share Q, Fernstrom M, Rezaei K, Lee SJ, Koch LG, Britton SL. Cardiovascular risk factors emerge after artificial selection for low aerobic capacity. *Science*. 2005;307(5708):418-420. (2) Koch LG, Britton SL. Artificial selection for intrinsic aerobic endurance running capacity in rats. *Physiol Genomics*. 2001;5(1):45-52.

**HEART RATE AND OXYGEN UPTAKE KINETICS DURING INTERMITTENT APNEIC EXERCISE**

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Introduction: Underwater hockey is a sport which is performed by repeated apneic swimming. Such combination of apnea and intermittent exercise may pose specific regulatory demands on oxygen delivery and uptake. Therefore we investigated the effects of repeated apneas on heart rate response patterns and oxygen uptake kinetics during intermittent exercise while increasing power output. Methods: 8 elite male underwater hockey players (VO<sub>2</sub>max=3.8±0.5 l/min) performed five dry apneas. The first apnea was performed at rest, and then four apneas were performed while exercising on a bicycle ergometer. Power output was increased from 25 W to 175 W by 50 W increments for each apneic exercise section which lasted 45 s. Recovery between the apneic exercises lasted two minutes. The athletes were connected to a spiro-ergometer (ZANR) and heart rate was collected on a beat to beat basis by telemetric device (Polar S810iR). Results: Two basic response patterns for heart rate were observed during apneic exercise. Either a monotonic heart rate decrease developed during the entire exercise, or a heart rate increase in the beginning changed to a bradycardia towards the end of the exercise (biphasic response pattern). The increase of power output elevated heart rate during the entire exercise and prolonged the tachycardia, but did not affect the basic response pattern. The total number of heart beats during the apneas increased only slightly (rest 61 beats, 25W 73 beats, 75W 76 beats, 125W 77 beats, and 175W 78 beats). Heart rate and oxygen uptake were elevated during the first minute of the recovery period and returned to baseline levels in the second minute. These post-exercise increases in heart rate and oxygen uptake were correlated positively with power output of the prior apneic exercise. Discussion: During apneic exercise the physiological conflict between "exercise-tachycardia" and "apnea-bradycardia" is predominantly solved in favor of the oxygen conserving heart rate decrease. But increase of power output counteracts this mechanism by an individually varying degree. During the recovery period after the apneic exercise, oxygen delivery and uptake increases in order to match prior metabolic costs.

**PRECONDITIONING EFFECT OF REPEATED EXERCISE BOUTS ON O<sub>2</sub> UPTAKE KINETICS**

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Introduction Short distance repetition of equal intensity bouts of aerobic exercise generally does not change the physiological response by time or fatigue factors. It has been demonstrated, however, that a short bout of heavy exercise may speed up oxygen consumption kinetics (V'O<sub>2</sub>kin) at the onset of a second aerobic exercise (preconditioning effect, PE). PE is effective only for high intensity exercise in young physically fit subjects, while it works also for moderate intensity exercise in elderly individuals. We speculated that if PE effectiveness is somehow inversely related to fitness, even a bout of moderate intensity exercise might exert a PE in individuals with different kinds of pathologies. Methods We reviewed the results of 119 subjects who performed two bouts of 6 min cycle ergometer exercise, separated by 6 min sitting rest, while connected to a metabolimeter for breath by breath recording of respiratory variables. The subjects pedaled at 60-70 strokes/min against a load below the individual first ventilatory threshold previously determined. The subjects were subdivided in 5 groups: 40 healthy young controls (HYS, 26±5yy, 173±8cm, 69±11kg), 27 Chronic Heart Failure (CHF, 66±6yy, 172±7cm, 77±12kg), 12 Type 2 Diabetic (DM2, 58±6yy, 169±10cm, 77±12kg), 15 medically treated hypertensive (HYP, 68±5yy, 171±4cm, 78±9kg), 25 healthy elderly (HES, 66±5yy, 171±8cm, 79±9Kg). Bxb oxygen values (V'O<sub>2</sub>bxb) were used to calculate oxygen deficit (defO<sub>2</sub>) as the difference between theoretical and real V'O<sub>2</sub> (defO<sub>2</sub>=(mean steady state V'O<sub>2</sub>\*360s - 1Σ360V'O<sub>2</sub>bxb)). The mean response time (MRT, in seconds) was calculated as the ratio between defO<sub>2</sub> and V'O<sub>2</sub>ss. The same method was applied to bxb V'CO<sub>2</sub>, Tidal Volume VT, and Ventilation VE. Results Data are presented as mean±SD. Two way ANOVA was used to detect significant differences among groups and between the first and the second trial of each group (P<0.05). We did not find statistically significant differences in MRT of any variable in HYS, DM2, HYP, or HES, either on the first or on the second trial. The CHF group, to the contrary, in the first trial had MRTV'O<sub>2</sub> (44.4 ± 11.3) significantly slower than that of the other groups (HYS 29.1 ± 13.1; DM2 29.3 ± 12.7; HES 25.9 ± 14.8; HYP 18.5 ± 8.4). In the second trial the CHF group showed a significant PE effect both on metabolic (MRTV'O<sub>2</sub> -11.5s, -19%; MRTV'CO<sub>2</sub> -12.2s, -16%) and on ventilatory (MRTVT -13.3s -39%; MRTVE -14.3s, -20%) responses. Discussion Thus, the preconditioning exercise bout does not always need to be of high intensity in order to speed up V'O<sub>2</sub>kin of the following moderate intensity exercise. This effect, however, requires a reduced cardiac function, indicating that the conditioning effect of a fully aerobic exercise regards oxygen transport mechanisms.

## Oral presentations

### OP-PM12 Training and Testing: Team Sports

#### USE OF SESSION-RPE FOR THE EVALUATION OF THE YOUTH WATER POLO TRAINING LOAD

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**Introduction** The assessment of internal training load (TL) using Borg's Category Ratio-10 (CR-10) RPE scale as a measure of exercise intensity has been demonstrated to provide valuable information (Foster, 2001), also in team sports with both adult and young players (Impellizzeri et al., 2004). Nevertheless, no studies investigated the use of this method during water polo trainings. Thus, the aim of this study was to evaluate youth water polo trainings, showing the correspondent level of reliability of session-RPE method. **Methods** Ten male youth water polo players (age=15.6±0.5 yrs; height=179.6±5.9 cm; weight=72.7±7.8 kg) took part in the study. Session-RPE (CR-10 Borg scale), heart rate (HR) monitor (Polar Team System) and duration were recorded for 60 individuals training sessions. The TL for each session was calculated multiplying the training duration in minutes by the mean training intensity (RPE score). The HR-based method proposed by Edwards (1993) for determining internal TL was used as criterion measure of internal TL in this study. An exercise score for each training unit was calculated by multiplying the accumulated duration in each HR zone by a coefficient allocated to each zone (50-60%HRmax=1, 60-70%HRmax=2, 70-80%HRmax=3, 80-90%HRmax=4, and 90-100%HRmax=5) and then summing the results. Individuals HRmax were calculated with the formula  $(220 - \text{age})$ . Pearson's correlation coefficient and Cohen's effect size (ES) was used to evaluate the relationship between the HR-based method and session-RPE scores. **Results** The HR frequency was meanly reported as follows: <50%HRmax=6±9%, 50-60%HRmax=24±17%, 60-70%HRmax=31±12%, 70-80%HRmax=28±14%, 80-90%HRmax=10±13%, 90-100%HRmax=1±3%. Correlations between the HR-based method and session-RPE scores were statistically significant (from  $r=0.46$  to  $r=0.65$ ,  $p<0.0001$ ,  $ES=0.6$ ). **Discussion** According to Impellizzeri et al. (2004), the present results confirmed the satisfactory correlation between the HR-based method and session-RPE scores, highlighting the latter as an easy and reliable method to evaluate the training load in youth water polo. **References** Foster C, Florhaug JA, Gottschall L, Hrovatin LA, Parker S, Doleshal P, Dodge C (2001), J. Strength Cond Res, 15(1), 109-115. Impellizzeri FM, Rampinini E, Coutts AJ, Sassi A, Martora SM (2004), Med Sci Sports Exerc, 36(6):1042-7. Edwards S. (1993) Sacramento: Fleet Feet Press, 113-123.

#### PHYSICAL DEMANDS IN MALE ELITE TEAM HANDBALL

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The present study examined the physical demands placed on male elite Team Handball (TH) players in relation to playing position. Male elite TH were closely observed and monitored over a six season time span. Each player (wing players: WP, circle runners: CR, backs: B) was evaluated during match play by use of video recording and subsequent time-motion and technical analysis. In addition, physiological measurements during match play, physical testing and anthropometric measurements were carried out. The mean body height (BH), body mass (BM) and age in best the Danish male Handball League in total were 189.6±5.8 cm, 91.7±7.5 kg and 26.1±3.9 years, respectively. VO2-max was in average 5.0±0.7 l O2/min corresponding to 55.2±4.1 ml O2/min/kg. The mean total running distance in the Yo-Yo intermittent recovery test (level 2, IR-2 test) was 895±184 m. The hardest shot was the set shot with three steps run-up (in average 92.8±5.3 km/hour). The mean total distance covered (TDC) per match was 3627±568 m with a mean total effective playing time (TPT) of 53:51±5:52 min:sec, and the mean speed was 6.40±1.01 km/hour. High intensity work (HIW) only constituted 1.7±0.9 % of TPT per match corresponding to 7.9±4.9 % of TDC. A game consisted in average of 1782±313 activity changes with an average of 53±14 high intensity runs per match. The amount of HIW was lower ( $p<0.05$ ) in the second half (130.4±77.2 m) than in the first half (155.3±92.6 m) corresponding to a mean decrease of 16.0 %. The players made in average in attack 6.0±5.2 fast breaks, received 34.5±24.7 checkings in total and gave 5.8±3.6 hard checkings and did 3.7±3.5 blocks and 3.9±3.0 claspings in the defence. The mean relative work load during match play was 70.9±6.0 % of VO2-max. Mean post match blood lactate concentration was 4.8±1.9 mM (range: 2.8 to 10.8 mM). The mean weight loss was 0.8±0.4 kg pr. match. WP had less BH and BM (184.9±5.7 cm, 84.5±5.8 kg,  $p<0.001$ ) compared to B (191.9±5.4 cm, 94.7±7.1 kg) and especially CR (194.8±3.6 cm, 99.4±6.2 kg). In the IR-2 test, WP (975±123 m) ran longer ( $p<0.05$ ) than B (897±108 m) and CR (827±264 m). Both B (3765±532 m) and WP (3641±601 m) performed a greater ( $p<0.05$ ) TDC per match than CR (3295±495 m). In addition, WP performed more HIW (10.9±5.7 % of TDC) than both CR (8.5±4.3 %,  $p<0.05$ ) and B (6.2±3.2 %,  $p<0.01$ ). Both in offence and in defence, WP received and gave less checkings in total per match (14.9±3.7, 19.5±8.9) than both B (29.8±16.1, 31.2±12.2,  $p<0.05$ ) and especially CR (70.5±23.7,  $p<0.001$ , 40.3±14.4,  $p<0.01$ ). In conclusion, male elite TH is a physically demanding intermittent game, which in particular places high demands on the anaerobic and to a lesser extent on the aerobic muscle energy production. There were indications that temporary fatigue may occur. Physical demands differed between playing positions, and anthropometry seems to have a vital influence on the playing performance on the various playing positions.

#### CHANGES IN BODY COMPOSITION AND ENERGY EXPENDITURE OVER THE SEASON IN ELITE JUNIOR BASKETBALL PLAYERS: IS THERE A LINK?

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**Introduction** The effect of an entire season in energy expenditure, specifically at rest (REE), may be determined by changes that occur in body composition. Therefore, the purpose of this study was twofold: to compare changes in body composition, REE, and total energy expenditure (TEE) over a season and to examine the contribution of changes in total and regional fat (FM) and fat-free mass (FFM) on REE in junior elite basketball players. **Methods** At the beginning of the pre-season and at the end of the competitive period, measures of total and regional FM, FFM, lean-soft tissue (LST), and bone mineral content (BMC) estimated by dual-energy x-ray absorptiometry and REE by indirect calorimetry were obtained in 8 males (Height: 1.75±0.05m; Weight: 77.7±6.6kg; %FM: 12.7±1.7%) and 10 females (Height: 1.94±0.05m; Weight: 63.5±7.2kg; %FM: 23.0±3.2%) of the Portuguese basketball team (16-17 yrs). Using doubly labeled water, TEE was assessed in a subsample of 5 males and 5 females. Activity energy expenditure (AEE) was calculated as the difference between TEE and REE while physical activity level (PAL) was determined as the ratio between TEE to REE. Changes were expressed as a percentage from the baseline values. **Results** Throughout the season, REE and TEE increased by 15.3±15.2% ( $p=0.001$ ) and by 13.1±12.5% ( $p=0.008$ ), respective-

ly, while no significant changes ( $p>0.05$ ) were observed in AEE ( $14.0\pm 25.5\%$ ) and PAL ( $-1.1\pm 17.1\%$ ). Increases in FFM were observed ( $5.1\pm 4.8\%$ ,  $p<0.001$ ) but no significant changes were found in FM ( $-1.0\pm 7.8\%$ ). A raise ( $p<0.001$ ) in total BMC ( $5.1\pm 4.8\%$ ) and regional LST of the arms ( $7.2\pm 6.5\%$ ), legs ( $4.2\pm 3.9\%$ ), and trunk ( $3.6\pm 3.5\%$ ) was observed while no changes ( $p>0.05$ ) were found for regional fat mass (arms:  $-3.9\pm 12.3\%$ ; legs:  $-1.8\pm 10.4\%$ ; trunk:  $1.0\pm 12.8\%$ ). The REE to FFM ratio significantly increased by  $11.1\pm 13.7\%$  ( $p=0.003$ ). Using multiple regression analysis, FFM changes explained 22.3% of the total variance in REE alteration ( $\beta=3.257$ ;  $p=0.049$ ), controlling for the effect of gender. From the remaining body composition variables, only legs LST variation explained 24.5% of the changes observed in REE ( $\beta=1.939$ ;  $p=0.044$ ), after adjusting for gender. Discussion Over the season, TEE, REE, and a higher resting metabolic rate per FFM units were observed and, as expected, the raise in REE was explained by an increase in FFM. Furthermore, these findings highlight the contribution of appendicular LST, specifically located at the lower limbs area, as a key component for the higher REE occurred over the season in elite junior basketball players.

### REACTIVE STRENGTH VS POWER: THE BEST PREDICTOR OF SPEED IN ELITE U'20 SUPER LEAGUE RUGBY PLAYERS?

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Introduction There is a paucity of research that as investigated what strength characteristics best transfer to the high intensity sprint movements performed by elite rugby-league players (Baker & Nance, 1999; Cronin & Hansen, 2005; Harris et al., 2008). Therefore, the aim of this study was to identify relationships between reactive strength and power and measures of speed, change of direction (COD) ability and reactive agility in elite rugby-league players. Method Sixteen Super League rugby-league players (age,  $19.7 \pm 0.8$  years, weight  $88.5 \pm 12.0$  kg, height  $177.3 \pm 6.1$  m) participated in the study. Tests included: sprint time (5-m, 10-m, 20-m and 30-m); COD ability (L-run); reactive agility (cut test); loaded (25 and 50% body weight) and unloaded vertical jump (VJ); squat jump (SJ) and reactive strength via a vertical rebound jump (10 to 5 repeated jump test) performed over a series of 10 repetitions with ground contact time of less than 0.25s. All tests were measured using Smart-speed/jump (Fusion Sport, Australia). Results The 5-m, 10-m, 20-m and 30-m sprint times were all significantly correlated ( $r=0.80$  to  $0.95$ ). Significant relationships ( $r=-0.54$ ) were found with 5-m speed and unloaded VJ height. In addition a significant relationship ( $r=-0.54$ ) was found between 30-m speed and loaded VJ (50%BW). The reactive agility (cut test) time had a significant relationship with SJ height ( $r=0.58$ ). The single best predictor of change of direction speed was SJ height ( $r=-0.75$ ). Squat jump height had significant relationships with all VJ heights ( $r=0.69$  to  $0.87$ ). Reactive strength had moderate to large relationships ( $r=-0.34$  to  $-0.51$ ) with all sprint measures and a large relationship with COD speed ( $r=-0.49$ ). Discussion Reactive strength had moderate to large relationships with all sprint distances, accounting for up to 26% of sprint performance. The lack of relationship between reactive strength and sprint performance however is not surprising. The running mechanics of rugby league players is characterised by a more slouched upper body posture with significant forward lean. Interestingly, it was the measures of concentric only (SJ) performance that resulted in the highest correlations with all speed measures. References Baker, D. G. & Nance, S. (1999). The relation between running speed and measures of strength and power in professional rugby league players. *Journal of Strength & Cond. Res.* 13, (3), 187-304. Cronin, J. B. & Hansen, K. R. (2005). Strength and power predictors of sports speed. *Journal of Strength Cond. Res.* 19, (2), 349-357. Harris, K.N., Cronin, J.B., Hopkins, W.G. & Hansen, K.T. (2008). Relationship between sprint times and the strength/power outputs of a machine squat jump. *Journal of Strength Cond. Res.* 22, (3), 691-698.

### THE COMPARISON OF SOME ANTHROPOMETRIC, MOTOR AND PHYSICAL FITNESS FEATURES OF IRAN AND PAKISTAN NATIONAL KARATE PLAYERS

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The purpose of this research is the definition and the comparison of some anthropometric and the motor and physical fitness features of Iran and Pakistan National karate players. The statistic community of this research consists of the karate players who were invited in Iran and Pakistan National teams. Statistic samples of this research are 20 people which consist of 10 karate players who have invited in national team, and 10 karate players from Pakistan national team who took part voluntarily in this research at the same condition. Anthropometric variables of this research follow as; age, weight, size, hand length. lower part of the body, percent fat, body fat level, body net weight (with no fat), BMI, and motor fitness variables are; agility (live lines) SEMO, 4\*9 meter running, long jump, high jump, reaction, 45 meter speed running, balance, sit-up. Undoubtedly, other variables like, the age of starting activity, back ground in activity and being in a national team was compared, too. In analyzing data, with explaining team, a separate T statistical method made by using of SPSS software in a meaningful level ( $P<0/05$ ). According to the results, there is a meaningful difference in variables like, the age of starting activity, the background in membership, players age, percent fat, reaction and sit-up. of course, there was not a meaningful difference in other variables such as background in activity. Weight, size, the lower part of the body, hand length, fat level, body net weight, BMI, agility with both test, 45 meter speed running, balance, long jump and high jump. According to these results, in contrast with anthropometric and motor fitness of Iranian and Pakistani karate players. There is a difference in some variables, and Iranian karateists were in an appropriate level than Pakistani karateists in some variables. It can be possible reason for difference in world classification of these two teams.

## Oral presentations

### OP-PM52 Science and Soccer

#### AEROBIC FITNESS AND PHYSIOLOGICAL PROFILE OF TRAINING AND MATCH PLAY IN 100 VETERAN FOOTBALL PLAYERS

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Introduction Several recent studies reported positive health and fitness effects of playing football in different populations (Krustrup et al., 2010). Most studies were well-controlled with regular supervised training. To date, scientific data with regard to fitness and health status

in subjects playing lifelong football in a real life setting are scarce. The present analysis aimed at describing the aerobic fitness as well as training and match play characteristics in veteran football players. Methods 100 veteran football players aged between 40 and 63 ( $47 \pm 5$ ) yrs underwent a complete medical check up incl. training history and a graded cycle ergometer test to determine maximal power output (Pmax) and peak oxygen uptake (VO<sub>2</sub>peak). In addition, a multi-stage graded field test was carried out to determine endurance capacity (maximal lactate steady state, MLSS (Stegmann et al., 1981) and maximal running velocity). In 54 players, heart rate (HR) and blood lactate concentrations (bLa) were collected during typical training sessions (90 min) and match play (70 min). Results Subjects played football for an average of  $36 \pm 8$  yrs. Training was scheduled on average one time per week and mean match frequency was  $27 \pm 8$  matches per year. Pmax was  $2.8 \pm 0.6$  W/kg and VO<sub>2</sub>peak  $40.1 \pm 7.3$  ml/(min\*kg). Field testing revealed a mean running velocity at MLSS of  $10.6 \pm 1.3$  km/h and at maximum of  $14.5 \pm 1.6$  km/h. Maximal HR and bLa were  $181 \pm 9$  min<sup>-1</sup> and  $11.3 \pm 2.3$  mmol/l. HR during training was  $144 \pm 13$  (80% HRmax) on average and  $177 \pm 13$  min<sup>-1</sup> at peak (98% HRmax). During competition mean and maximal HR were  $140 \pm 16$  (77% HRmax) and  $180 \pm 13$  min<sup>-1</sup> (99% HRmax). Maximal and average bLa during training were  $5.7 \pm 2.6$  mmol/l and  $4.8 \pm 2.2$  mmol/l and during competition  $6.0 \pm 2.5$  mmol/l and  $4.8 \pm 2.1$  mmol/l, respectively. Intensity was above 80% HRmax for about 43% of playing time. There were no significant differences between training and matches for HR and bLa recordings ( $p > 0.28$ ). Discussion Aerobic fitness of German veteran soccer players is comparable to untrained young men and better than in the general population. Intensity in training and matches was slightly lower than recently reported in middle-aged men (Randers et al., 2010). Nonetheless, playing football regularly for a long time in a real life setting seems to induce beneficial fitness adaptations. References Krstrup P, Dvorak J, Junge A, et al. (2010) Scand J Med Sci Sports, 20 (Suppl 1), 132-135. Randers MB, Nybo L, Petersen J, et al. (2010) Scand J Med Sci Sports, 20 (Suppl 1), 14-23. Stegmann H, Kindermann W, Schnabel A. (1981) Int J Sports Med, 2, 160-165. supported by the German Football Association (Deutscher Fußball-Bund; DFB)

### MUSCULAR STRENGTH IMBALANCE INFLUENCES FATIGUE AFTER SOCCER SPECIFIC INTERMITTENT PROTOCOL

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Introduction Epidemiological studies have suggested that muscular strength imbalance and fatigue might increase the susceptibility of a player to injury, especially during the last quarter of the match (Croisier et al., 2008). This study aimed to investigate the muscular strength imbalance dependence of the effect of fatigue induced by an exhaustive laboratory-based soccer-specific exercise on conventional (Hcon:Qcon) and functional (Hecc:Qcon) ratios of soccer players. Methods Nineteen male professional soccer players were assigned to two groups: players with (UNBG - N=8, age:  $23.2 \pm 3.8$  years, VO<sub>2</sub>max:  $55.2 \pm 3.5$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) and without muscular imbalance (BG - N=11, age:  $23.1 \pm 3.1$  years, VO<sub>2</sub>max:  $54.9 \pm 3.7$  ml.kg<sup>-1</sup>.min<sup>-1</sup>). The players were allocated into one of two groups in accordance to their personal Hcon:Qcon (BG = Hcon:Qcon > 0.60; UNBG = Hcon:Qcon < 0.60). Before (Pre) and after (Post) an exhaustive laboratory-based soccer-specific exercise (Drust et al., 2000) each player performed maximal concentric contractions for knee extensors (KEcon) and flexors (KFcon) at 60°.s<sup>-1</sup> and 180°.s<sup>-1</sup>. Furthermore, maximal eccentric contractions for knee flexors (KFecc) at 180°.s<sup>-1</sup> were assessed. Results KEcon and KFcon at 60°.s<sup>-1</sup> were significantly reduced after exercise for both groups. However, KFecc at 180°.s<sup>-1</sup> was significantly reduced only in BG. Hcon:Qcon and Hecc:Qcon were significantly reduced after exercise in BG (0.65 vs. 0.62; 1.38 vs. 1.20, respectively), but not in UNBG (0.55 vs. 0.54; 1.19 vs. 1.13, respectively). Discussion The principal original finding of this investigation was that the effect of fatigue induced by an exhaustive laboratory-based soccer-specific exercise on Hcon:Qcon and Hecc:Qcon in the dominant leg of professional soccer players is dependent on muscular strength balance. Specifically, consistent with previous studies (Delestrat et al., 2010), both Hcon:Qcon and Hecc:Qcon of BG were reduced after exercise. However, UNBG did not present reduction on Hcon:Qcon and Hecc:Qcon after exercise. Thus, epidemiologic observations of increased hamstrings strain incidence during the latter stages of match play (Hawkins et al., 2001) do not seem to be explained by further impairment of Hcon:Qcon and Hecc:Qcon after exercise in UNBG. References Croisier JL, Ganteaume S, Binet J, Genty M, Ferret JM. (2008). Am J Sports Med, 36, 1469-1475. Delestrat A, Gregory J, Cohen D. (2010). Int J Sports Med, 31, 192-197. Drust B, Reilly T, Cable NT. (2000). J Sports Sci, 8, 885-892. Hawkins RD, Hulse MA, Wilkinson C, Hodson A, Gibson M. (2001). Br J Sports Med, 35, 43-47.

### TIME MOTION ANALYSIS AND PHYSIOLOGICAL DEMANDS OF PLAYMAKER IN SEMI PROFESIONAL FEMALE HANDBALL

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Introduction Athletes' movements patterns combined with heart rate (HR) responses and sources of muscular energy are classically used to provide insight into the physiological demands of team sports (Rannou et al., 2001; Coutts et al., 2003). The aim of the research was to determine movements and physiological demands of semi professional performance playmaker during official matches in handball. Methods The analysis of movement and physiological demands of player was done using the "Suunto t6" running pack (Finland) in a official matches (n=7) of the Lithuanian female championship in 2010/2011. VO<sub>2</sub>max, HRmax, aerobic and anaerobic thresholds were determined by means of an incremental treadmill test with spirometry until exhaustion in the beginning of the season. Energy resources, EPOC, ventilation, VO<sub>2</sub>max demands were estimated on the basis of HR indices. Results The mean distance covered were  $4.96 \pm 0.68$  km, velocitymax –  $12.2$  km/h<sup>-1</sup>. The indices of HR were  $175.7 \pm 7.2$ , HRmax –  $193$  bpm, EPOC –  $237 \pm 51$  ml/kg<sup>-1</sup>, ventilation  $77.8 \pm 2.3$  l/min<sup>-1</sup>; VO<sub>2</sub>max –  $44.5 \pm 5.5$  ml/kg<sup>-1</sup>.min<sup>-1</sup>. Demands of energy resources were used in such a way: under aerobic threshold – 10.3 %, between aerobic and anaerobic threshold – 81.7 %, and over anaerobic threshold – 8 %. Discussion The mean HR of player in matches were higher as the Manchado and Platen (2008) estimated in female handball (162 beats.min<sup>-1</sup>). The HRmax of playmaker was the same as the Manchado and Platen (2008) estimated in modern handball, but the mean of VO<sub>2</sub>max less. Mean run distance during the match was less as Manchado and Platen (2008) estimated in modern handball. We conclude (Gorostiaga et al., 2006) that less distance covered, higher HR, but less VO<sub>2</sub>max, demonstrate not enough fitness of semi-professional subject and for practical needs may have good information for designing training programme. References Coutts, A., Reaburn, P., & Abt, G. (2003). Heart rate, blood lactate concentration and estimated energy expenditure in a semi-professional rugby league team during a match: A case-study. Journal of Sports Sciences, 21, 97-103. Gorostiaga, E., Granados, C., Ibanez, J., Gonzalez-Badillo, J., Izquierdo, M. (2006). Effects of an Entire Season on Physical Fitness Changes in Elite Male Handball Players. Medicine Science Sports Exercise, 38, 2, 357-366. Rannou, F., Prioux, J., Zouhal, H., Gratas-Delamarche, A., & Delamarche, P. (2001). Physiological profile of handball players. Journal of Sports Medicine and Physical Fitness, 41, 349-353. Manchado, C., Platen, P. (2008). Motion analysis and physiological demands in international women's team handball. 14th annual ECSS Congress Estoril/Portugal, July 9-12, 2009.

## A HIGH AND HOMOGENOUS LEVEL OF AEROBIC ENDURANCE IN YOUNG ELITE SOCCER PLAYERS

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JGU, MAINZ/GERMANY (1), UKT, TÜBINGEN/GERMANY(2)

**Introduction** In modern football, players on any position have to meet widespread requirements in technical, tactical, cognitive and physical condition skills. High endurance performance belongs to one of the elementary abilities. But at which point in time it is most suitable for young soccer players to improve aerobic capacity? Here we therefore investigated a large cohort of junior soccer players for differences between age groups and for intra-individual improvements of aerobic capacity over time. **Methods** We assessed the data of 832 field tests of 161 German premier division players (PDP) in the age groups U16 U17, U19 and U23. Velocity (km/h) at individual anaerobic threshold (IAT) and at 4mmol/l was determined by blood lactate measurement in an incremental running test with an increase of velocity of 2 km/h every 3min until exhaustion. Intra-individual change in the thresholds was determined for all players that were assessed in at least three consecutive seasons (n=50). **Results** Aerobic endurance measured by IAT differed over all age groups significantly ( $p=0.038$ ) between pre-season 14.0 km/h (95% CI: 14.1-14.0) to in season 14.2 km/h (95% CI: 14.3-14.2), while no significant difference ( $p=0.12$ ) was obtained for the 4mmol/l threshold between pre-season 15.5 km/h (95% CI: 15.6-15.5) to in season 15.6 km/h (95% CI: 15.7-15.6). Neither IAT nor velocity at 4mmol/l lactate differed significantly between the age groups U16, U17 and U19. Only the U23 collective showed significant differences in mean velocity on both respective thresholds by an average of 0.4 km/h compared to U16, U17 and U19 ( $p\leq 0.001$ ). However, no significant ( $p=0.56$ ) intra-individual improvements of both thresholds could be observed in the group of 50 PDP that were continuously monitored over at least 3 seasons. **Discussion** Surprisingly, our data show that between the age groups of U16, U17 and U19 no significant changes can be observed in a large cohort of PDP. The high but stable level of anaerobic capacity between the 3 younger age groups is corroborated by the finding that no intra-individual improvements of aerobic capacity could be observed. Given the data it is highly likely that the higher aerobic capacity in U23 players is based on a selection of players rather than an improvement of players over age. Longitudinal intervention or observation studies in cohorts of players younger than 15 years of age will have to clarify the aspect of how long and how effective aerobic endurance can be trained in elite soccer players. **References** Hoff J. Training and testing physical capacities for elite soccer players. *J Sports Sci.* 2005 Jun;23(6):573-82. McMillan K, Helgerud J, Grant SJ, Newell J, Wilson J, Macdonald R, Hoff J. Lactate threshold responses to a season of professional British youth soccer. *Br J Sports Med.* 2005 Jul;39(7):432-6.

## RE-EXAMINATION OF THE POST HALF-TIME REDUCTION IN SOCCER WORK-RATE

LOVELL, R.1, BARRETT, S.1, PORTAS, M.2, WESTON, M.2

THE UNIVERSITY OF HULL

**RE-EXAMINATION OF THE POST HALF-TIME REDUCTION IN SOCCER WORK-RATE** Lovell, R.1, Barrett, S.1, Portas, M.2, Weston, M.2 1:University of Hull, UK. 2:Teesside University, UK. **Introduction** Studies have shown that the work-rate of soccer players is reduced in the first 15 minutes of the 2nd half of matches (46-60 min), in comparison to the corresponding phase in the 1st half (0-15 min; Bradley et al., 2009; Weston et al., 2011a). However, 15-min pre-determined segmentation of the game is not sensitive to the intricacies of the work-rate pattern (Drust et al., 2007) and a comparison yielded only small effect sizes (Weston et al., 2011a). Furthermore, using players' physical performances in the opening 5- or 15-min of the 1st half as a criterion to make subsequent inferences of fatigue, pacing or insufficient preparation is questionable given the intensity of the game at this stage (Weston et al., 2011b). Therefore, the aim of this study was to re-examine the work-rate of soccer players immediately after a passive half-time interval (HT). **Methods** Time motion analysis data (5 Hz GPS; MinimaxX, Catapult Innovations), were collected from 20 elite youth players (Age:  $17 \pm 1$  yrs;  $VO_{2max}$ :  $61 \pm 6$  ml•kg<sup>-1</sup>•min<sup>-1</sup>) during 21 competitive league fixtures (5  $\pm$  3 matches per player). Data were included from outfield players who participated in 90 min of match-play. Physical performances were categorised into total distance, total low-speed running (LSR: 0-14.9 km•h<sup>-1</sup>) and total high-speed running (HSR; 15.0-35.0 km•h<sup>-1</sup>). These dependent variables were subsequently time averaged into pre-determined periods of 5, and 45 minutes duration and expressed in relative (m•min<sup>-1</sup>) terms to allow direct comparisons between match periods of different lengths. During the 15-min HT players were passive (seated rest). **Results** There was a large reduction in relative total distance covered (ES 1.10), LSR (ES 0.95) and HSR (ES 1.04) during the opening 5-min phase of the second half (46-50 min) when compared to the 1st half mean (0-45 min). When comparing the 51-55 and 55-60-min periods, effect sizes were smaller for relative total distance covered (ES 0.01-0.11), LSR (ES 0.04-0.05) and HSR (ES 0.01-0.19). **Discussion** Players' work-rate was markedly lower in the first 5-min after a passive HT, although this phenomenon was transient in nature. Further research is required to determine if this phenomenon is caused by insufficient physical preparation as a consequence of a passive HT, or whether players adopt a sub-conscious pacing strategy to attenuate fatiguing symptoms in the latter stages of match-play. **References** Bradley PS, Sheldon W, Wooster B, Olsen P, Boanas P, Krstrup P. (2009). *J Sports Sci*, 27(2): 159-168. Drust B, Atkinson G, Reilly T. (2007). *Sports Medicine*, 37(9): 783-805. Weston M, Batterham A, Castagna C, Portas M, Harlely J, Barnes C, Lovell R. (2011a). *Int J Sports Phys Perf*, In Press. Weston M, Drust B, Gregson W. (2011b). *J Sports Sci*, DOI: 10.1080/02640414.2010.543914

## Oral presentations

### OP-SH01 Sociology and Philosophy

## SPORTING CRIMINAL TO SPORTING CITIZEN: EMBODIED IDENTITY CHANGE AND THE REHABILITATIVE ROLE OF PHYSICAL ACTIVITY

DAY, J., SPARKES, A.C.

UNIVERSITY OF EXETER AND LIVERPOOL JOHN MOORES UNIVERSITY

**SPORTING CRIMINAL TO SPORTING CITIZEN: EMBODIED IDENTITY CHANGE AND THE REHABILITATIVE ROLE OF PHYSICAL ACTIVITY** Day, J. and Sparkes, A. C. **Introduction** Research into criminal activity has historically focused on how people have got into and stay involved in crime. Over the past thirty years interest has grown in how people get out and stay out of a criminal lifestyle and develop an adaptive pro-social identity and lifestyle. The Social Exclusion Report (2002) highlights nine key factors that influence re-offending one of which is mental and physical health. Within the Criminal Justice System there exist a range of sport and physical activity interventions designed to give people an opportunity to improve their health and well-being and facilitate their rehabilitation. A review of the literature and empirical studies indicates there is a need to develop the theoretical understanding of how these may or may not play a rehabilitative role. Some scholars

have commented that the impact of sport on crime is indirect and may work through other processes such as the development of personal and social goals (Bailey, 2005). Method A narrative research study was undertaken to examine the lived experience of people with criminal convictions that are trying to live a pro-social lifestyle. The research explored people's stories about the change process and the role played by sport and physical activity. Life history interviews were undertaken with sixteen people at different stages of change and semi-structured interviews with fourteen Criminal Justice staff. Results A narrative and thematic analysis was undertaken of the interview data. Case examples will be used to highlight seven key themes with a focus on the 'success' stories and the embodied nature of life transformation. The results aim to unpack and explore the complex relationship of identity change and the rehabilitative role of physical activity. Demonstrated are the benefits and the difficulties that may arise in making sense of how physical activity can contribute to people's attempts to 'go straight'. Discussion The implications for theorising about the rehabilitative role of sport and physical activity within the Criminal Justice System will be considered. In particular, the importance of available narratives resources to enable change, the holistic nature of identity and lifestyle change, and the benefits of considering an embodied perspective to offender rehabilitation. References The Social Exclusion Report (2002). Reducing re-offending by ex-prisoners. London. Office of the Deputy Prime Minister. Bailey, R. (2005). Evaluating the relationship between physical education, sport and social inclusion. *Educational Review*, 57, 1, 71-90.

### THE BODY AS A FOCAL POINT

HOGENOVA, A.

CHARLES UNIVERSITY

The body as a focal point Prof. PhDr. Anna Hogenová, Ph.D. Department of Philosophy Charles University Pedagogical Faculty Rettigové 4 Prague 1 11639 Our body should never be divided if we want to understand the essence of human existence, where sports also belong. The material and spiritual parts of our being should not be studied separately even if at first sight it seems quite logical and obvious. Obviousness is always an indication of that which something elemental conceals. Sporting achievement should be understood as a focal point of life's strength. This is also true for all other forms of human existence. Hence, it is necessary to describe sporting achievement as the result of the unity of physical and spiritual activity (but also passivity), which is in the form of a focal point, i.e. simplicity. The issue of the simplicity of human life is hidden within intentionality, which is the origin of the focal activity of man. This unity is best displayed through sport, but it is also the most neglected. An analytical – Cartesian approach is the most important methodological assumption even when examining the human body. This article focuses on an explanation of intentionality (mental inexistence). This phenomenon was discovered by Aristotle, later by Tomáš Akvinský and later still by Brentano. Edmund Husserl adapted Brentano's meaning of it and based his phenomenology on it. This article explains the essence of human exploit in the current functioning of the physical and spiritual parts of our being through protentionality in our flow of cogitations. From this point of view we want to familiarize the student with the body image as a basic condition of the focal understanding of human movement in sport. The body image is a background from which we derive the focal point of movement linked with physical and spiritual potential. It is a familiarization with the phenomenon of intentionality. The achievement of an athlete is always simplicity, a focal release of the athlete's whole being, where cognitivity, emotion and will, and memory cannot be separated from physical predisposition. Literature: Merleau-Ponty, M. *Fenomenologie vnímání*. Berlin: Rudolf Boehm 1966. McNamee, M. *Ethics, Dis/ability and Sports* (2009) <http://www.routledgesport.com/books/Ethics-DisAbility-and-Sports-ISBN9780415487979>

### INDIGENOUS PEOPLES GAMES: GENDER, IDENTITY AND CULTURAL DIVERSITY

ROCHA FERREIRA, M., CAMARGO, V.R.T.

UNICAMP

Indigenous games are part of the material and immaterial patrimonial richness of the continents. This paper aims to study the Brazilian Indigenous Peoples Games as a local to build up new indigenous identities for male and female and cultures diversities. In the last centuries, the contact with European invaders brought about significant changes within native societies, such as high indices of mortality as a result of epidemics, hunger, wars, displacements, confinements and slave labor. Furthermore, the pacification process and, later on, the introduction of indigenous peoples into the national states was always tumultuous, without acknowledgment of cultural diversity. The present state of cultural and linguistic revitalization is a consequence of a socio-historical process for each ethnical group in the country. Many of the traditional games were inserted into sacred ceremonies and rituals and 'forced' to be forgotten. In the last decades the processes of new indigenous movements in politics, economy, education, health and sport have affected the national picture. METHODS The data was obtained through the bibliographies and ethnographic research in the 10 editions of National Indigenous Peoples Games, 1996 – to – 2009. The organizers, the chiefs (caciques) or their local representatives, plus sports leaders and "indigenous athletes" were interviewed inside the lodgings of the games. RESULTS AND CONCLUSIONS The Indigenous Peoples Games express the growing significance worldwide of indigenous cultural politics. They are initiatives of the Intertribal Committee of Indigenous Memory and Science integrate with the Ministry of Sports, the National Indigenous Foundation (FUNAI), the State and Municipality Secretariat of Sports and other institutions. The events give opportunities for the indigenous and now indigenous peoples to exchange experiences, to fraternize, to learn how to know and respect other ethnic groups and languages, to show and to renew their culture, traditions and values, to affirm their rights, to sell their arts and crafts, to play football (male and female), to show their "differences" to white people and thus obtain acknowledgement. They represent important places for the women to build up new social roles, such as players and athletes, to affirm the women rights in front of the indigenous male and in the national society and to re-think their social role in their settlements and in the national society. REFERENCES. Dunning, E. Sport, gender and civilization. In: *Sport matters: sociological studies of sport, violence and civilization*. Routledge. London, 1999, p. 219-248. Rocha Ferreira, M.B et. al. *Jogos indígenas, realizações urbanas e construções mímicas*. Ciência e Cultura. Ano 60, n. 4, 2008. Taussig, M. *Mimesis and alterity a particular history of the senses*. New York/London: Routledge, 1993.

### DOPING IN SPAIN FROM THE PERSPECTIVE OF THE PROFESSIONAL TEAM MANAGERS OF THE FUTURE: COMPARISON BETWEEN FORMER AMATEUR VS PROFESSIONAL CYCLISTS

FREIRE, C., MORENTE-SÁNCHEZ, J., FEMIA-MARZO, P., SÁNCHEZ-MUÑOZ, C., ZABALA, M.

UNIVERSITY OF GRANADA

Introduction Events occurred in recent years such as "Operation Puerto" in 2006 or the dispossession of the Tour of France to Floyd Landis in the same year made cycling lose much of its credibility from a social point of view (1). However, perspective about cycling is different depending on who, when and where is questioned (2). The objective of this study was to know the opinion of the future Spanish profes-

sional team managers in relation to the phenomenon of doping in cycling, discriminating according to their former cyclist experience (amateur vs professional). Methods The study included a total of 87 participants involved in the course to be professional Team Manager in Cycling (highest level) during 2009 and 2010 years (all of them passed and got the license). Of the total sample, 40 students had been "Professional" cyclists and 29 were cyclists until "Amateur" category. A descriptive design was carried out using a specific questionnaire consisting in 7 free-response questions, and then answers were analyzed and categorized. Results The data obtained, in percentage, comparing the responses of professional vs amateur categories, were: 1-Words associated with doping: Cheating (75.86% vs 45%), Money (34.4% vs 45%). 2- Responsible agents of Doping: Laboratories (62.07% vs 67.15%), Coach / Manager (86.21% vs 52.50%). 3- Differences Cycling vs Other sports: Media Impact (62.07% vs 30%), Discriminatory treatment (79.31% vs 67.5%). 4-Reasons for initiation in doping: Sport achievements (58.62% vs 37.5%), Contract / money (65.52% vs 35%), External pressure (44.83% vs 47.5%). 5 - Have you been suggested to dope?: Amateur (Yes 62.1%) vs Professional (Yes 67.5%). 6 - Have you seen another person inciting/being incited?: Amateur (Yes 62.1%) vs Professional (Yes 70%). 7- Proposed solutions: Prevention at early age (58.62% vs 30%), More controls and punishment (44.83% vs 27.15%). Discussion The results of this study show the problem of doping is recognized both by amateur and professional cyclists. The amateur relates it to 'cheating' possibly motivated for getting a 'better contract', while professionals links it to 'money' being 'external pressures' towards achieving the 'sporting achievement' (1). Coaches/managers are the main responsible for the amateur, while professionals focus their attention on the laboratories. Both believe there is a discriminatory treatment by media in relation to other sports. It is claimed prevention in early ages and an increase in punishment. It would be interesting to propose similar studies in other categories and sports to make comparisons. References Waddington I, Smith A et al. (2009). *Drugs in sport. Addicted to winning?*, Routledge, London and New York. Petróczi, A.; Aidman, E. & Nepusz, T. (2008). *Capturing doping attitudes by self-report declarations and implicit assessment: a methodology study. Substance abuse treatment, prevention and policy.* 3: 9.

## Oral presentations

### OP-SH02 Sport Psychology 1

#### REFLECTION AND ATTAINED SENIOR COMPETITIVE LEVEL

JONKER, L.1, ELFERINK-GEMSER, M.T.1,2, VISSCHER, C.1,2

1: UMCG, RUG (GRONINGEN, THE NETHERLANDS), 2: HAN UNIVERSITY OF APPLIED SCIENCES (NIMEGEN, THE NETHERLANDS)

Introduction Elite youth athletes commit to extensive numbers of training hours (Ericsson et al., 1993), but what they derive from training may be even more important to reach senior elite level. The best athletes learn more efficiently and discriminate themselves on reflection (Jonker et al., 2010). Reflection is the capacity to use past knowledge to improve in the future (Cleary & Zimmerman, 2001; Ertmer & Newby, 1996). Our purpose was to longitudinally assess reflection in elite youth athletes 4 years before their transition up to the moment of transition. Methods Participants were 54 elite youth athletes. Of them, 19 attained senior international status and 35 became nationals. In the 4-year period before transition, they had between 6.5 (sd=3.6) and 10.3 (sd=2.7) years sport experience and trained between 6.5 (sd=3.2) and 17.7 (sd=10.5) hours per week. 141 measurements were obtained on a yearly basis starting 4 years before transition. Multilevel modelling was applied to observe developmental trends in reflection measured with the SRL-SRS (Toering et al., in press). The effects on reflection of senior and junior competitive level, sport training, sport experience, type of sport (team or individual) and gender were tested. A randomly assigned control group (n=14) was used to verify the model with a Wilcoxon test. For all tests,  $p < .05$  was adopted. Results In the 4-year period before transition, senior internationals had higher scores on reflection than nationals ( $t=2.870$ ,  $df=1$ ,  $p < .01$ ). The use of reflection was stable for both the senior internationals and nationals 4 years before the transition up to the moment of transition ( $t=.676$ ,  $df=1$ ,  $p > .05$ ). No other significant results were found ( $p > .05$ ). By knowing the score on reflection before transition, the senior competitive level can be predicted: senior competitive level = (reflection - 4.079) / 0.264. The control group showed that predicted scores did not differ significantly from actual scores ( $z=-1.505$ ,  $p > .05$ ) and confirmed model fit. Discussion This study shows that what elite youth athletes derive from training, for example by means of reflection, is related to the attained senior competitive level. Regardless of junior competitive level, type of sport and gender, and with similar numbers of sport training and experience, results suggest that elite youth athletes' reflection scores can assist in predicting which athletes have the best chance to reach the top. References Cleary TJ, Zimmerman BJ. (2001). *J Appl Sport Psych*, 13, 185-206 Ericsson KA, Krampe RT, Tesch-Römer C. (1993). *Psych Rev*, 100, 363-406 Ertmer PA, Newby TJ. (1996). *Instr Sci*, 24, 1-24 Jonker L, Elferink-Gemser MT, Visscher, C. (2010). *JJS*, 28, 901-908 Toering TT, Elferink-Gemser MT, Jonker L, van Heuvelen MHG, Visscher C. (in press)

#### THE QUIET EYE PERIOD AND PERFORMANCE FAILURE UNDER PRESSURE

VINE, S.J., MOORE, L., WILSON, M.R.

UNIVERSITY OF EXETER

Introduction Research has shown that the Quiet Eye (QE; Vickers, 1996) is an optimal visuomotor strategy that underlies highly skilled performance in a range of visuomotor tasks. However, the QE is susceptible to shortening under pressure, leading to reductions in accuracy (Vine & Wilson, 2010; Vine, Moore & Wilson, 2011). The aim of this study was to examine changes in the QE at the specific point of performance failure in a pressurised putting task. Methods Seventeen elite golfers (mean age = 21.23, SD = 2.63; mean handicap = 2.72, SD = 1.95) performed putts on an artificial putting green from 5 feet and were instructed to successfully hole as many balls as possible until they missed. Anxiety was manipulated by offering financial incentives and non contingent feedback, and measured before and after putting using the mental readiness form 3 (MRF-3; Krane, 1994). Gaze was recorded using an ASL mobile eye tracker. QE onset, offset and duration were calculated for the penultimate and final (missed) putts and subjected to paired sample t-tests. Results Anxiety was significantly increased as a result of the manipulation (7.4 vs. 3.0;  $t(16) = 17.65$ ,  $p < .001$ ). There were no significant differences in QE onset between the penultimate and final putt; but significantly earlier QE offset (2574 vs. 3607;  $t(16) = 2.86$ ,  $p < .05$ ) and significantly shorter QE durations (1492 vs. 2216;  $t(16) = 3.60$ ,  $p < .005$ ). Conclusions Performance failure, due to pressure, may be caused by an early QE offset leading to reduced QE durations. Performers should attempt to maintain effective QE durations at the specific point of pressure to prevent performance breakdown. References Krane, V. (1994). The mental readiness form as a measure of competitive state anxiety. *The Sport Psychologist*, 8, 189-202. Vickers, J.N. (1996). Visual control when aiming at a far target. *Journal of Experimental Psychology: Human Perception and Performance*, 2, 324-354. Vine, S.J. & Wilson, M.R. (2010). Quiet Eye Training: Effects on Learning and Performance Under

Pressure. *Journal of Applied Sport Psychology*, 22(4), 361-376. Vine, S.J., Moore, L.J. & Wilson, M.R. (2011). Quiet eye training facilitates competitive putting performance in elite golfers. *Front. Psychology*, 1:8, doi:10.3389/fpsyg.2011.00008.

### **SELF-ORIENTED PERFECTIONISM IN SPORT: A SIGN OF EVENTUAL SUCCESS OR MOTIVATIONAL VULNERABILITY?**

HILL, A.

*YORK ST JOHN UNIVERSITY*

Few athletes are equipped to cope with the physical and psychological demands of elite sport. A number of sport psychologists have suggested that perfectionism may be a hallmark characteristic of elite athletes (e.g., Anshel & Eom, 2002; Dunn, Causgrove, Dunn, & Syrotuik, 2002; Henschen, 2000). However, while a total commitment to exceptionally high standards is considered essential for high achievement (Weinberg, Burton, Yukelson, & Wiegand, 2000), some have argued that poorer psychological adjustment and negative achievement behaviours are likely to be evident in athletes who are characterised by higher levels of perfectionism (Flett & Hewitt, 2005). One particular dimension of perfectionism that has been found to have a number of positive features is self-oriented perfectionism (Hewitt & Flett, 1991). This entails a personal commitment to exceptionally high standards and intolerance of substandard performance. In a similar manner to the broader debate, the nature of self-oriented perfectionism is unclear. Empirical examination of self-oriented perfectionism outside of sport has failed to resolve this debate. Some research suggests that this dimension may lead to psychological difficulties (e.g., Blankstein, Lumley, & Crawford, 2007; Flett, Hewitt, Blankstein, Mosher, 1995; Hewitt et al., 2002), while other studies suggest that it may be a component of positive achievement striving (e.g., Bieling, Israeli & Antony 2004; Enns, Cox, & Clara, 2002; Frost, Heimberg, Holt, Mattia & Neubauer, 1993). A series of studies examined the correlates of self-oriented perfectionism amongst athletes and the manner in which athletes with higher levels of self-oriented perfectionism respond to achievement difficulties. The findings of these studies suggest that self-oriented perfectionism energises a distinct pattern of engagement that includes both high levels of commitment but also motivational vulnerability. The findings provide support for those who suggest self-oriented perfectionism is likely to be problematic for athletes (e.g., Flett & Hewitt, 2005, 2006). Self-oriented perfectionism appears to be best considered a vulnerability factor that may render athletes vulnerable to psychological and motivational problems if personal goals are thwarted.

### **BRINGING SELF-DETERMINATION THEORY AND THE REALITIES OF COACHING SOCCER TO DISADVANTAGED YOUTH CLOSER TOGETHER**

COWAN, D., TAYLOR, I.M., BAKER, J.S.

*UNIVERSITY OF THE WEST OF SCOTLAND*

**Introduction** Self-determination theory (SDT; Ryan & Deci, 2002) provides a useful framework for investigating coach behaviours and the subsequent impact on adolescents participating in sport. Nonetheless, existing research has largely employed self-report measures to assess the general motivational environment and is based on the assumption that coach behaviours advocated by self-determination theorists are easily applicable to the sport context. We aimed to extend this research by qualitatively exploring coaching behaviours in a soccer programme aimed at promoting life skills to disadvantaged youth. Specifically, we investigated the complex, real-world relationships between SDT-based coaching behaviours and whether theoretically adaptive behaviours are easily transferred to the soccer context. **Methods** The primary author immersed himself in a 13-week soccer-based educational programme for young people who are not in education, employment or training. Following this, with the second author acting as a critical friend, SDT was used to interpret data from multiple sources, such as observations, field notes, video footage, and interviews with the participants. **Results and Discussion** In some circumstances, employing autonomy supportive strategies without appropriate levels of structure may have been counterproductive because participants lacked the belief and knowledge to seize opportunities to take leadership roles, responsibility and make appropriate choices. Further, coaches who were interpersonally involved with participants, in particular those who successfully built relationships through the use of humour, were able to offset some negative consequences of controlling and theoretically maladaptive coach behaviours. Finally, the presiding authoritarian coach culture in soccer provided an obstacle to the integration of some coach behaviours advocated by self-determination theorists. Overall, this study gives new insight into the complex relationships that exist between SDT-based coaching behaviours and the influence that the soccer context may have on these relationships. **References** Ryan, R. M., & Deci, E. L. (2002). An overview of self-determination theory: An organismic-dialectical perspective. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of self-determination research* (pp. 3-33). Rochester, NY: University of Rochester.

### **IS HEART RATE VARIABILITY THE KEY TO UNDERSTANDING THE LINK BETWEEN EMOTIONS AND DECISION-MAKING IN SPORTS?**

LABORDE, S.

*GERMAN SPORT UNIVERSITY*

**Introduction:** It has become apparent that, in order to fully understand the decision-making of athletes, it is necessary to explore the option-generation process. This requires moving away from final choice as the ultimate factor. However, the emotional state of the athlete while making a decision has seldom been taken into account. The aim of this study is to fill this gap. More specifically, we seek to understand the influence of emotions on the option-generation process of athletes. This approach takes into account both subjective and physiological components of emotions. **Methods:** Ninety handball players (30 non-experts, 30 near-experts, and 30 experts) were involved in the study. The participants came twice to the lab, once for a familiarization session, and a second time for the experimental task. A between-subject design was used, with three emotional conditions: positive, neutral, and negative. Their emotions were successfully manipulated using, for example, music and imagery. The experiment included an option-generation task, with 31 3D video clips of handball attack situations. The decision-making process of athletes was operationalized using six dependent variables, assessing decision quality and efficiency. The options generated were recorded using audio software. The subjective component of emotions was assessed by the PANAS. The physiological component (i.e., heart rate variability, or HRV) was measured with the Nexus 4 device. **Results:** A MANOVA indicated no session effect for the choice variables. Further correlation analyses were run, between the decision-making variables, the PANAS, and HRV. Very weak relationships were found with the PANAS, whereas strong relationships were found with HRV. More specifically, the LF/HF ratio was found to be significantly related with decision time ( $r = .25$ ), with generation time ( $r = .24$ ), with the quality of initial option ( $r = -.21$ ), and with the mean quality of options ( $r = -.24$ ). **Discussion:** Our findings show, that HRV influences the decision-making process of athletes, and more precisely the option-generation process. In effect, the lower the LF/HF ratio, the better and faster the decision. This corresponds to the neurophysiological integration model (Thayer, Hansen, Saus-Rose, & Johnsen, 2009), in which



a vagally mediated HRV was found to improve the functioning of cognitive processes. Further research should explore the influence of HRV biofeedback training on decision-making, and also verify the results for task-specificity. Thayer, J. F., Hansen, A., Saus-Rose, E., & Johnsen, B. (2009). Heart Rate Variability, Prefrontal Neural Function, and Cognitive Performance: The Neurovisceral Integration Perspective on Self-regulation, Adaptation, and Health. *Annals of Behavioral Medicine*, 37(2), 141-153. doi: 10.1007/s12160-009-9101-z

### UNIQUE ENVIRONMENTS AND THE PERSONAL QUALITIES OF SPORT PSYCHOLOGISTS: A SPORTS MEDIC PERSPECTIVE

CHANDLER, C., EUBANK, M., NESTI, M.

LIVERPOOL JOHN MOORES UNIVERSITY

Understanding of the skills and characteristics that make Sport Psychologists effective has been informed by coach/athlete perceptions and practitioners' own reflective accounts (Gould et al, 1991; Lindsay et al, 2007). The personal qualities that underpin Sport Psychologists' effectiveness remain relatively unexplored, yet it is these qualities, such as self-awareness and self-knowledge, that are important for effective practice (Ravizza, 2002). Moreover, Sport Psychologists will find themselves having to address organisational and cultural processes within their work and therefore need an awareness of the unique environments that exist. Such environments can be volatile and arduous, and it is argued that Sport Psychologists need to possess qualities such as resilience, commitment, presence, authenticity and empathy to survive (Nesti, 2004). The Health Professions Council (HPC) Standards of Proficiency (2009) require Sport Psychologists to consider the dynamics of their practice environment. This includes recognising the role of other professionals working within the multidisciplinary team and how to contribute effectively to it. Psychologists often work alongside Sports Medics whose practice, like that of the Sport Psychologist, has the potential for significant impact on athlete well-being. The importance of character and personal qualities as indicators of success within effective Medics has previously been documented, and resonates with this study given the often difficult and challenging environments within which they work (Glick, 2000). Sports Medics were therefore deemed to be a population who could offer genuine insights about the effective practice of Sport Psychologists within these environments. A sample of highly experienced Sports Medics, working in elite UK sport, was interviewed to gather their perspectives about Sport Psychologists' characters, and their effectiveness. Data uncovered several personal qualities considered necessary for effective Sport Psychology delivery, such as stability, empathy and honesty. These were discussed in relation to the Sport Psychologist's understanding of the environment, their role within that environment, and their ability to work as part of an interdisciplinary team. Comparisons to the literature on Sport Psychology provision and the potential impact of findings on practitioner education and training will be considered. Glick, S. M. (2000). *Medical Teacher*, 22, 443-447. Gould et al. (1991). *TSP*, 5, 111-127. HPC. (2009). *Standards of Proficiency - Practitioner Psychologists*. Lindsay et al. (2007). *TSP*, 21, 335-352. Nesti, M. (2004). *Existential Psychology and Sport: Theory and Application*. London: Routledge. Ravizza, K. H. (2002). *IJSP*, 33, 4-18.

17:00 - 18:15

## Plenary sessions

### PS-PL01 NEW HORIZONS: For the Challenge of Reducing Sedentary Activity in Humans

#### PROMOTING A PHYSICALLY ACTIVE LIFESTYLE: SELF-REGULATION AND SELF-RESPONSIBILITY OR A NANNY KNOWS BEST?

VAN MECHELEN, W.

VU UNIVERSITY MEDICAL CENTER

Prevalence rates of physical inactivity are high worldwide, as are associated diseases. Physical inactivity has been identified as the fourth leading independent risk factor for global mortality (6% of deaths globally). In the WHO European Region physical inactivity: is estimated to account for nearly one million deaths per year, i.e. 10% of the total and accounts for 8.3 million disability-adjusted life-years (DALYs - about 5% of the total). Dealing with this important risk factor would reduce the risks of cardiovascular diseases, non-insulin dependent diabetes, hypertension, some forms of cancer, musculoskeletal diseases and psychological disorders. According to the most recent Eurobarometer data 60% of the European population states to never or rarely participate in organised sports and if it comes to engagement in regular physical activity only 27% say to do so (i.e. performing at least 5 times a week at least moderate intensity physical activity). Next to the recognition of physical inactivity as an independent risk factor for many chronic disease, regular physical activity and exercise are currently seen as 'medicine' in the treatment of many disease states. There are now f.i. position statements and recommendations regarding physical activity/exercise and: diabetes type II, hypertension, bone health, cancer, obesity, arthritis, pregnancy-related hypertension and mental health. Next to these health-related effects, physical inactivity has economic bearing also, f.i. because of its relationship with sick leave. Research has shown that physical activity at a vigorous intensity level for at least three times a week has a positive effect on sick leave. From a review conducted for the World Economic Forum and WHO on the 'effectiveness and economic impact of worksite interventions to promote physical activity and healthy diet' we have learned that such interventions yield a 1 in approx. 2-4,5 return on investment, both from the direct cost, as well as from the indirect cost perspective. So the question is not so much about more evidence on the relationship between physical (in-)activity and health, or on the therapeutic benefits of physical activity and exercise, but more on the implementation end of things; i.e. how do we get both the still healthy population as well as patients to become physically more active or to pick-up exercising? In answering this question the critical question should be asked whether or not physical inactivity is abnormal behaviour in an normal environment, or whether it is normal behaviour in an abnormal environment?, i.e. is it all about self-responsibility and self-regulation or are we in need of a Nanny State to help us out? Depending on the outcome of this question, action plans should be made. This is what this plenary talk will be about.

**PLEASE STAND! ISSUES AND CHALLENGES IN SEDENTARY BEHAVIOUR CHANGE**

BIDDLE, S.

*LOUGHBOROUGH UNIVERSITY*

Sedentary behaviour, or excessive sitting time, has become a significant research trend in the past few years. Many researchers previously interested only in physical activity are now investigating sedentary behaviour, either alone or alongside physical activity. Although not new, with Jerry Morris studying occupational sitting over 50 years ago, the current impetus is marked. In this presentation I will highlight: a). the little we seem to know about modifiable correlates of sedentary time; b). the weakness of studying only screen time; c). what we currently know from interventions designed to reduce sedentary time. I will also touch on issues of sedentary behaviour measurement and the implications this may have for intervention design. Illustrative examples from Project STAND – an RCT designed to reduce sitting time in young adults at risk of Type 2 diabetes – will be highlighted.

# Thursday, July 7th, 2011

## 08:30 - 10:00

### Invited symposia

#### IS-PM04 The Biological Significance of Exercise and Heat Shock Proteins

##### EXERCISE-INDUCED INDUCTION OF HSPTS IN HUMAN SKELETAL MUSCLE

MORTON, J.

LIVERPOOL JOHN MOORES UNIVERSITY

Exercise-Induced Induction of HSPs in Human Skeletal Muscle James Morton, RISES, Liverpool John Moores University The study of the exercise-induced induction of the cytoprotective Heat Shock Protein (HSP) family is important for the exercise scientist as it may provide a valuable insight into the molecular mechanisms by which regular exercise provides increased protection against related and non-related stressors. As molecular chaperones, HSPs are also fundamental in facilitating the cellular remodelling processes inherent to the training response. Whilst the exercise-induced stress response of rodent skeletal muscle is relatively well characterised, data from humans are less conclusive. This presentation will review data from our laboratory and others which has attempted to characterise the stress response of human skeletal muscle as well as elucidate some of the cellular stressors and methodological factors influencing the magnitude of the response. Data indicate that acute endurance and resistance type exercise protocols increase the muscle content of ubiquitin,  $\alpha$ B-crystallin, HSP27, HSP60, HSC70 and HSP70. Although HSP transcription occurs during or within several hours post-exercise, time-course studies have typically demonstrated increases in protein content are only detectable within 1-2 days following exercise. However, comparison amongst studies is complicated by variations in exercise protocol (mode, intensity, duration, damaging, non-damaging), muscle group examined, predominant HSP measured and moreover, differences in subject characteristics both within and between studies (training status, recent activity levels, nutritional status, age, gender etc). Following non-damaging exercise (that induces no overt structural and functional damage), the stress response is thought to be mediated by redox signalling as opposed to increases in contracting muscle temperature per se. Following damaging exercise (that induces overt structural and functional damage), the stress response is likely initiated by mechanical damage to protein structure and further augmented by the secondary damage associated with inflammatory processes. Exercise training induces an increase in basal HSP levels which is dependent on a sustained and unknown dose of training as well as initial training status. Furthermore, trained subjects display an attenuated or abolished stress response to customary exercise, likely due to adaptations of basal HSP levels and the antioxidant system. Given the cytoprotective properties of HSPs, further work is needed to accurately characterise an exercise dose-response (e.g. intensity, duration, mode etc) relationship so as to devise an appropriate exercise intervention (specific to the population of interest) which may offer optimal HSP mediated cytoprotection. This is particularly important given the role of HSPs in modulating cell signalling pathways associated with health and disease such as diabetes and ageing.

##### HEAT SHOCK PROTEINS IN HEALTH AND DISEASE

HENSTRIDGE, D., BRUCE, C.R., FEBBRAIO, M.A.

BAKERIDI HEART & DIABETES INSTITUTE

We have recently identified an essential role of heat shock protein (Hsp) 72 in preventing insulin resistance in the context of high-fat feeding<sup>1</sup>. In this previous study, overexpression of Hsp72 was accompanied by a marked reduction in high fat diet-induced activation of JNK in skeletal muscle which is implicated in insulin resistance<sup>2</sup>. However, it is not possible to attribute this as the mechanism by which Hsp72 overexpression prevents the development of insulin resistance, since Hsp72 transgenic mice were protected from developing obesity despite having similar food intake when placed on a high fat diet<sup>1</sup>. In addition, markers of oxidative capacity in skeletal muscle were increased in Hsp72 transgenic mice<sup>1</sup>. These data are in agreement with our previous observations that correlate increased Hsp72 expression with mitochondrial enzyme activity in human skeletal muscle<sup>3</sup>. We now show that HSP72 expression plays a pivotal role in regulating skeletal muscle oxidative capacity. Skeletal muscle specific transgenic HSP72 (HSP72Tg) and control (WT) mice were fed a regular chow (chow) or high fat diet (HFD) for 10 weeks. While the HFD markedly increased ( $P<0.05$ ) body weight, intramuscular lipid accumulation (DAGs and TAGs) and induced insulin resistance in WT, no such effects were seen in HSP72Tg mice. Despite equivalent food intake, whole body oxygen consumption, fatty acid oxidation and oxidative enzyme activity in skeletal muscle were increased ( $P<0.05$ ) in HSP72Tg irrespective of diet. When subjected to an endurance exercise treadmill test, HSP72Tg mice displayed a 2-fold increase ( $P<0.05$ ) in running capacity relative to WT mice. Consistent with this oxidative phenotype, HSP72Tg mice exhibit a 50% increase in mitochondria and a significant increase in Tfam mRNA expression ( $P<0.05$ ). In contrast, HSP72 knockout (HSP72<sup>-/-</sup>) mice develop obesity and insulin resistance and display marked accumulation of lipid in skeletal muscle. In addition, oxygen uptake, insulin-stimulated glucose uptake and fatty acid oxidation rates are lower ( $P<0.05$ ), while fatty acid esterification rates higher ( $P<0.05$ ) in primary myocytes obtained from HSP72<sup>-/-</sup> mice compared with WT. Together, these data indicate that HSP72 prevents obesity and insulin resistance by increasing oxidative metabolism in skeletal muscle. 1. Chung, J., et al. HSP72 protects against obesity-induced insulin resistance. *Proc Natl Acad Sci U S A* 105, 1739-1744 (2008). 2. Hirosumi, J., et al. A central role for JNK in obesity and insulin resistance. *Nature* 420, 333-336 (2002). 3. Bruce, C.R., Carey, A.L., Hawley, J.A. & Febbraio, M.A. Intramuscular heat shock protein 72 and heme oxygenase-1 mRNA are reduced in patients with type 2 diabetes: evidence that insulin resistance is associated with a disturbed antioxidant defense mechanism. *Diabetes* 52, 2338-2345 (2003).

**HSPS AND CELL SIGNALLING: EFFECT OF EXERCISE AND AGEING**

MC ARDLE, A., KAYANI, A.C., VASILAKI, A., CLOSE, G.L., LIGHTFOOT, A., SAKELLARIOU, G., MC ARDLE, F., JACKSON, M.J.

UNIVERSITY OF LIVERPOOL

ROS generation is increased in skeletal muscles of adult mice following a period of isometric contractions and this is associated with increased Heat shock protein (HSP) content of the muscle. In contrast ROS generation and the ability to activate a stress response are modified in skeletal muscle with age. Transgenic studies have demonstrated that this blunted stress response plays a key role in development of age-related functional deficits. Lifelong overexpression of the cytosolic HSP, HSP70 in skeletal muscle of mice prevented the age-related loss of specific force generation but not the age-related loss of maximum tetanic force generation observed in muscles of old wild type (WT) mice. Unlike muscles of old WT mice, HSP70 overexpression facilitated the complete recovery of force generation in EDL muscles of old transgenic mice at 28 days following a severe protocol of damaging lengthening contractions. This effect was mimicked in muscles of old WT mice treated with a pharmacological inducer of HSP70. The mechanisms by which lifelong or acute increased muscle content of HSP70 provide this protection are unclear although data demonstrate that lifelong overexpression of HSP70 results in a reduction in the accumulation of markers of oxidative stress in old mice and reverses the inability to activate NF $\kappa$ B following contractile activity. Lifelong overexpression of the mitochondrial chaperone, HSP10 in skeletal muscle of mice prevented the age-related loss of force and cross-sectional area observed in old WT mice and protected muscles of both adult and old mice from damage following contraction-induced injury. Studies have demonstrated that mice lacking Cu,Zn superoxide dismutase showed an accelerated loss of skeletal muscle mass and function and examination of adaptive responses in muscles of adult Sod1<sup>-/-</sup> mice show aberrant DNA binding activity of AP-1 and NF- $\kappa$ B similar to that observed in muscles of old WT mice also suggesting that aberrant HSP responses may play a role in the modified cytokine production seen in old age. These data demonstrate that the development of age-related muscle weakness and atrophy are not inevitable and strengthen the hypothesis of the involvement of mitochondrial dysfunction in the development of these deficits and the differential effects of different HSPs highlight the specific functions of individual HSPs in skeletal muscle. The mechanism responsible for the inability to activate a stress response in old muscle is unclear although modified signalling by Reactive Oxygen Species is thought to play a role. Data suggest that the defect occurs prior to dissociation of the Heat Shock transcription factor, HSF1 from an inactive to an active form in the cytosol since data from mice treated with the HSP90 inhibitor and HSF1 activator, 17-AAG, demonstrate an increased HSP70 content of skeletal muscles of adult and old mice. This work was funded by Research into Ageing, BBSRC, MRC and National Institutes of Health (USA).

**Invited symposia****IS-BN02 Control of Gait and Posture: Science and Rehabilitation****GOAL-DIRECTED BEHAVIOUR IN CHILDREN WITH CEREBRAL PALSY**

LEDEBT, A.

VU UNIVERSITY AMSTERDAM

Introduction Children with spastic hemiparetic cerebral palsy (SHCP) have reduced functional abilities in the limbs of the affected side. Most children with SHCP participate in daily activities although they might not perform as well as typically developed children. Reduced functional abilities are thought to be a combination of impairments such as spasticity, weakness, and also motor control deficits. Daily activities include frequent interceptive actions, which require tight coupling between posture, movement coordination and perception. Different studies are presented to shed some light on the coupling between movement and perception. Methods Two main paradigms were used: one investigates the bilateral coordination of the upper limbs while sitting and the other the walking, reaching and gaze behavior during the interception of a moving ball. Bimanual coordination was examined under conditions of visual feedback created by placing a glass screen, opaque screen or a mirror between the arms (Feltham et al., 2010). The 'mirror box' creates a visual illusion of a zero lag symmetric movement between two arms. Kinematics and muscular activity are reported. For the interception of a moving ball the children had to intercept a ball at three different velocities with their impaired or less-impaired hand (van Kampen et al., 2010). Results and discussion Bilateral coordination: children with SHCP had longer phases of eccentric activation and shorter phases of inactivation in the elbow flexor of the more impaired arm during the glass condition compared to the screen and mirror condition. Furthermore, they had shorter phases of concentric activation in the elbow extensor of the more impaired arm during the mirror condition compared to the screen and glass condition. The effects of the availability of visual feedback in children with SHCP are explained by the matching of the afferent visual feedback with the efference copy, which overrides the neuromuscular activation (Smorenburg et al., 2011). Interceptive action: when was grasped with the impaired hand, children initially moved faster to the interception point. It showed that children with SHCP were able to take their impairment into account. However, these adjustments in walking velocity were not sufficient to compensate totally for the limited reaching ability in the impaired hand. Analysis of eye movements showed that some of the children with SHCP relied more on constant visual control during the entire interceptive action. References Feltham MG; Ledebt A; Deconinck FJA, Savelsbergh GJP (2010). Res Dev Disabil, 31, 1525-1535. Van Kampen PM; Ledebt A; Deconinck FJA, Savelsbergh GJP (2010). Disabil and Rehabil, 32, 1527-1537. Smorenburg AR, Ledebt A, Deconinck FJ, Savelsbergh GJP (2011). Res Dev Disabil, Feb 7. [Epub ahead of print].

**VIRTUAL REHABILITATION IN CEREBRAL PALSY: FROM MAGIC CARPET TO GOBLIN POST OFFICE**

BARTON, G.J.1, HAWKEN, M.B.1, FOSTER, R.J.1, HOLMES, G.2, BUTLER, P.B.3

1:LIVERPOOL JOHN MOORES UNIVERSITY 2:ALDER HEY CHILDREN'S NHS FOUNDATION TRUST 3:THE MOVEMENT CENTRE

Virtual Rehabilitation Virtual reality is a computer generated simulation of the real world in which the user can interact with a virtual environment through a human-machine interface (Holden, 2005). There is a growing interest in applying virtual reality in a movement rehabilitation context. A computer based reactive environment provides the key elements of motor learning – repetition, feedback, and motivation (Rizzo et al., 2002). Improvement of reduced core control in cerebral palsy The primary abnormalities characterising cerebral palsy (CP) include loss of selective muscle control, muscle imbalance and deficient equilibrium reactions (Gage and Novacheck, 2001). These abnormalities affecting the pelvis and trunk lead to reduced stability and control of the core which reduces mobility of distal body segments leading to inefficient performance of activities of daily living. There is evidence that primary problems resulting from brain damage improve in response to specific exercises that take advantage of the brain's capacity to reorganise. Virtual reality based com-

puter games can focus on control of specific movements, and provide enhanced motivation for continuing these training exercises. Projects Custom made computer games were created for the CAREN system, which were used to test and train movement control of the core. A series of studies were conducted both with healthy controls and children with CP aiming to improve selective movement control of the core and consequential improvement of movement function. Quantification of game performance ranged from simple methods of movement variability or straightness of flight trajectories to determination of the maximal settled speed which develops as a result of an adaptive algorithm adjusting forward speed of the games. Findings derived from virtual rehabilitation games Initial studies focused on the learning process of controlling pelvic and trunk rotations to drive a real-time game (Foster et al., 2008). The effect of game speed on performance was examined (Hawkins et al., 2008). Segmental differences of control were established in children with CP before games training (Barton et al., 2009). In a pilot study the performance of children with CP was followed through a six-week period of games. Indications of altered selective control could also be derived from dynamic coupling between the trunk and pelvis. References Holden MK (2005). *Cyberpsychol Behav*, 8, 187-211. Rizzo AA, Buckwalter G, van der Zaag C (2002). *Handbook of virtual environment technology*. 1027-64. Lawrence Erlbaum, London. Gage JR, Novacheck TF (2001). *J Pediatr Orthop B*, 10, 265-74. Foster RJ, Hawken MB, Barton GJ (2008). *Gait & Posture*, 28S, S10-S11. Hawkins P, Hawken MB, Barton GJ (2008). *Gait & Posture*, 28S, S70-S71. Barton GJ, Hawken MB, Butler PB, Holmes G, Foster RJ (2009). *Gait & Posture*, 30S1, 147-8.

### VISUAL GUIDANCE OF WALKING IN OBESE CHILDREN

LENOIR, M., D'HONDT, E., DE BOURDEAUDHUIJ, I., DEFORCHE, B.

UNIVERSITY OF GHENT

Introduction It is well documented that childhood obesity has a negative impact on the motor competence. The presence of excess mass and a not-optimal distribution of that mass over the body hampers a smooth execution of motor task, especially in tasks that imply a displacement of (parts of) the body, like running or jumping. An alternative, but not exclusive, explanation for the lower motor competence in obese children is a lower quality of perceptual-motor functioning (D'Hondt et al., 2008). This study investigates the integrity of perceptual-motor functioning by manipulating visual information during walking. Methods Sixteen obese children (OB; BMI 29.92 +/- 4.90) between 7 and 12 years and sixteen normal weight control children (NW; BMI 17.46 +/- 1.85) walked barefoot on an instrumented walkway at a constant self-selected speed. In the LIGHT condition, the room was normally lit, while in the DARK condition the room was completely darkened with the exception of a small light source at the end of the walkway. 3-D kinematics were collected through 8 infrared Proreflex cameras at 240 Hz. Data were averaged over the gait cycles of five trials in each experimental condition. Analyses of variance (2 (BMI group) x 2 (visual condition)) with repeated measures on the last factor were performed on each dependent variable. Significance level was set at  $p < .05$ . Results The walking pattern of obese children was characterized by a larger step width ( $p < .001$ ), but no significant difference in walking speed, or any other spatiotemporal parameter, although they tended to walk slower as compared to their normal-weight peers. The visual manipulation resulted in a more conservative gait pattern, featured by a lower speed, cadence, and step length, but a larger step width in the DARK condition (all  $p$ -values  $< .001$ ). Significant interaction effects on about half of the spatiotemporal parameters showed that the obese group was much more vulnerable to the absence of visual information, resulting in more time spent in stance phases in the DARK, while these differences were less pronounced in the normal-weight group. Conclusions In sum, the adaptations to the gait pattern in the absence of light are indicative of a safer walking pattern in both the obese and the normal-weight children. The greater impact of altered visual conditions on obese children's walking suggest that they might differently cope with sensory information during walking. This supports the hypothesis that differences in behavior between obese and normal-weight children might not solely be a problem of mechanics, but also a perceptual-motor problem. References D'Hondt, E., Deforche, B., De Bourdeaudhuij, & Lenoir, M. et al. (2010). Childhood obesity affects fine motor skill performance under different postural constraints. *Neuroscience Letters*, 440, 72-75.

### Invited symposia

#### IS-SH03 Gender and Physical Education

### EUROPEAN CHALLENGES: MIGRATION, GENDER, CULTURAL AND RELIGIOUS DIVERSITY - NARRATIVES OF MUSLIM GIRLS AND WOMEN

BENN, T.

UNIVERSITY OF BIRMINGHAM

One reality for Europe is the continued presence and growth of cultural and religious diversity as migrant populations increase, with Islam as Europe's second largest religion (Fekete 2008). This presentation focuses on the reality that physical education / sport structures, policies and practices can exclude young people who have cultural and religious needs that may differ from those in the mainstream education system (Dagkas et al 2011). Muslim girls and women (pupils and teachers) can experience greater disadvantage than boys and men in sport-related spaces. The focus, then, is on intersections of gender, ethnicity and religion. How can providers achieve more inclusive practice in and beyond schools? Although unified by belief in common tenets of Islam, the life experiences of Muslim people are diverse, influenced by many factors. These include family, religiosity and the adoption of private or public manifestations of faith, for example women's wearing of the hijab (head covering). Challenges in schools can arise when the religious needs of Muslim girls cannot be met, usually involving attention to requirements for body modesty and, for some, gender segregation for practical physical activities. Case studies (eg UK and Denmark) are used to explore the interface of Muslim girls'/ women's experiences in compulsory schooling and the dilemmas for providers. The cases illustrate girls' negotiation of positioning and the importance of context, historical, political and socio-cultural situation, in determining decision-making on inclusive policy and practice in physical education and sport in schools (Benn et al 2011, With-Nielson & Pfister 2011). References Benn, T., Dagkas, S., & Jawad, H. (2011) Benn, T., Dagkas, S., and Jawad, H. (2011),b Embodied faith: Islam, religious freedom and educational practices in physical education, *Sport, Education and Society* 16:1, pp 17 – 34). Dagkas, S., Benn, T., & Jawad, H. (In press) Dagkas, S., Benn, T. & Jawad, H. (In Press) 'Multiple Voices: Improving participation of Muslim Girls in Physical Education and School Sport', *Sport, Education and Society*. Fekete, L. (2008) *Integration, Islamophobia and civil rights in Europe*. (London, Institute of Race Relations). With-Nielson, N., & Pfister, G. (In press) *Gender constructions and negotiations in PE – Case Studies*, *Sport, Education and Society*.

**DANCE AND THE GENDER WARS – NARRATIVES OF BOYS AND MEN WHO DANCE**

GARD, M.

*CHARLES STURT UNIVERSITY*

We have moved into a period of history when scientific theories about the 'true' differences between males and females are resurgent (Fine 2010). This is perhaps not as inevitable as some might assume. Although new forms of biological determinism based on neo-evolutionary ideas appeared in the early 1970s, sparking bitter debates inside and outside academia, their sheer crudeness and lack of rigour could well have spelt the end of the enterprise (Lewontin 1993). However, particularly from the beginning of the early 1990s onwards, a combination of genetic and neurological science has reinvigorated the search for 'hard-wired' differences between the sexes (Jordan-Young 2010). Assuming that one is inclined to do so, there are many ways of challenging biological determinism. In this paper I read my qualitative research interviews with boys and men who dance against the claims that are made about 'natural' masculinity. These males appear, at least in the way they talk about themselves, to be a complex mixture of the stereotypically male and stereotypically female. For example, what are we to make of males who appear highly emotionally literate while also professionally competitive and avowedly heterosexual? Listening to the voices of different kinds of men is one way in which we can at least start to show not only how much more complex the world is than mars-vs-venus gender theories. These voices also hint that thinking in mars-vs-venus terms is not even a good place to start. In the 21st century, one of the most important struggles for freedom will centre on convincing people that biology is not destiny. Qualitative social science, especially researchers dealing with body disciplines such as sport and dance and in powerful places such as physical education, will have an important role to play. References Fine, C. (2010) *Delusions of Gender: The Real Science Behind Sex Differences* (London, Icon Books). Jordan-Young, R. (2010) *Brain Storm: The Flaws in the Science of Sex Differences* (Cambridge, Mass., Harvard University Press). Lewontin, R. C. (1993) *Biology as Ideology: The Doctrine of DNA* (New York, Harper Perennial).

**EXTENDING PHYSICAL EDUCATION BEYOND THE CURRICULUM – NARRATIVES OF GIRLS WITH LEARNING DISABILITIES**

STRIDE, A., FITZGERALD, H.

*LEEDS METROPOLITAN UNIVERSITY*

There is an emerging tradition in sports research that seeks to value and recognize young people as key informants about their lives (O'Sullivan and MacPhail, 2010). Within this body of research there continues to be a lack of engagement with girls with learning disabilities. This absence reinforces wider discourses of inequality that position people with learning disabilities at the bottom of a disability hierarchy (Deal, 2003). We contend these deficiencies in research, and also sports practice, serve to reinforce a view that girls with learning disabilities matter less in sport than other performers. In this presentation, we want to rearticulate the position of learning disabled girls within notions of girlhood in ways that move beyond 'an invisible presence' (Erevelles and Mutua, 2005). We situate our presentation within an after-school football initiative that sought to forge a partnership between Bryant Park Special School and Liberty High School, both based in different suburbs within one city in the north of England. We ask the following question: How are after-school football initiatives, designed to enhance football opportunities and links between special and mainstream schools, being experienced by a range of stakeholders? In seeking to explore this question we offer a series of non-fiction narratives that capture the different ways in which a number of girls with learning disabilities, a male football coach and the male Head teacher of a special school experience the realities of the football initiative. These tales illustrate not only the practical challenges of attempting to enhance football opportunities but also the theoretical challenges of exploring intersectional discourses concerned with girls, learning disability and girlhood. References Deal, M. (2003) 'Disabled people's attitudes towards other impairment groups: a hierarchy of impairments', *Disability & Society* 18 (7): 897-910. Erevelles, N. and K. Mutua, 'I Am a Woman Now!: Rewriting Cartographies of Girlhood From the Critical Standpoint of Disability', in P.J. Bettis and N.G. Adams (eds.) *Geographies of Girlhood: Identities In-Between*. London: Lawrence Erlbaum Associates. O'Sullivan, M. and MacPhail, A. (2010) (eds.) *Young People's Voices in Physical Education and Youth Sport*. London: Routledge.

**Invited symposia****IS-SH04 Talent Identification in Sport****HEY MATEY – ARE WE THERE YET? A FAIR DINKUM LOOK AT 25 YEARS OF NATIONAL TALENT IDENTIFICATION AND DEVELOPMENT IN AUSTRALIA**

GULBIN, J.

*AUSTRALIAN SPORTS COMMISSION*

Australia's first serious attempt at a sports specific talent identification and development (TID & D) program was pioneered by Australian Institute of Sport scientist Professor Allan Hahn commencing in 1987. Multiple rowing crews won gold medals at junior and senior world championships, and the Olympic Games. Emulating Dr Hahn's early success has proven exceedingly difficult despite the evolution of varying techniques and interventions that have now been trialled for 25 years. Despite the recognition that TID & D is one of the nine key pillars related to the success of a number of international sporting systems (De Bosscher et al, 2006), the reality of the Australian experience is that TID & D remains more "fringe" than mainstream. This is especially evident at a policy level. After two and half decades, it is only now that we are beginning to understand how TID & D best adds value to national sporting organisations, and what role TID & D could potentially play in achieving the broader outcomes of the high performance system. This presentation will condense 25 years into four key evolutionary periods - the concept, growth, refinement and maturation phases (Gulbin, 2011), and will use insights and examples to discuss if TID & D might actually reinvent itself as a key driver related to the optimisation of the talent development pathway. That is, based on the concept of deliberate programming (Bullock et al, 2009), TID & D becomes the key bridging discipline to ensure that an athlete has the highest probability of transitioning smoothly from a "grass-roots" participant to that of an elite performer. This is often easier said than done, and relies on a complex choreography of coach, athlete, sport, research and other system elements. References Bullock, N., Gulbin, J., Martin, D., Ross, A., Holland, T., & Marino, F. (2009). Talent identification and deliberate programming in skeleton: Ice novice to Winter Olympian in 14 months. *Journal of Sports Sciences*, 27, 397-404. De Bosscher, V., De Knop, P., van Bottenburg, M., Shibli, S. (2006). A conceptual framework for analysing sports policy factors leading to international sporting success. *European Sport Management Quarterly*, 6 (2), 185-215. Gulbin J.P. (2011). Applying talent identification programs at a system wide level: the evolution of

Australia's national program. In Baker, J., Cobley, S. & Schorer, J. (Eds). Talent Identification and Development in Sport: International Perspectives, London, Routledge, (in press).

## IS IT WORTH EVALUATING PHYSICAL CAPACITIES IN TALENT IDENTIFICATION PROGRAMS?

BUCHHEIT, M.

*ASPIRE*

Contemporary research on talent identification lies on dynamic and multidimensional analyses of physiological, technical, tactical and psychological skills to establish the ultimate profile of talented and successful players (Vaeyens et al. 2008). While (young) elite players generally perform better on physical capacity-related tasks compared with sub-elite players (depending on the sport and the age considered), we seize the opportunity of this symposia to question and discuss the value of physical capacities as determinants of (physical) competitive performance in team sports, and in turn, the value of evaluating physical capacities in a talent identification (TID) perspective. 1. Since (young) elite players generally train more/better than their sub-elites, whether their greater physical capacities is the cause or the consequence of their high playing standard is difficult to evaluate. 2. While it is intuitive that greater physical capacities may help to win duels and increase scoring opportunities, there is no causal link between match physical performance and the final outcomes of a game (i.e., winning or losing). 3. Physical performance during games is not consistently reported to be greater in elite/more successful compared with sub-elite/ less successful teams (Rampinini et al. 2009), and the less successful teams can even run more (Dupont et al. 2011). 4. Match-induced physical fatigue does not always translate into reduced skill-related performance (Carling et al. 2011). 5. Recent data in youth soccer clearly show that playing positions likely constrain the expression of physical capacities during games (Buchheit et al. 2010, Mendez-Villanueva et al. 2011). 6. The increase in physical capacities with age in young soccer players is not associated with parallel increases in match running performance (Buchheit et al. 2010). 7. We all have anecdotal evidences of successful elite players that do not possess extraordinary physical capacities (i.e., "compensation phenomenon") (Vaeyens et al. 2008). While it is evident that 'who can do more, can also do less', there is a general feeling of overemphasis on the importance of physical capacities for successful team-sport match performance and long-term career at the elite level. More dynamic and longitudinal assessments of match activity profiles according to playing position, maturation status and physical capacities, as well as a better understanding of the match-associated physiological load and technical demands are still warranted to improve TID test batteries and long-term training interventions. References Buchheit (2010) Int J Sports Med, 31, 818-25 Carling (2011) J Sports Sci, 29, 63-71 Dupont (2010) Am J Sports Med, 38, 1752-8 Mendez-Villanueva (2011) J Strength Cond Res, In press Rampinini (2009) J Sci Med Sport 12, 227-33 Vaeyens (2008) Sports Med, 38, 703-14

## HOW CAN I REACH THE TOP IN SPORTS?

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Marije T. Elferink-Gemser<sup>1,2</sup>, Chris Visscher<sup>1,2</sup>: 1: Center for Human Movement Sciences, UMCG, University of Groningen, The Netherlands, 2: Institute for Studies in Sports and Exercise, HAN University of Applied Sciences, Nijmegen, The Netherlands Introduction Considerable resources are invested in identifying talented athletes at an early age (Vaeyens et al., 2008). Still, current talent identification programs focus mainly on the current level of performance in the sport youth athletes are already active in (Phillips et al., 2010). Method In the Groningen talent studies we aim to objectify what it is that characterized adult elite athletes in their youth. For this purpose, over a thousand talented athletes have been and are being followed for the last ten years into adulthood applying a longitudinal design, accounting for the relation between the sport performance, an athlete's personal multidimensional performance characteristics, and the environment (Elferink-Gemser et al., 2007). Results Successful athletes distinguish themselves from their less successful counterparts by a combination of sports-specific and general performance characteristics. On several characteristics such as technical skills, successful athletes outscore less successful athletes already by the age of 12 and remain better (Huijgen et al., 2009). On other characteristics, such as interval endurance capacity, differences in favour of the successful athletes develop over time with the age-band of 14-16 proving crucial (Roescher, 2010). Remarkable is the essential role of tactical skills (Kannekens et al., 2010) and the successful athletes' ability to profit maximally from training displayed by high levels of reflection and effort; aspects of self-regulation of learning (Jonker et al., 2010). Discussion Talent identification programs are encouraged to not merely focus on the current level of performance but in stead on the potential a youth athlete has to develop performance characteristics. The ultimate successful ones take responsibility for their own learning and development process which may help them accomplish their goals in reaching the top. This is reflected in the rate they improve themselves over time. Sport science can help by repeatedly constructing a profile of talented athletes' multidimensional characteristics. References Elferink-Gemser, M.T., Visscher, C., Lemmink, K.A.P.M., Mulder, Th. (2007). JSS, 25, 481-489. Huijgen, B.C.H., Elferink-Gemser, M.T., Post, W.J., Visscher, C. (2009). Int J Sports Med, 30, 585-591. Jonker, L., Elferink-Gemser, M.T., Visscher, C. (2010). JSS, 28, 901-908. Kannekens, R., Elferink-Gemser, M.T., Visscher, C. (2010). Sc J Med Sc Sports, Epub. Phillips, E., Davids, K., Renshaw, I., Portus, M. (2010). Sports Med, 40, 271-283. Roescher, C.R., Elferink-Gemser, M.T., Huijgen, B.C.H., Visscher, C. Int J Sports Med, 31, 174-179. Vaeyens, R., Lennox, M., Williams, M., Philippaerts, R. (2008). Sports Med, 38, 703-714.

## Oral presentations

### OP-PM01 Vascular Adaptation

#### ROLE OF REACTIVE OXYGEN SPECIES ON THE NITRIC OXIDE SYSTEM IN AGING HUMANS: IMPACT OF LIFELONG PHYSICAL ACTIVITY

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Introduction Nitric oxide (NO) is a potent vasodilator that contributes to the regulation of blood pressure and skeletal muscle blood flow at rest and potentially during exercise. An age-related increase in reactive oxygen species (ROS) may, however, critically affect the bioavailability of NO. Accordingly, the present study aimed to investigate whether the increase in blood pressure and attenuated skeletal muscle blood flow during exercise, often observed in aging humans, is associated with lowered NO availability due to enhanced ROS formation, and to what extent lifelong physical activity affects these systems. Methods We measured hemodynamics at rest and during one-leg

knee-extensor exercise (12 W and 45% Wmax) in healthy lifelong sedentary (SED; age:  $63 \pm 4$  years;  $\text{VO}_{2\text{max}}$ :  $23.8 \pm 0.9$  ml  $\text{O}_2$   $\text{min}^{-1}$   $\text{kg}^{-1}$ ; MAP:  $114 \pm 4$  mmHg) and healthy lifelong physically active (PA; age:  $64 \pm 3$  years;  $\text{VO}_{2\text{max}}$ :  $43.8 \pm 3.7$  ml  $\text{O}_2$   $\text{min}^{-1}$   $\text{kg}^{-1}$ ; MAP:  $98 \pm 2$  mmHg) male subjects without (CON) or with constant venous infusion of the antioxidant N-acetylcysteine (NAC) to scavenge ROS. Results Infusion of NAC increased resting leg blood flow (LBF) in both SED (~30%) and PA (~33%). There was no difference in LBF between SED and PA during the same absolute workload (12 W;  $1.7 \pm 0.1$  vs.  $1.6 \pm 0.1$  l  $\text{min}^{-1}$ ). NAC infusion did not affect LBF during exercise at 12 W (SED:  $1.6 \pm 0.1$  l  $\text{min}^{-1}$ ; PA:  $1.7 \pm 0.1$  l  $\text{min}^{-1}$ ) and 45% Wmax (SED ( $20 \pm 2$ W):  $2.3 \pm 0.2$  vs.  $2.2 \pm 0.2$  l  $\text{min}^{-1}$ ; PA ( $34 \pm 3$ W):  $2.8 \pm 0.4$  vs.  $2.7 \pm 0.4$  l  $\text{min}^{-1}$ ). Infusion of NAC lowered MAP during resting conditions in SED (~7%), during exercise at 12 W in both SED (~7%) and PA (~9%), and during 45 % Wmax in PA (~9%). Discussion The finding that antioxidant infusion lowered blood pressure at rest and during exercise and increased resting blood flow suggests that NO bioavailability is compromised due to increased formation of ROS in aging humans. Despite these effects, blood flow to the exercising leg remained unchanged with antioxidant infusion in both groups. This suggests that an age-related perturbation in the NO system, due to enhanced ROS formation, does not account for the lower blood flow during exercise in aging humans. Furthermore, lifelong physical activity does not affect the age-related attenuation in blood flow during exercise. Sources of funding: Lundbeck Foundation and Danish Medical Research Council.

### ASSESSMENT OF THE ACUTE EFFECTS OF CONTINUOUS AND HIGH-INTENSITY INTERVAL EXERCISE ON ENDOTHELIAL FUNCTION IN INDIVIDUALS WITH CORONARY ARTERY DISEASE

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**Introduction** Cardiovascular disease is characterized by decreased endothelial function (Zhang et al., 2000). Cardiac rehabilitation exercise training improves endothelial function (Vona et al., 2009) and typically involves continuous aerobic exercise (CON). The overload principle states that the exercise stimulus which causes the greatest acute stress on the body will result in the greatest chronic adaptations following training. This study investigated if CON and a novel high-intensity interval protocol (HIT) resulted in similar acute changes in endothelial function as predicted by the overload principle. **Methods** Ten individuals ( $66 \pm 11$  yrs) with coronary artery disease participated in 2 sessions. Endothelial function was measured pre and 60-minutes post-exercise. Endothelial-dependent function was assessed using flow-mediated dilation (FMD). Brachial artery diameters and velocities were collected using Doppler ultrasound at baseline, and for 90-seconds following a 5-minute ischemic period. Endothelial-independent function was assessed using a 0.4-mg sublingual dose of nitroglycerin (NTG). Diameters were collected at baseline and 3 and 4-minutes post administration. Exercise was performed on a cycle ergometer. CON involved 30-minutes at 55% of peak power output (PPO). HIT involved 10, 1-minute bouts at 80% PPO separated by 1-minute bouts at 10% PPO. **Results** Absolute FMD was increased ( $p=0.012$ ) following CON (pre:  $0.24 \pm 0.18$  mm, post:  $0.31 \pm 0.24$  mm) and HIT (pre:  $0.25 \pm 0.13$  mm, post:  $0.29 \pm 0.13$  mm), with no group differences. A time effect for FMD normalized to the shear stress area under the curve was also observed ( $p=0.021$ ) after CON (pre:  $0.005 \pm 0.004$ , post:  $0.010 \pm 0.011$ ) and HIT (pre:  $0.005 \pm 0.004$ , post:  $0.009 \pm 0.011$ ). Relative FMD (%), and absolute and relative NTG responses were unchanged following CON and HIT ( $p>0.05$ ). **Discussion** Contrary to our hypothesis, acute increases not impairments, in FMD responses were observed following CON and HIT. The increases in FMD, and unchanged NTG responses are in agreement with some previous acute exercise investigations (Harvey et al., 2005; Silvestro et al., 2002) and may highlight the acute physiological benefits of exercise in a clinical population. HIT is currently being used in a cardiac rehabilitation training study to assess chronic changes in endothelial function. **References** Zhang X et al. (2000). *Atherosclerosis*, 149, 19-24. Vona M et al. (2009). *Circulation*, 119, 1601-1608. Harvey et al. (2005). *J Hypertens*, 23, 285-292. Silvestro et al. (2002). *Atherosclerosis*, 165, 277-283.

### EFFECTS OF 8-WEEKS CYCLE EXERCISE TRAINING ON BRACHIAL ARTERY FUNCTION IN HUMANS: ROLE OF ARTERIAL SHEAR STRESS

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**1** Research Institute for Sport and Exercise Science, Liverpool John Moores University, UK, **2** Department of Physiology, Radboud University Nijmegen Medical Centre, The Netherlands **3** School of Sport Science, Exercise and Health, The University of Western Australia **Introduction:** Exercise training is a potent stimulus to improvement in vascular function and is consequently associated with decreased cardiovascular risk. Animal studies indicate that episodic increases in shear stress are an important stimulus for vascular adaptation. Cycling exercise in humans is not only associated with changes in arterial shear stress, but also to large changes in blood pressure which is another potential haemodynamic stimulus for vascular adaptations. We examined bilateral brachial artery endothelial function across an 8 week period of cycling exercise training in healthy young men. Whilst both brachial arteries were exposed to the same blood pressure signal, we unilaterally manipulated shear stress by cuff inflation around the forearm. We hypothesised that attenuating shear stress would mitigate exercise-induced improvement in vascular adaptations. **Methods:** Nine healthy young males ( $22 \pm 1$  year) were recruited. Subjects performed three 30-min cycling exercise bouts/wk at 80% of their individual predicted maximum heart rate. During each bout, a cuff was inflated around one forearm to 60mmHg. Duplex ultrasound was used to measure bilateral brachial artery nitric oxide-mediated endothelial function (using flow-mediated dilatation; FMD) and dilation to glyceryl trinitrate (GTN: endothelium-independent dilation) at 0, 2, 4, 6 and 8 weeks. **Results:** A time-dependent change in brachial artery FMD was observed (ANOVA:  $P<0.05$ ). Brachial artery FMD in the non-cuffed arm significantly increased from  $5.8 \pm 4.1\%$  to  $8.6 \pm 3.8\%$  at week 2 (post hoc;  $P<0.01$ ) and returned towards baseline levels at week 4, 6 and 8 ( $7.4 \pm 3.5$ ,  $6.9 \pm 2.4$ , and  $6.0 \pm 2.3$ , respectively). No changes in FMD were observed in the cuffed arm. No changes in GTN-response across the 8-week period were found in the non-cuffed or cuffed forearm. **Discussion:** We observed a time-dependent change in brachial artery endothelial function in response to cycling training in healthy young men. When shear stress during exercise was attenuated by cuff inflation, no adaptations were observed. These data indicate that shear stress in humans is a key stimulus for adaptations in vascular function in humans.



**EXERCISE-MEDIATED CHANGES IN CONDUIT ARTERY WALL THICKNESS IN HUMANS: ROLE OF SHEAR STRESS**

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**Background.** Exercise training is a potent stimulus to improve vascular function and artery wall thickness, changes associated with decreased progression of atherosclerosis. Whilst previous studies have demonstrated that shear stress is the principle stimulus for adaptations in vascular function, less is known about whether episodic increases in shear stress induce training-induced adaptation in arterial wall remodeling in humans. **Purpose.** To examine the role of shear stress in adaptations in wall thickness during 8-week handgrip training in healthy humans. We hypothesised that manipulation of exercise-induced shear stress would induce differences between the limbs in artery wall thickness. **Methods.** We examined bilateral brachial artery wall thickness using high-resolution ultrasound in healthy men across an 8-week period of bilateral handgrip training (2-weekly intervals). Exercise training was performed 4 times a week, using 30-min exercise bouts. During these exercise bouts, shear rate was attenuated unilaterally during every exercise bout by cuff inflation to 60 mmHg. **Results.** Grip strength, forearm volume and girth improved similarly between the limbs. Acute bouts of handgrip exercise increased shear rate ( $P < 0.005$ ) in the uncuffed limb, whereas cuff inflation successfully decreased exercise-induced increases in shear. Handgrip training had no effect on baseline brachial artery diameter, blood flow or shear rate. Exercise training significantly decreased brachial artery wall thickness from  $254 \pm 30 \mu\text{m}$  to  $231 \pm 23$  and  $228 \pm 22 \mu\text{m}$  after 6 and 8 weeks, respectively ( $P < 0.001$ ). Wall-to-lumen ratio decreased significantly from  $0.062 \pm 0.009$  to  $0.055 \pm 0.008$  after 8 week handgrip training ( $P = 0.005$ ). The decrease in brachial artery wall thickness and wall-to-lumen ratio after exercise training was similar in the uncuffed and cuffed arms ( $P = 0.49$  and  $0.51$ , respectively). **Conclusion.** These results demonstrate that exercise training in healthy young men leads to a time-dependent change in brachial artery wall thickness. Moreover, we provide evidence that exercise-induced increases in shear are not obligatory for conduit artery wall remodeling in response to exercise training in healthy subjects. In contrast to changes in artery lumen diameter and size, changes in wall thickness following exercise training are apparently related to systemic, rather than localised, hemodynamic stimuli.

**MICROVASCULAR ADAPTATIONS IN RESPONSE TO HIGH INTENSITY INTERVAL TRAINING IN SKELETAL MUSCLE**

COCKS, M.I., SHEPHERD, S.I., TIPTON, K.D.I., RANASINGHE, A.I., BARKER, T.I., SHAW, C.S.I., WAGENMAKERS, A.J.M.I

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Structural and functional changes in skeletal muscle (SM) microvessels play an important role in the pathogenesis of insulin resistance and hypertension. Nitric oxide (NO) bioavailability influences both microvascular density and function. NO bioavailability is determined by its synthesis via endothelial nitric oxide synthase (eNOS), and scavenging through NAD(P)H-oxidase (NOX2) mediated generation of superoxide. High intensity interval training (HIT) elicits similar metabolic and macrovascular adaptations to traditional endurance training (ET). However, today its effects on the SM microvasculature have not been investigated. We therefore aimed to see if HIT elicited similar changes in capillary density and microvascular endothelial enzyme content (eNOS content and phosphorylation and NOX2-content) to ET. 16 Young sedentary males matched for age and BMI (mean age  $21 \pm 0.7$  y, BMI  $23.8 \pm 0.7 \text{ kg.m}^{-2}$ ) were randomly allocated to either HIT (performing 4-6 Wingate tests 3 times per week) or ET (performing 40-60 minutes of cycling at  $\sim 65\% \text{ VO}_{2\text{peak}}$ , for a period of 6 weeks). Muscle biopsies were taken from the vastus lateralis pre and post training. eNOS content and phosphorylation (eNOS Ser1177) and NOX2 content were assessed in the SM microvascular endothelium and sarcolemma (NOX2 only) using quantitative immunofluorescence microscopy. Capillary density was also determined using immunofluorescence microscopy. Both HIT and ET increased all measures of SM capillarization (capillary contacts per fibre, ET 20%, HIT 21%; individual capillary to fibre ratio, ET 22%, HIT 24%; capillary density, ET 32%, HIT 27%; main effects  $P < 0.05$ ). HIT caused an increase in SM microvascular eNOS content (36%;  $P < 0.05$ ) and although ET tended to increase eNOS this failed to reach significance (14%;  $P = 0.069$ ). Basal eNOS Ser1177 decreased following training (ET -13%, HIT -19%; main effects  $P < 0.05$ ) and endothelial and sarcolemmal NOX2 were unaltered by training (endothelial NOX2;  $P = 0.805$ , sarcolemma NOX2;  $P = 0.124$ ). While both ET and HIT are effective at increasing SM microvascular density, HIT appears more effective at increasing microvascular eNOS content. eNOS phosphorylation was reduced by training which may be related to a reduced shear stress stimulus resulting from the increased capillarization. NOX2 was unaltered by training, suggesting that any improvements in microvascular function in a young healthy but sedentary group are mediated by an increased production of NO rather than a reduction of NO scavenging. In conclusion, HIT is an effective and time efficient intervention to increase capillary density and microvascular eNOS expression with potential relevance to the treatment of insulin resistance and hypertension.

**Oral presentations****OP-BN03 Tendons/Stiffness****THE INFLUENCE OF LOADING ON MUSCLE-TENDON UNIT BEHAVIOUR DURING A STRETCH SHORTENING CYCLE KNEE EXTENSION TASK**

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**Introduction** Differences in vastus lateralis (VL) muscle-tendon unit (MTU) behaviour have been examined as movement velocity is varied in isokinetic and jump-type stretch-shortening cycle (SSC) tasks. However, little is known about how muscle and tendon behaviour changes under different loading conditions during maximum velocity isoinertial movements. Such information is important as load variation is a critical variable in resistance training programmes. **Methodology** Eight healthy physically active men performed single-leg, maximum intensity isoinertial leg extensions at loads of 20, 60 and 90% of their one-repetition maximum. After warm-up and familiarisation, subjects performed three repetitions of each load with a full countermovement, during which VL fascicle behaviour was measured using ultrasonography (12.5 MHz freq., 95 Hz sampling rate). MTU length was estimated by entering goniometer-derived knee joint angles into a previously published model. Minimum and maximum fascicle length and lengthening-shortening velocity were obtained. Tendon-aponeurosis (TA) lengthening-shortening was estimated by subtracting the displacement of the aponeurosis-fascicle insertion from MTU lengthening-shortening distance. Variables were compared across loads using ascending paired t-tests ( $p < 0.05$ ). **Results** Fascicle shortening velocity significantly decreased as load increased (20%:  $69.2 \pm 47.7$ ; 60%:  $33.6 \pm 21.4$ ,  $p = 0.03$ ; 90%:  $23.3 \pm 13.6 \text{ cm.s}^{-1}$   $p = 0.03$ )

while no significant differences were found between loads for fascicle or TA lengthening velocity, which were consistent with the observed concentric and eccentric movement velocities. TA shortening velocity was significantly ( $p=0.01$ ) slower at 90% ( $11.93 \pm 5.58$  cm·s<sup>-1</sup>) than 60% ( $16.05 \pm 8.36$  cm·s<sup>-1</sup>) but no significant differences were found between 60% and 20% ( $17.02 \pm 7.66$  cm·s<sup>-1</sup>). Lastly, TA recoil tended to decrease as load increased (20%:  $11.2 \pm 2.1\%$ ; 60%:  $10.3 \pm 2.9\%$ ; 90%:  $9.1 \pm 1.4\%$ ), however this difference was only significant ( $p=0.03$ ) between 20 and 90%. Discussion The current findings that fascicle shortening velocity and TA recoil decrease and fascicle strain remains constant as counter movement load increases differ from previous findings in jumping, which show that fascicle strain decreased and TA strain increased with greater volitional intensity. This may be due to either the large range of motion of the leg extensions or the torque needed to overcome the downward momentum of the load, which could make it impractical for the muscle to work in a quasi-isometric state. The current study is the first to find differences in MTU behaviour between commonly used training loads, and may provide information as to the mechanical stimuli which will elicit load specific training adaptations in muscle and tendon.

## EFFECT OF AGEING ON QUADRICEPS MUSCULO-ARTICULAR AND MUSCLE STIFFNESS

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Introduction Musculo-articular stiffness (MAS) is a comprehensive measurement which includes stiffness of the muscle-tendon unit, along with that of the surrounding articular surfaces, ligaments, and skin and is often assessed with the free oscillation technique (Ditroilo et al, 2010). In contrast, a more localized and selective measurement of just muscle stiffness (MS) can be performed with a myometer (Bizzini and Mannion, 2003). It is well established that ageing is characterized by a loss in muscle mass and strength (Reeves et al, 2006). It is also known that ageing reduces tendon stiffness (Reeves et al, 2006), however its effect on stiffness of other biological components is yet to be well established. The aim of the present cross-sectional study was to assess MAS and MS in two groups of male subjects young and older in order to gain a better insight into how ageing affects stiffness of different biological structures. Methods Fourteen young (YM, age  $22.1 \pm 3.0$ y, height  $179.7 \pm 5.0$ cm, mass  $79.0 \pm 11.9$ kg) and 12 older sedentary men (OM, age  $65.4 \pm 5.7$ y, height  $171.2 \pm 6.9$ cm, mass  $82.7 \pm 11.6$ kg) were assessed for maximal isometric voluntary contraction (MVC), MAS and MS of the quadriceps (at 15% of MVC). Results were compared by using an independent t-test. Results The mean results were  $288.6 \pm 36.2$  and  $194.3 \pm 35.4$  Nm ( $p < 0.05$ ) for MVC;  $1239.8 \pm 235.0$  and  $951.8 \pm 220.0$  Nm<sup>-1</sup> ( $p < 0.05$ ) for MAS;  $435.4 \pm 70.3$  and  $387.7 \pm 71.1$  ( $p = 0.11$ ) for MS, in YM and OM, respectively. MAS normalized to individual load was not significantly different between groups ( $100.1 \pm 13.0$  vs  $101.3 \pm 16.0$  Nm<sup>-1</sup>kg<sup>-1</sup>,  $p = 0.81$ ), whereas OM displayed significantly higher values in MS ( $23.2 \pm 5.2$  vs  $18.6 \pm 4.6$  Nm<sup>-1</sup>kg<sup>-1</sup>,  $p < 0.05$ ). Discussion When the normalization procedure was implemented, so that the effect of the different loads supported was neutralized, it was interesting to notice that the differences in MAS between YM and OM disappeared. In contrast, MS appeared to be higher in OM. It has been previously reported that tendon stiffness, as measured by ultrasonography, is reduced by the ageing process (e.g. Reeves et al, 2006). When combining the latter results with the outcomes of this study it could be speculated that the overall level of MAS remained unaltered because an increase in MS was offset by a decrease in tendon stiffness. Although caution should be exercised when comparing results from various studies collected with different techniques, this seems to be a very interesting and promising scenario, warranting further research. References Bizzini M, Mannion AF. (2003). Clin Biomech, 18, 459-61 Ditroilo M, Watsford M, De Vito G. (2010). J Electr Kinesiol Reeves ND, Narici MV, Maganaris CN. (2006). Man Ther, 11, 192-96

## ARE TENDON, JOINT AND LEG STIFFNESS MAJOR DETERMINANTS OF RUNNING ECONOMY IN WELL-TRAINED RUNNERS?

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Are tendon, joint and leg stiffness major determinants of running economy in well-trained runners? Anthony J. Blazevich[1,2], David R Coleman[1], Dale Cannavan[3] and Sara Horne[1] 1 Brunel University, London, UK. 2 Edith Cowan University, Perth, Australia. 3 Seattle Pacific University, Seattle, USA. The stiffness of an elastic system is a major determinant of both its natural oscillation frequency, the oscillation frequency at optimum oscillatory efficiency, and the peak force produced during recoil after stretching. Therefore, the stiffness of the lower limb during running (leg stiffness) and of the elastic structures that strongly influence leg stiffness (i.e. the Achilles and patellar tendons) have been hypothesised to influence the performance, and economy, of moderate-to-fast human running. However, few studies have examined the relation between running economy and the mechanical properties of the leg and its major tendons, and, particularly, no research has examined these relationships simultaneously in a single subject cohort in order to investigate possible interaction effects. Hence, the relative impact of each is unknown, and it is not clear whether stiffness of a particular tendon or joint is more predictive of running economy than another. In the present research, the relationship between running economy and tendon (Achilles and patellar), joint (ankle and knee) and whole leg stiffness (measured during running) was examined in 12 well-trained male middle distance runners. Leg stiffness was calculated from synchronously-obtained real-time motion analysis and forceplate data. Also, medial gastrocnemius (MG) and vastus lateralis (VL) tendon force-elongation properties were measured using in vivo ultrasonographic tendon visualisation during isometric maximal voluntary contractions, stiffness of the ankle and knee joints were calculated using inverse dynamics during running, and running economy was assessed by standard VO<sub>2</sub> measurements during an incremental treadmill protocol (0.5% grade). Using regression analyses, values for all variables were calculated at a running speed of 16 km/h. The data showed that MG tendon stiffness and peak isometric ankle joint moment were significantly correlated with economy ( $r = -0.66$  and  $-0.68$ , respectively), and each other, but leg and joint stiffness were not. Thus, a stiffer Achilles tendon and greater plantarflexor strength may provide a functional benefit by increasing the efficiency of the energetically demanding propulsive phase. However, analysis revealed no relationship between tendon, joint and leg stiffness, so both joint and leg stiffness during running must be determined largely by factors other than the stiffness of the major tendons. Determinants possibly include muscle activation patterns and/or the joint configuration of the leg during ground contact. Leg and joint stiffness values are therefore not reflective of tendon stiffness and cannot be used as a surrogate for it.

## ARCHITECTURE AND MECHANICS OF THE TENDINOUS INSCRIPTION – FASCICLE INTERACTION OF THE HUMAN SEMITENDINOSUS MUSCLE

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**Introduction** The semitendinosus (ST) is one of the four components of the hamstring muscle group. A unique characteristic of the ST muscle is the presence of a tendinous inscription (TI) along its middle belly. To our knowledge, the mechanics of architecture relative to the TI have not investigated in human muscle. The aim of this study was to examine the TI using dissection (cadavers) and ultrasound (in vivo). **Method** Ultrasonography (US) scans were taken in 18 young males at rest and maximum voluntary contraction (MVC). Further, the ST was dissected and removed from its origins in 10 cadaveric specimens (5 cadavers). **Results** The cadaveric long arm of the TI was  $6.67 \pm 0.64$  cm ( $6.45 \pm 1.21$  cm in US) long while the shorter arm was  $2.39 \pm 0.38$  cm ( $1.99 \pm 0.75$  cm in US). The angle formed by the two TI arms ranged from  $53.19$  (US) to  $56.05^\circ$  (cadavers) while more superficial fascicles intersected the inscription at significantly higher angles (range  $31.98 \pm 6.15^\circ$  to  $34.69 \pm 7.71^\circ$ ) compared with deeper fascicles ( $p > 0.05$ ). Fascicle length did not differ between compartments, but it was significantly smaller in superficial layers compared with deeper layers ( $p < 0.05$ ). With the exception of the angle between the TI arm and the deep aponeurosis, all measured angles as well as the length of the long arm of the TI increased significantly from rest to MVC ( $p < 0.05$ ). **Discussion** The role of the TI probably lies in the local inter-connections with the fascicles of either compartment, which upon contraction, is such that ST muscle contracts as one muscle. However, the TI arm morphology changes from rest to MVC, indicating a non-uniform displacement of the TI, mainly between the superficial and deeper layers of the muscle.

## TENDON STRAIN FOLLOWING YEARS OF SYSTEMATIC STRETCHING

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**Introduction** Stretching is commonly used as a means of improving sports performance, reducing injury risk, and in rehabilitation (Doucette and Goble, 1992, Wilson et al., 1992, Woods et al., 2007), while evidence of such effects at best is limited. Longitudinal studies with stretching interventions of up to 8 wks have been performed, but the musculotendinous response to chronic stretching is not well understood (Weppeler and Magnusson, 2010). We had the opportunity to examine a unique group of elite gymnasts; thus the purpose of the present study is to report patellar tendon mechanical properties in this group. **Methods** Twenty four national team rhythmic gymnasts (GYM) were compared to 10 control subjects (CON). This abstract presents data from 8 GYM and 6 CON. GYM ( $17 \pm 1$  yrs) had undertaken  $10 \pm 2$  years of systematic stretching, while CON ( $18 \pm 1$  yrs) had been active in sports for  $11 \pm 4$  years, without systematic stretching. Maximal voluntary isometric knee extension force (MVC) was obtained at a knee joint angle of  $90^\circ$ . Tendon force was determined based on moment arm calculations (O'Brien et al., 2010). Patellar tendon length was obtained by ultrasonography at rest and during isometric knee extension. Tendon strain at 25 and 50% of MVC was determined. **Results** No difference in MVC tendon force was seen between groups (GYM  $3322 \pm 596$  N; CON  $3477 \pm 653$  N). Patellar tendon strain tended to be greater in CON compared to GYM ( $11.0 \pm 7.9\%$  vs  $6.4 \pm 7.7\%$  at 25% MVC,  $16.5 \pm 7.2\%$  vs  $10.5 \pm 8.4\%$  at 50% MVC) ( $p = 0.15$  and  $0.09$ ). **Discussion** Habitual stretching is believed to reduce the stiffness of force transmitting tissues (Taylor et al., 1990). The present study utilizes a unique group of subjects to provide new insights. At matched force levels, tendon strains were similar, if not lower, in GYM. This suggests that chronic stretching does not reduce tendon stiffness, and is in line with Kubo et al., 2002, who found no effect on tendon stiffness after 3 wks of stretching. It is possible that rigorous stretching imposes mechanical loads similar to those of strength training, with corresponding tendinous adaptations (Seynnes et al., 2009). In conclusion, tendon does not appear to contribute to increased knee joint ROM following chronic stretching. The large joint ROMs seen in gymnasts may relate to factors such as increased muscle length or intramuscular connective tissue adaptations. **References** Doucette SA, Goble E (1992). Am J Sports Med, 20 Kubo K, Kanehisa H, Fukunaga T (2002). J.Appl.Physiol, 92 O'Brien et al. (2010). J Biomech, 43 Seynnes et al. (2009). J Appl Physiol, 107(2) Taylor et al. (1990). Am J Sports Med, 18 Weppeler CH, Magnusson SP (2010). Phys Ther, 90 Wilson GJ, Elliott BC, Wood GA (1992). Med Sci Sports Exerc, 24

## RESISTANCE TRAINING INCREASES TENDON STIFFNESS AND AFFECTS FORCE PRODUCTION CHARACTERISTICS IN PREPUBERTAL CHILDREN

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Age-related increases in muscular strength occur as a result of normal muscular growth and can be enhanced by resistance training. As a result, tendons must adapt in order to transmit greater forces efficiently to the bone and to minimise the risk of tendon injury. In adults, tendon mechanical properties have been shown to adapt to chronic loading. Such increases are thought to influence the rate of muscular force production, in addition to training-induced increases in the rate of muscle activation. Here, we asked whether training-induced adaptations in tendon stiffness and muscle activation could be elicited in prepubertal children, and whether such changes would affect rapid force production. Eighteen prepubertal children (aged  $9.0 \pm 0.3$  years) were divided into control (non-training) and experimental (training) groups. The experimental group completed a twice-weekly resistance training intervention over a 10-week duration. Each training session was part of a class-based physical education lesson and consisted of 2-3 sets of 8-15 plantarflexion resistance efforts, performed on a recumbent calf raise machine. Achilles tendon stiffness (slope of the tendon force-elongation curve), Young's modulus, electromechanical delay (EMD; time between the onsets of muscle activity and force), rate of force development (RFD; slope of the force-time curve) and rate of EMG rise (RER; slope of the EMG-time curve) were measured during maximum isometric plantarflexion contractions before and after training. No time-dependent changes were found in any of the dependent variables in the control group. In the experimental group, tendon stiffness and Young's modulus increased significantly ( $\sim 35\%$  and  $\sim 34\%$ , respectively). Tendon CSA remained unchanged after training, thus increases in stiffness were attributed to microstructural changes of the tendon, reflected by increases Young's modulus. RFD and RER remained unchanged after training whilst EMD decreased significantly ( $\sim 13\%$ ); this decrease was greatest for those who had the greatest increase in tendon stiffness ( $r = 0.59$ ). The present data show that the Achilles tendon adapts in response to resistance training in prepubertal children. This adaptation is associated with a shorter time to transfer muscular forces to the skeleton but not the rate at which this force is produced. Such a change has the potential to influence movement performance. As RFD was not influenced by the changes in tendon stiffness, the mechanisms underpinning rapid force production in children appear to be different to those found in adults. These findings are a significant step towards a more holistic understanding of age-related differences in muscular force production characteristics.

## Oral presentations

### OP-PM06 Protein Synthesis

#### INFLUENCE OF WHEY PROTEIN DOSE ON MUSCLE PROTEIN SYNTHESIS FOLLOWING LEG RESISTANCE EXERCISE

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**Purpose:** Protein ingestion following resistance exercise enhances the muscle protein synthetic response to a greater extent than exercise alone. However, there appears to be a limit to the rate of muscle protein synthesis (MPS) that can be attained. Amino acids not used to synthesize new proteins are simply oxidised. The optimal amount of whey protein to ingest following exercise to maximally stimulate MPS has not been determined. Moreover, the response of MPS to differing doses of whey protein following exercise in the fed state is unknown. Therefore the purpose of this study was to determine the response of MPS to differing amounts of whey protein ingested after resistance exercise performed in the post-prandial state. **Method:** Thirty resistance-trained males performed a bout of unilateral leg resistance exercise in a parallel designed study. Exercise consisted of 8 x 10 repetitions at 80% one repetition maximum on both leg press and leg extension machines. Each subject consumed a beverage containing either 20g (20WP) or 40g (40WP) of whey protein or a placebo (PLA) ~20 min post exercise. Exercise was performed 3h following consumption of a high protein (~30% energy) breakfast. Myofibrillar protein synthesis was measured over the 4h recovery period by a primed constant infusion of L-[ring-13C6]phenylalanine and muscle biopsies immediately after and 4h post resistance exercise. Arterialized blood samples were collected throughout the trial. Diet was controlled for two days prior to the infusion trial to match habitual energy intake and dietary composition. **Results:** Plasma amino acid concentrations did not change for PLA, but increased following protein ingestion (40WP>20WP>PLA;  $p<0.05$ ). Peak amino acid concentrations were observed between 0.25 and 0.5h post drink in 20WP and 0.75 to 1h post drink in 40WP. Amino acid levels remained elevated for 4h post drink ingestion in both 40WP and 20WP. FSR was significantly higher in 40WP ( $0.079\pm0.003\%/h$ ) by 51% and 20WP ( $0.074\pm0.005\%/h$ ) by 41% than PLA ( $0.053\pm0.005\%/h$ ), however there were no differences between 40WP and 20WP over the 4h recovery period. Area under the curve of urea production post-drink ingestion was significantly higher in 40WP ( $5\pm1 \mu\text{mol}/\text{min}/\text{kg}\cdot4h$ ) and 20WP ( $4\pm3 \mu\text{mol}/\text{min}/\text{kg}\cdot4h$ ) than PLA ( $-5\pm2 \mu\text{mol}/\text{min}/\text{kg}\cdot4h$ ). Insulin concentrations were significantly higher in 40WP than PLA at 0.5 and 1h post drink ingestion. Glucose concentrations were not different between conditions. **Conclusion:** Our results are the first to show that when exercise is performed 3h following food intake there is a limit to the rate of post-exercise MPS following protein ingestion. Whey protein ingestion above 20g does not provide any additional benefit to MPS. Funded by GlaxoSmithKline Nutritional Healthcare

#### SEX-BASED DIFFERENCES IN FED-STATE MYOFIBRILLAR PROTEIN SYNTHESIS AND ANABOLIC SIGNALLING EARLY AND 24 H AFTER RESISTANCE EXERCISE

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**Introduction** Men and women achieve comparable skeletal muscle hypertrophy after resistance training (Hubal et al., 2005) despite markedly disparate testosterone concentrations both basally and after an acute bout of resistance exercise (Vingren et al., 2009). Our aim was to examine anabolic mechanisms in men and women by measuring myofibrillar protein synthesis (MPS) and anabolic signalling early (1-5 h) and late (24-28 h) in recovery after resistance exercise and protein feeding. **Methods** Eight men ( $20\pm1$  y, BMI =  $24.3\pm2.4 \text{ kg}\cdot\text{m}^{-2}$ ) and eight women ( $22\pm1.8$  y, BMI =  $23.0\pm1.9 \text{ kg}\cdot\text{m}^{-2}$ ) received a primed, constant infusion of L-[ring-13C6]phenylalanine to assess MPS. Following a single biopsy to measure resting MPS, participants performed 5 sets of leg press at ~10 repetition maximum and 3 sets of both knee extension and hamstring curl at ~12 repetition maximum. Participants consumed 25 g of whey protein immediately after exercise and at 26 h of recovery. Additional biopsies were obtained at 1, 3, 5, 24, 26, and 28 h post-exercise. **Results** Akt-Ser473 phosphorylation was elevated to a greater extent ( $P<0.01$ ) in men at 1 h post-exercise and returned to basal levels in both groups for the remaining biopsy time points. mTORser2448 phosphorylation was elevated in men and women at 1, 3 and 5 h post-exercise and at 28 h, following protein feeding; however, there was a main effect for sex (men > women,  $P<0.01$ ). Responses of MPS data ( $n=4$ ) showed similar basal synthesis rates and increases in men (124 and 94% at 1-5 and 26-28 h, respectively) and women (48 and 162% at 1-5 and 26-28 h, respectively) after resistance exercise and protein feeding. **Discussion** Our study is the first to examine the effects of resistance exercise and protein feeding on myofibrillar protein synthesis (MPS) and anabolic signalling in men and women at both early (1-5 h) and late recovery (24-28 h) time points. Akt-mTOR phosphorylation was elevated by resistance exercise and feeding in men and women, but to a greater extent in men. Differences in Akt-mTOR signalling may contribute to marked elevations in MPS early post-exercise in men. Interestingly, while the mechanisms are unclear, women showed pronounced elevations in MPS 24 h in recovery despite similar signalling responses to men. **References** Hubal MJ, Gordish-Dressman H, Thompson PD et al. (2005). Med Sci Sports Exerc., 37(6), 964-72. Vingren JL, Kraemer WJ, Hatfield DL et al. (2009). Steroids, 74(13-14), 1033-9.

#### INCREASED TIME UNDER TENSION DURING LOW-INTENSITY RESISTANCE EXERCISE STIMULATES A PROLONGED ELEVATION OF MYOFIBRILLAR PROTEIN SYNTHESIS AND P70S6K PHOSPHORYLATION

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**Introduction** There are no data available on the influence of time under muscle tension during resistance exercise on acute responses of muscle anabolism. Thus, we aimed to determine if the time that loaded muscle is under tension (TUT) during low intensity resistance exercise affects the synthesis of myofibrillar and mitochondrial proteins and p70S6K phosphorylation. **Methods** Eight men ( $23\pm1$  y, BMI =  $26.5\pm1.0 \text{ kg}\cdot\text{m}^{-2}$ ) received a primed, constant infusion of L-[ring-13C6]phenylalanine and biopsies of the vastus lateralis were obtained during fasting conditions, 6 h, 24 h, and 30 h post-exercise. Participants performed 3 sets of unilateral knee extension exercise at 30% 1RM performed at either a slow TUT (6 s concentric and eccentric; SLOW) until voluntary failure or an external work-matched control TUT (1 s concentric and 1 s eccentric; CTL). After exercise, participants consumed 20 g of whey protein and at 24 h exercise recovery **Results** Exercise at SLOW and CTL were identical in the number of contractions performed for sets 1-3 (12, 7, and 3 repetitions, respectively). TUT was greater ( $P<0.05$ ) for all 3 sets in SLOW (3.3 min, 2 min, 1.5 min for sets 1-3) as compared to CTL (0.4 min, 0.2 min, 0.2 min for sets 1-3).

There was no acute stimulation of myofibrillar protein synthesis rates during 0-6 h recovery in either the SLOW or CTL conditions ( $P > 0.05$ ). However, at 24-30 h of recovery there was an increased rate of myofibrillar protein synthesis (~2.3 fold increase above fasted rates), but only in the SLOW condition ( $P < 0.001$ ) that was related to p70S6K phosphorylation ( $r = 0.42$ ,  $P = 0.02$ ). In addition, exercise-induced rates of mitochondrial protein synthesis were elevated by 114% above fasting rates during 0-6 h recovery only after the SLOW condition; however, during 24 - 30 h recovery both CTL (126%) and SLOW (175%) conditions were elevated above fasting rates (all  $P < 0.05$ ). Summary Our data demonstrate that low-intensity resistance exercise performed with a slow TUT mediates a carryover effect on p70S6K phosphorylation and the feeding-induced stimulation of muscle protein synthesis rates at ~24 h exercise recovery. These data are consistent with other data demonstrating an enhanced sensitivity of myofibrillar protein synthesis to protein feeding during 24 h exercise recovery after high or low intensity exercise performed until failure (Burd et al., 2011). Thus, resistance exercise stimulates muscle protein synthesis rates at times beyond the immediate acute exercise period. Work supported by NSERC. References Burd NA, West DWD, Moore DR, Atherton PJ, Staples AW, Prior T, Tang JE, Rennie MJ, Baker SK, Phillips SM (2011). J. Nutr. In press.

### INTERACTION OF MUSCLE GLYCOGEN AVAILABILITY AND NUTRITION ON CELL SIGNALLING AND MYOFIBRILLAR PROTEIN SYNTHESIS FOLLOWING RESISTANCE EXERCISE

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Introduction: Training with low muscle glycogen concentration can augment adaptation responses to endurance training but the effect of glycogen availability on anabolic signalling and protein synthesis in skeletal muscle following resistance exercise (REX) is unknown. Aim: To determine the effect of muscle glycogen availability and post-exercise nutrition on anabolic signalling and myofibrillar protein synthesis (MPS) during the early recovery period following REX. Methods: Sixteen men ( $22.7 \pm 0.9$  years; BMI =  $23.9 \pm 0.5$  kg/m<sup>2</sup>, values are mean  $\pm$  SEM) were randomly assigned to nutrient or placebo groups ( $n = 8$ /group). After 48 h diet and activity control, subjects reported to the laboratory the evening before an experimental trial and performed a glycogen-depletion protocol consisting of one-leg cycling to fatigue (LOW), while the other leg rested (NORM). After exercise, subjects consumed a low carbohydrate (CHO) meal. After an overnight fast, a primed, constant infusion of L-[ring-13C6] phenylalanine was commenced and then subjects completed 8 sets of 5 unilateral leg press repetitions at 80% one repetition maximum. Immediately after REX and 2 h later subjects consumed a 500 mL bolus of a protein/CHO beverage (20 g whey + 40 g maltodextrin) or placebo. Muscle biopsies from both legs (vastus lateralis) were taken at rest and at 1 and 4 h after REX. Results: The depletion protocol generated divergent muscle glycogen concentrations that were higher in the NORM than LOW leg in both nutrient and placebo groups ( $P < 0.05$ ). Muscle glycogen in LOW increased between 1 and 4 h post-exercise in the nutrient (~84 mmol/kg dw-1,  $P = 0.009$ ) but not placebo group. Phosphorylation of mTORSer2448 increased above rest at 1 and 4 h (~8-18 fold) in NORM and from rest to 1 h (~11 fold) in LOW in the nutrient group, but was only elevated from rest at 1 and 4 h post-exercise (~2-4 fold) in LOW with placebo. There were no differences between NORM and LOW legs at any time point. Nutrient ingestion stimulated a greater rise in MPS compared to placebo in both NORM (nutrient vs. rest:  $0.070 \pm 0.008$  vs.  $0.045 \pm 0.007$  %h<sup>-1</sup>,  $P < .05$ ) and LOW legs ( $0.068 \pm 0.006$  vs.  $0.049 \pm 0.006$  %h<sup>-1</sup>,  $P < .05$ ) during the 1-4 h recovery period, but were not different between NORM and LOW within nutrient or placebo groups. Conclusion: Our results indicate that commencing high-intensity REX with reduced muscle glycogen availability does not suppress anabolic signalling and subsequent rates of MPS, at least in the initial 4 h post-exercise recovery period. However, it remains plausible that the effects of undertaking REX in a low glycogen state may be manifest through muscle protein breakdown. This study was funded by the Australian Sports Commission.

### THE INFLUENCE OF CARBOHYDRATE-PROTEIN CO-INGESTION FOLLOWING ENDURANCE EXERCISE ON MYOFIBRILLAR AND MITOCHONDRIAL PROTEIN SYNTHESIS

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MCMMASTER UNIVERSITY

Purpose: The aim of the present study was to determine mitochondrial and myofibrillar muscle protein synthesis (MPS) when carbohydrate (CHO) or carbohydrate plus protein (C+P) beverages were ingested following prolonged cycling exercise. The intracellular mechanisms thought to regulate MPS were also determined. Method: In a single-blind, cross-over study, 10 trained cyclists (age  $29 \pm 6$  yr,  $\text{O}_2\text{max}$   $66.5 \pm 5$  mL/kg-1 min-1) completed two trials in a randomized order. Subjects cycled for 90 min at  $\sim 77 \pm 1\%$   $\text{O}_2\text{max}$  before ingesting a CHO (25 g of carbohydrate) or C+P (25 g carbohydrate + 10 g whey protein, Lucozade Sport Recovery Powder, GlaxoSmithKline, Brentford, UK) beverage immediately and 30 min post-exercise. A primed constant infusion of L-[ring-13C6] phenylalanine began 1.5 h prior to exercise and continued until 4 h post-exercise. Muscle biopsy samples were obtained to determine myofibrillar and mitochondrial MPS and the phosphorylation of intracellular signalling proteins. Arterialized blood samples were obtained throughout the protocol. Results: Plasma amino acid, plasma urea and serum insulin concentrations increased following ingestion of C+P only. Myofibrillar protein synthesis was ~35% greater for C+P compared to CHO ( $0.087 \pm 0.007$  and  $0.057 \pm 0.006$  %h<sup>-1</sup>, respectively;  $P = 0.025$ ). Mitochondrial protein synthesis rates were similar for C+P and CHO. mTORSer2448 phosphorylation was greater for C+P compared to CHO at 4 h post-exercise ( $P < 0.05$ ). p70S6KThr389 phosphorylation increased at 4 h post-exercise for C+P ( $P < 0.05$ ), whilst eEF2Thr56 phosphorylation increased by ~40% at 4 h post-exercise for CHO only ( $P < 0.01$ ). Conclusions: The present study demonstrates that the ingestion of protein in addition to carbohydrate following prolonged cycling stimulates an increase in myofibrillar, but not mitochondrial, MPS. These data indicate that the increase in myofibrillar MPS for C+P may be mediated through the phosphorylation of p70S6K, downstream of mTOR, which in turn may release the inhibition of eEF2 on mRNA translation elongation.

## Oral presentations

### OP-PM13 Training and Testing: Cycling

#### THE EFFECTS OF PACING STRATEGY ON AEROBIC AND ANAEROBIC ENERGY PRODUCTION IN ELITE OARSMEN.

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Purpose: Even pacing is considered to be the most efficient physiological strategy for activities similar in duration and intensity to rowing. However the profile for elite competitive races follows a pattern characterised by a fast start, a decrease in speed over the middle portion and a sprint finish (positive pacing = PP). The physiological consequences of a PP strategy are an increase in anaerobic energy contribution and metabolic acidosis which could impair performance. This study quantifies and compares the anaerobic and aerobic components of the most commonly used pacing strategy in rowing i.e. PP, calculated from the 2003 World Championship, against a negative (NP) and an even pacing (EP) strategy. Methods: To ascertain a baseline for pacing manipulation eight elite rowers completed a maximal 2-km time trial on a rowing ergometer. Following a 48 h rest they completed a test to volitional exhaustion, using 3-min intervals and 30W incremental stages (VO<sub>2</sub> max trial). Accumulate oxygen deficit (AOD) regression equations were calculated from four 10-min sub maximal trials. Two 10-min sub maximal trials, with 30-min rest, at 230W and 320W for heavyweight (HW >72.5kg) or 200W and 290W for lightweight rowers (LW <72.5kg) were performed 48 h following the VO<sub>2</sub> max trial. After 24h rest the rowers performed a further two 10 min trials at 260W and 290W for HW or 230W and 260W for LW. The rowers then performed three 1600m pacing trials, with 48h rest between. Pace was based on mean baseline 2-km speed and adjusted every 400m (PP = mean speed +3.64%; -0.64%; -1.72%; -1.27%; EP = mean 2-km time: NP = reverse of PP). During all rowing trials respiratory gas was measured breath-by-breath, heart rate and stroke-by-stroke power output were recorded and post-trial lactate was assessed. Results: Relative VO<sub>2</sub> consumption during EP was significantly higher than both PP (P=0.013) and NP (P=0.005). Furthermore, EP resulted in a significantly greater proportion of aerobic energy production 77.1% (+/-2.9) compared with both PP (67.2% +/-2.7) and NP (69.5% +/-3.7) during the 1600-m ergometer trial. The difference in VO<sub>2</sub> between EP and PP was initiated at 400-m (P=0.011), whereas the difference between EP and NP commenced at 800-m (P=0.008). There was a significant difference in post trial lactate between PP (9.96 +/-2.04 mmol.l<sup>-1</sup>) and NP (11.33 +/-2.77 mmol.l<sup>-1</sup>; P=0.028), but not for EP (10.94 +/-2.62 mmol.l<sup>-1</sup>). There was no difference in the heart rate during the three trials (P=0.236). Conclusion: Even pacing results in a greater aerobic contribution to energy production during the 1600m trial and therefore may be a more efficient pacing strategy than those commonly utilised in competitive rowing.

#### THE EFFECT OF AN EVEN PACING STRATEGY ON EXERCISE TOLERANCE IN WELL TRAINED CYCLISTS

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Introduction Numerous authors have suggested that an even-pacing strategy is optimal in events > 2 mins (Atkinson et al., 2003; Gordon, 2005). Few studies have tested this assertion for prolonged endurance events, and those that have do not provide support for an even-pace strategy (Ham & Knez, 2009; Lander et al., 2009). In contrast to this we (Thomas et al., 2009) found cyclists perception of effort during constant-load even-paced exercise was lower than when exercise was self-paced; though the constant load nature of the task might explain these findings. Accordingly, the aim of this study was to compare a self-paced exercise bout, an even paced exercise bout where the exercise intensity is imposed independent of cadence, and an even-paced exercise bout where a target intensity is prescribed but the actual intensity is free to vary. Methods Data collection for this study is ongoing. Eight well-trained male cyclists (VO<sub>2</sub>max mean (SD) = 4.79 (0.32) L/min) took part in a pilot study, completing a self-paced (SP) 20-km time trial (TT) followed by two time- and work-matched even-paced trials based on performance in SP. In one even-paced trial the power output was imposed independent of cadence, akin to a constant load assessment (EP-IMP). In the other even-paced trial the exercise intensity was free to vary, but participants were instructed to maintain a target power output equivalent to the mean power output attained in SP (EP-FTV). The order of EP trials was randomised. Results Mean 20-km TT power output was 276 ± 22 W. Of the 8 participants, 4 successfully completed both EV-IMP and EV-FTV trials (mean ± SD power 271 ± 20 and 270 ± 19 for EV-IMP and EV-FTV respectively). Four participants failed to complete the EV-IMP trial and were unable to successfully complete the EV-FTV trial at their SP average power output (280 ± 28 W in SP compared to 267 ± 32 W in EV-FTV). Discussion The preliminary results of the study suggest that an even-paced strategy might be less than optimal in well-trained cyclists, contradicting previous recommendations. The small sample size and variability in response means these results should be interpreted with caution, and further data collection is currently in progress to strengthen these conclusions and to elucidate the underpinning physiological mechanisms. Atkinson G, Davison R, Jeukendrup A, Passfield L. (2003). J Sport Sci, 21, 767-787. Gordon S. (2005). Sports Engineering, 8, 81-90. Ham DJ, Knez WL. (2009) J Str Cond Res, 23, 1016-1021. Lander PJ, Butterly RJ, Edwards AM. (2009). Br J Sports Med, 43, 789-795. Thomas K, Stone M, St Clair Gibson A, Thompson K, Ansley L. (2009). J Sport Sci, 27, S42.

#### PHYSIOLOGICAL RESPONSES DURING 1 H CONSTANT AND VARIABLE POWER CYCLING AND SUBSEQUENT SUBMAXIMAL RUNNING

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Narora Etxebarria<sup>1,2,3</sup>, Julie E A Hunt<sup>2</sup>, Stephen A Ingham<sup>1</sup> and Richard A Ferguson<sup>2</sup> <sup>1</sup> English Institute of Sport, EIS Performance Centre, Loughborough University, United Kingdom. <sup>2</sup> School of Sport, Exercise and Health Sciences, Loughborough University, United Kingdom. <sup>3</sup> Faculty of Health, Sports Studies, University of Canberra, Australia. Introduction The diverse nature of Olympic distance triathlon race venues elicits a wide range of physiological demands in the cycle and run legs. In particular, variations in terrain and course profile, especially numerous narrow turns requiring acceleration and deceleration may have substantial effects on the power distribution profile during the cycle leg, and consequently on physiological responses during the subsequent run. We compared the effects of variable versus constant power output during a 1 h cycling bout on physiological responses to submaximal running and time to exhaustion. Methods Nine well-trained male triathletes (V̇O<sub>2</sub>peak 67.8 ± 3.5 ml.kg<sup>-1</sup>.min<sup>-1</sup>) undertook an incremental step-wise running test (range 11-18 km.h<sup>-1</sup>) trial under three conditions: one trial without (CONTROL) and two trials (culminating in a time to exhaustion) with prior exercise consisting of 1 h cycling at either variable (VAR) or constant (CON) power. VAR involved intermittent efforts with race-specific power

outputs between 40 and 140% of maximal aerobic power (MAP) while in CON subjects held a mean power of 65% of MAP. CON and VAR trials were also matched for pedal cadence. Heart rate (HR), expiratory ventilation ( $\dot{V}E$ ), pulmonary oxygen uptake ( $\dot{V}O_2$ ), blood lactate (Bla) and rating of perceived exertion (RPE) were measured in all trials. Results During cycling  $\dot{V}E$  ( $22 \pm 14\%$ ; mean  $90\% \pm$  confidence limits) and Bla ( $179 \pm 48\%$ ) were substantially higher in VAR compared with CON. At the start of the submaximal run, HR ( $7.2 \pm 5.2\%$ ), Bla ( $216 \pm 54\%$ ),  $\dot{V}E$  ( $20 \pm 15\%$ ) and RPE ( $19 \pm 11\%$ ), were substantially elevated after VAR cycling compared with the CONTROL run. These initial differences disappeared during the run when the workload reached  $\sim 70\% \dot{V}O_{2peak}$ . There was no substantial difference in time to exhaustion between the conditions (CON  $217 \pm 232$  sec; VAR  $186 \pm 261$  sec; mean  $\pm$  SD, difference between the means  $17 \pm 111\%$ ; mean  $\pm 90\%$  confidence limits). Discussion Variable power cycling at race-specific power outputs for 1 h induces higher physiological responses compared to constant power cycling. Although variable power cycling elicits a transient elevation in subsequent running physiological responses there is little effect on run time to exhaustion.

## NEURAL AND MUSCULAR ADJUSTMENTS FOLLOWING REPEATED CYCLING SPRINTS IN NEUTRAL AND MODERATELY HOT ENVIRONMENTS

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**Introduction** The intention of this study was to determine the effect of an exposure to a moderately hot environment on neural and muscular adjustments following repeated cycling sprints. **Methods** Twelve active participants performed 10, 6-s "all-out" sprints on a cycle ergometer, interspersed with 30 s of recovery, followed, after 6 min of passive recovery, by five 6-s sprints, again interspersed by 30 s of recovery in either a neutral ( $24^\circ\text{C}/30\%\text{rH}$ ) or a moderately hot ( $35^\circ\text{C}/40\%\text{rH}$ ) environment. Neuromuscular tests including motor nerve (MN) and transcranial magnetic (TMS) stimulations during brief (5 s) and sustained (30 s) isometric contractions of the knee extensors were performed before and after exercise. **Results** Irrespectively of the condition, maximal strength ( $-12\%$ ) and rate of force development ( $\sim -15$ - $26\%$ ) during brief contractions decreased ( $P < 0.001$ ) after exercise. Resting twitch amplitude declined ( $P < 0.001$ ) by 42% and 40% (MN and TMS, respectively), independently of the condition. Under fatigue, there were neither significant change in voluntary activation estimated both from MN ( $\sim 80\%$ ) or TMS ( $\sim 90\%$ ) nor changes in TMS-based responses (i.e. motor evoked potential amplitudes and silent period durations at 50, 75 and 100% MVC) responses during brief maximal contractions. Voluntary activation declined ( $P < 0.01$ ) during the sustained contraction in all conditions, but reductions were more pronounced ( $P < 0.05$ ) after exercise. **Conclusion** Maximal and rapid muscle force characteristics were acutely affected concurrently with substantial reductions in muscle contractility following the repetition of cycle sprints. Whereas the contribution of neural mechanisms was less evident, end-exercise neuromuscular adjustments were minimally affected by an exposure to a moderately hot environment.

## Oral presentations

### OP-PM10 Heat and Dehydration

#### MUSCLE AND CEREBRAL OXYGENATION DURING UNCOMPENSABLE HEAT STRESS EXERCISE

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**MUSCLE AND CEREBRAL OXYGENATION DURING UNCOMPENSABLE HEAT STRESS EXERCISE** Julien D. Périard<sup>1</sup>, Martin W. Thompson<sup>1</sup>, Corinne Caillaud<sup>1</sup> and Valentina Quaresima<sup>2</sup> 1: University of Sydney (Lidcombe, Australia), 2: University of L'Aquila (L'Aquila, Italy) **Introduction** Oxygenation patterns in the brain and locomotor muscles during prolonged exercise in the heat have been suggested to impair performance (Neary et al., 2001; Subudhi et al., 2009). The purpose of this study was to investigate the influence of thermal and cardiovascular strain on muscle and cerebral oxygenation patterns during moderate and intense exercise to exhaustion in the heat. **Methods** Using near-infrared spectroscopy, oxygenation was examined in eight subjects cycling to exhaustion in an uncompensable hot environment ( $40^\circ\text{C}$ , 50% RH) at 60% (H60%) and 75% (H75%)  $\dot{V}O_{2max}$ , and for 60 min in cool conditions ( $18^\circ\text{C}$ , 40% RH) at 60%  $\dot{V}O_{2max}$  (C60%). Prefrontal cortex and vastus lateralis oxygenation were measured along with heart rate, cardiac output and mean arterial pressure. Core and skin temperature and skin blood flow were also measured. **Results** Rectal temperature reached  $39.8^\circ\text{C}$  (H60%),  $39.3^\circ\text{C}$  (H75%) and  $38.2^\circ\text{C}$  (C60%). Muscle oxygen saturation declined with exercise intensity in the first 5 min and remained depressed in all trials. The decline was greater in H60% and H75% due to greater deoxygenation. Cerebral oxygen saturation in C60% was maintained after an initial decrease. Throughout H60% and H75% cerebral oxygen saturation declined and was highly correlated with cardiovascular adjustments ( $R^2 = 0.80$  to  $0.99$ ). Exhaustion under heat stress occurred  $>96\%$  of maximum heart rate and was accompanied by significant declines in stroke volume, cardiac output and mean arterial pressure. **Discussion** The significant deoxygenation in locomotor muscles during H75% and H60% appears to indicate a limitation in oxygen delivery, rather than an inability to utilize the available oxygen (Rupp & Perrey, 2008). Given that perfusion and oxygenation are directly related to neuronal activity, the decrease in prefrontal cortex oxygenation saturation during exercise in the heat may reduce central neural drive. However, cerebral deoxygenation does not exclusively limit exercise in normoxic conditions (Amann et al. 2007), and prefrontal cortical activity is associated with goal-oriented behaviour, which influences motivation (Miller & Cohen, 2001). Therefore, our findings indicate that fatigue in an uncompensable hot environment is associated with a significant deoxygenation and reduction in oxygen delivery to locomotor muscle, and a progressive reduction of oxygen saturation in the brain that may influence the will to continue exercising. **References** Amann M et al. (2007). J Physiol 581, 389-403. Miller EK & Cohen JD. (2001). Annu Rev Neurosci 24, 167-202. Neary J et al. (2001). Eur J Appl Physiol 85, 427-433. Rupp T & Perrey S. (2008). Eur J Appl Physiol 102, 153-163. Subudhi AW et al. (2009). J Appl Physiol 106, 1153-1158.

#### COLD WATER IMMERSION RECOVERY FOLLOWING INTERMITTENT-SPRINT EXERCISE IN THE HEAT

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**Introduction** Implementation of cold water immersion (CWI) recovery has become increasingly popular in many professional sports, particularly following exercise in hot environmental conditions. To date, mechanisms for an ergogenic effect of CWI recovery following high-intensity, intermittent-sprint exercise in the heat remain equivocal. As such, this study examined the effects of CWI on recovery of

performance, physiological and neuromuscular function following simulated team-sport exercise in the heat. This investigation aimed to examine possible mechanisms responsible for previously reported beneficial effects of CWI recovery following exercise in the heat. Methods Ten male team-sport athletes performed two sessions of a 2x30-min intermittent-sprint protocol (ISE) in 32°C and 52% humidity, followed by a 20-min CWI recovery intervention or passive recovery (CONT) in a randomized, crossover design. The ISE involved a 15-m sprint every minute separated by bouts of hard-running, jogging and walking. Maximal voluntary isometric force (MVC) and voluntary activation (VA), ratings of perceived muscle soreness (MS) and blood markers for muscle damage (creatine kinase (CK), aspartate aminotransferase (AST) and c-reactive protein (CRP)) were measured pre- and post-exercise, and immediately post-recovery, 2-h and 24-h post-recovery. Physiological measures of core temperature (Tcore), heart rate (HR), lactate (La-) and perceptions of exertion, thermal strain and thirst were also recorded throughout exercise and at the aforementioned time points. Results Exercise in the heat resulted in a reduction in MVC and VA, with an increase in Tcore, La-, CK, AST and CRP ( $P < 0.05$ ). CWI enhanced the post-exercise rate of reduction in Tcore ( $1.43 \pm 0.36^\circ\text{C}$  CONT v  $1.66 \pm 0.48^\circ\text{C}$  CWI), HR and MS, whilst increasing post-recovery MVC and VA ( $P < 0.05$ ). A large trend for increased activation and peak twitch force of the right knee extensor was evident immediately and 2h post CWI recovery ( $P = 0.09$ - $20$ ;  $d = 0.8$ ). In contrast, 24-h post-recovery MVC and activation were significantly higher in CONT compared to CWI ( $P = 0.05$ ). Conclusion Following exercise in the heat, CWI accelerated the reduction in physiological and cardiovascular load and improved acute recovery of MVC. With an increase in Pt, VA and blunted rise in AST following CWI, improvements in acute MVC were potentially due to a complex interplay of peripheral and centrally-mediated mechanisms. However, despite improved acute recovery of MVC, CWI resulted in an attenuated MVC 24 h post-recovery. While positive acute effects of CWI recovery were present post-exercise, prolonged use of CWI recovery warrants further investigation to fully elucidate the effects of CWI recovery on muscle repair and adaptation.

## RELATIONSHIPS BETWEEN PEAK AND SELF-PACED EXERCISE IN THE HEAT

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Reductions in peak oxygen uptake (VO<sub>2peak</sub>) and, in turn, a higher percentage of VO<sub>2peak</sub> (%VO<sub>2peak</sub>) at a given submaximal exercise intensity have been proposed as factors mediating voluntary reductions in exercise intensity in the heat. However, this hypothesis has not been tested. Thus, the purpose of this study was to describe and compare the cardio-respiratory outcomes of self-paced and peak exercise in the heat. Eleven physically active male subject's peak cardio-respiratory and self-paced exercise responses were measured in both hot (HOT,  $40.2 \pm 0.3^\circ\text{C}$ ) and moderate (MOD,  $20.4 \pm 0.7^\circ\text{C}$ ) conditions. The peak exercise bouts consisted of exhaustive incremental exercise, while during the self-paced exercise subjects completed as much work as possible in 30 min. At submaximal intensities (power outputs) during incremental exercise, oxygen uptake (VO<sub>2</sub>) was ~7% higher ( $P < 0.05$ ) in HOT than in MOD. VO<sub>2peak</sub> (MOD,  $4.64 \pm 0.83$  L/min; HOT,  $4.54 \pm 0.77$  L/min), peak cardiac output (Qpeak; MOD,  $33.9 \pm 3.4$  L/min; HOT,  $33.8 \pm 4.5$  L/min), and core temperatures (Tc; MOD,  $37.8 \pm 0.4^\circ\text{C}$ ; HOT,  $37.9 \pm 0.4^\circ\text{C}$ ) were similar ( $P > 0.05$ ) between conditions. However, peak heart rate (MOD,  $176 \pm 10$  bpm; HOT,  $183 \pm 7$  bpm) and skin temperatures (Tsk; MOD,  $31.2 \pm 1.5^\circ\text{C}$ ; HOT,  $36.6 \pm 0.6^\circ\text{C}$ ) were higher ( $P < 0.01$ ) in HOT. During self-paced exercise, total work completed (MOD,  $346.6 \pm 79.7$  kJ; HOT,  $271.5 \pm 58.4$  kJ), and thus mean power output (MOD,  $201 \pm 56$  kJ; HOT,  $154 \pm 33$  kJ), was lower ( $P < 0.01$ ) in HOT. VO<sub>2</sub> was similar ( $P > 0.05$ ) through 15 min after which it was lower ( $P < 0.05$ ) in HOT. Relative to MOD, this represented a higher ( $P < 0.05$ ) and lower ( $P < 0.05$ ) %VO<sub>2peak</sub> during the initial and later stages of exercise. Heart rate was elevated ( $P < 0.05$ ) in HOT between 10 and 20 min, after which it was similar ( $P > 0.05$ ). Mean arterial pressure was lower ( $P < 0.05$ ) in HOT following 20 min, while stroke volume was lower ( $P < 0.05$ ) in HOT at 30 min. Cardiac output was similar ( $P > 0.05$ ) throughout both trials (mean: MOD,  $31.6 \pm 6.6$  L/min; HOT,  $30.1 \pm 6.0$  L/min), and thus represented a similar ( $P > 0.05$ ) percentage of Qpeak. Tsk was higher ( $P < 0.001$ ) throughout in HOT (mean: MOD,  $32.4 \pm 1.1^\circ\text{C}$ ; HOT,  $37.3 \pm 0.4^\circ\text{C}$ ), but Tc was similar ( $P > 0.05$ ) in both conditions until 30 min, upon which it was higher ( $P < 0.05$ ) in HOT (final Tc: MOD,  $38.5 \pm 0.3^\circ\text{C}$ ; HOT,  $38.7 \pm 0.3^\circ\text{C}$ ). The perception of effort was similar ( $P < 0.05$ ) in both trials. These results support the proposal that in the heat any given exercise intensity elicits a higher % VO<sub>2peak</sub>. However, in the current paradigm, when only Tsk is elevated, voluntary reductions in exercise intensity were not associated with changes in Qpeak or VO<sub>2peak</sub>. Therefore, this higher % VO<sub>2peak</sub> in the heat appears related to increases in VO<sub>2</sub> at a given submaximal intensity.

## EFFECT OF DIURETIC-INDUCED DEHYDRATION ON PROLONGED RUNNING PERFORMANCE IN HOT AND COOL CONDITIONS

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Introduction Prolonged exercise performance in hot condition challenges the cardiovascular and thermoregulatory systems in maintaining homeostasis. The imposition of mild dehydration (2-3% bodyweight deficit) is thought to exacerbate the circulatory and thermal strain. However, leading runners appear to be the most dehydrated in such conditions (Noakes et al., 2003). The aim of this study was to investigate the effects of hypohydration on prolonged running performance in hot and cool conditions. Methods Eight male runners (age:  $32.8 \pm 6.1$  yr; body mass, BM:  $72.2 \pm 6.5$  kg; height:  $177.9 \pm 9.3$  cm; VO<sub>2max</sub>:  $65.5 \pm 6.4$  mL/kg/min) undertook four 60 min bouts of treadmill running at 65% VO<sub>2max</sub> followed by 1% gradient increase every 3 min until volitional fatigue: 1) euhydrated in 20°C (E20); 2) dehydrated in 10°C (D10); 3) euhydrated in 35°C (E35) and 4) dehydrated in 35°C (D35). Lasix® (1 mg /kg BM) was used in D10 and D35 trials to induce ~3% BM deficit. Results Subjects reached their point of fatigue at ~95%, of HRmax ( $177 \pm 10$  beats/min) and rating of perceived exertion (RPE) was equally high in all trials ( $18.4 \pm 1.1$ ). Time to fatigue in the E20 ( $75.3 \pm 3.5$  min) and D10 ( $73.7 \pm 4.2$  min) trials was significantly longer ( $p < 0.05$ ) than the E35 ( $64.7 \pm 6.8$  min) and D35 ( $40.6 \pm 13.6$  min) trials. At 25-min of running, cardiac output in all trials was similar  $\sim 22.2 \pm 4.1$  L/min, while heart rate (HR) was ~23 and ~14 beats/min higher in D35 ( $p < 0.001$ ) and E35 ( $p < 0.05$ ) trials respectively, when compared with E20 and D10 ( $\sim 143$  beats/min) trials. Skin temperature (Tsk) was ~6°C lower in E20 and D10 trials, compared with E35 and D35 trials ( $p < 0.001$ ) at 25-min and at fatigue. Similarly, body core temperature (Tcore) was ~0.5°C lower in E20 and D10 trials compared with E35 and D35 trials ( $p < 0.05$ ) at 25-min but there was no significant difference between D35 ( $39.2 \pm 0.5^\circ\text{C}$ ) and D10 ( $38.8 \pm 0.4^\circ\text{C}$ ) trials at fatigue. Thirst sensation increased over time and was significantly higher in E35 and D35 trials, compared to E20 and D10 trials ( $p < 0.05$ ). Discussion Running performance in E35 and D35 trials was impaired, in association with elevated ambient temperature, but not hypohydration. This performance decrement was approximately 10-35 minutes less endurance time in E35 and D35 respectively and was further associated with a greater upward HR drift, elevated Tsk, and Tcore. Furthermore, mild dehydration did not have an adverse effect on the running performance in cool conditions. RPE was similar across all conditions despite thirst sensation being greater in the hot conditions. In conclusion mild dehydration did not adversely affect endurance performance in hot or cool conditions. References Noakes, T. & Maharam, L.G. (2003). Clin J Sport Med. 13, 309-318.



## SOLAR RADIATION CONTRIBUTES TO LATE-RACE HEAT GAIN DURING MASS-PARTICIPATION MARATHON RUNNING IN A WARM-HUMID ENVIRONMENT

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Thermodynamic properties of the environment modulate the endogenous heat strain arising from exercise (Kenney, 1998). This study aimed to investigate the magnitude and temporal nature of thermal exchanges occurring during a mass-participation 42.2 km footrace held in a warm and humid environment. Nineteen (12 males and 7 females) recreational distance runners participating in the Singapore marathon volunteered to take part in this ethically-approved study. Comprehensive mathematical models (ISO, 2004; Parsons, 2003) were used to quantify sources of gain and loss in body heat content during the race from continuous measurements of running speed, skin temperature (T<sub>sk</sub>) and weather conditions, with pre- to post-race change in body mass corrected for dietary intakes/outputs taken as an index of sweating. Body core temperature (T<sub>c</sub>) was also recorded using an intestinal sensor ingested 6 to 8 h beforehand. Data were averaged at 4.2 km intervals (i.e. 10% of total race length) and single-factor analyses of variance with repeated measures were employed to investigate changes in all variables as a function of distance covered. All volunteers completed the race in a mean  $\pm$  SD time of 4 h 30 min  $\pm$  40 min. Wet bulb globe temperature averaged 25.3°C from start to finish (range: 23.4–31.8°C). Potential for body heat storage occurred as globe temperature increased ( $p < 0.05$ ) and dry heat loss decreased ( $p < 0.05$ ) following sunrise at 13.5  $\pm$  1.8 km. This eventually resulted in gradual and significant ( $p < 0.05$ ) elevations in T<sub>sk</sub> and T<sub>c</sub> being observed across 25.3–42.2 km and 29.5–42.2 km, respectively, despite concomitant declines ( $p < 0.05$ ) in running speed and metabolic heat production. Exogenous heat gain via radiation occurred from 25.3–29.5 km and increased significantly thereafter ( $p < 0.05$ ), reaching 87  $\pm$  22 W/m<sup>2</sup> in the last 4.2 km. Metabolic heat production averaged 388  $\pm$  45 W/m<sup>2</sup> before the first significant deceleration at 29.5–33.8 km and was reduced to 352  $\pm$  54 W/m<sup>2</sup> across the final split ( $p < 0.05$ ), whereas convective and evaporative heat losses amounted to 59  $\pm$  41 W/m<sup>2</sup> and 278  $\pm$  66 W/m<sup>2</sup>, respectively. T<sub>c</sub> at finish was 39.2  $\pm$  0.6 °C and corresponding T<sub>sk</sub> was 34.5  $\pm$  1.9 °C. These results illustrate that during marathon running in warm and humid conditions, body heat gain consecutive to increasing solar radiation can outweigh the decrease in metabolic heat production associated with 'hitting the wall', thereby contributing to the deterioration of thermal balance. Kenney (1998). *Int J Sports Med*, 19, S92-95. ISO (2004). *Ergonomics of the thermal environment, international standard n°7933*. Parsons KC (2003). *Human thermal environments*, Taylor and Francis, London, pp.1-29.

## THE EFFECT OF BEVERAGE TEMPERATURE ON THERMOREGULATION AND ENDURANCE PERFORMANCE IN THE HEAT

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Introduction Endurance exercise in the heat causes a rise in core body temperature and may influence the evolution of fatigue. Cooler beverage temperature may attenuate the rise in body temperature and improve endurance performance in the heat by generating a heat sink (Lee et al, 2008) or via oral sensory mechanisms (Mundel et al., 2010). The aim of this study was to investigate the effect of cool beverage consumption during exercise in the heat on thermoregulatory mechanisms. The effect of cool beverage consumption or mouthwash on endurance performance was also evaluated. Methods Seven male participants cycled at steady state (65% VO<sub>2peak</sub>) for 90 min (SS) followed by a 5 kJ per kg body mass time trial (TT) in 32°C and 40% relative humidity. Participants ingested 3.5 ml per kg body mass 7.4% carbohydrate electrolyte beverage every 15 min during SS at 37°C (CON) or -1°C (COLD). During SS of a trial, participants consumed CON and every 5 min rinsed a cold (-1°C) 30g ice puree in the mouth for 25 s and expectorated (WASH). Rectal temperature (Tr), skin temperature (T<sub>sk</sub>), skin blood flow (SBF), heart rate (HR) and changes in body mass were measured. Venous blood was sampled for vasoactive intestinal peptide (VIP) and plasma osmolality. Results Tr and HR were not significantly different between trials ( $p < 0.05$ ). Preliminary data show during SS, T<sub>sk</sub> and SBF were lower in COLD versus CON. Heat storage was lower in COLD (14.8 $\pm$ 10.1 W.min<sup>2</sup>) versus CON (21.5 $\pm$ 10.4 W.min<sup>2</sup>) however data currently underpowered therefore a significant difference could not be detected. Sweat rate during SS was higher in COLD (3.2 $\pm$ 0.4kg) versus WASH (3.0 $\pm$ 0.5kg) and CON (3.0 $\pm$ 0.3kg) but not significantly different. During TT, heat storage was significantly higher in COLD (77.6 $\pm$ 30.6 W.min<sup>2</sup>) versus CON (27.7 $\pm$ 38.9 W.min<sup>2</sup>,  $p=0.03$ ) but not WASH (48.2 $\pm$ 24.1 W.min<sup>2</sup>,  $p<0.05$ ). TT performance was improved in the COLD (18.9  $\pm$  1.2min) versus WASH (20.6 $\pm$ 1.4min,  $p=0.7$ ) and CON (21.6 $\pm$ 1.9min,  $p=0.03$ ). Blood serum analysis not yet completed. Discussion Cold beverage consumption had no effect on Tr, however SBF was decreased causing a concomitant decrease in T<sub>sk</sub> (Wimer et al., 1997). Reduced T<sub>sk</sub> gradient above ambient temperature allowed for greater sweat loss. This initially reduced heat storage and allowed for increased capacity during TT where participants worked at a higher intensity and improved performance. Performance was improved with WASH versus CON suggesting oral sensory mechanisms may exist. Research currently limited by lack of power however further data is being collected. References Lee, JK, Shirreffs, S, Maughan, R. (2008). *Med Sci Sports Exerc*, 40(9), 1637-1644 Mundel, T, Jones, D. (2010). *Eur J Appl Physiol*, 109(1), 59-65 Wimer, G, Lamb, D, Sherman, W, Swanson, S. (1997). *Can J Appl Physiol*, 22, 479-493

## Oral presentations

### OP-SH03 Physical Activity and Movement Skills

## ABILITIES OF CHILDREN GIFTED IN SPORTS ACCORDING TO PHYSICAL EDUCATION TEACHERS

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Abilities of children gifted in sports according to Physical Education teachers Platvoet, SWJ. 1, Elferink-Gemser, MT. 1,2 & Visscher, C.1,2 1: HAN (Nijmegen, The Netherlands) 2:UMCG, RuG (Groningen, The Netherlands) Introduction Bailey and Morley's Model of talent development in Physical Education (2006), derived from Gagné's DMGT (2000), recognizes the influence of nature and nurture and takes into account the dynamic and multidimensional features of sport talent (Vaeyens et al, 2008). However, the model does not have a detailed, explanatory theoretical rationale underpinning yet (Phillips et al 2010). The aim of this study is to identify those abilities that according to PE teachers characterize children 6-8 years of age gifted in sports. This age-band is considered appropriate to assess gifts (i.e., natural abilities) because specific sport training most often has not occurred yet (Van Rossum and Gagné, 2007). Methods 165 Dutch physical education (PE) teachers in primary education filled in a digital questionnaire about abilities of children gifted in sports. A principal compo-

nent analysis (PCA) was conducted on the 69 items with orthogonal rotation (varimax). Temporal stability of the questionnaire was examined by determining the relative and absolute test-retest reliability. Results The Kaiser-Meyer-Olkin measure verified the sampling adequacy and Bartlett's test of sphericity was  $\chi^2 (2080) = 5248, 52, p < .05$ . Seven factors were extracted which account for 50.4% of the variance. Based on their content the factors were labeled Psychological Ability, Ability to respond, Creativity, Psychomotor Ability, Self regulation, Interpersonal and Intellectual Ability. All subscales had sufficient internal consistency (Cronbach's  $\alpha = .74$  to  $.84$ ) and relative temporal stability (ICC's  $.51$  -  $.86$ ), except the creativity scale. The mean differences between both measurements were non-significant ( $p < .05$ ) for each subscales except for IQ, indicating sufficient absolute reliability. Discussion According to PE teachers a child gifted in sports is characterized by seven abilities. These abilities are a specification of the abilities in Bailey and Morley's model and can be used for talent detection in the setting of PE. A next step is to investigate the relative significance of each ability for talent identification and talent development for different kinds of sports. References Bailey, R. & Morley, D. (2006). Sport, Edu. and Soc., 11-3, 211-230 Gagné, F. (2000). International Handbook of Res. and Dev. of Giftedness and Talent (2nd) (Oxford, Elsevier) Phillips, E., Davids, K., Renshaw, I. & Portus, M. (2010). Sports Med. 40-4, 271-283 Vaeyens, R., Lenoir, M., Williams, M. & Philippaerts, R. (2008). Sports Med, 38-9, 703-714 Van Rossum, J.H.A. & Gagné, F. (2004). The Handbook of Secondary Gifted Education (pp. 281-316). Washington: National Association for Gifted Children

### **"IF THERE WASN'T THE TECHNOLOGY THEN I WOULD PROBABLY BE OUT EVERYDAY": A QUALITATIVE STUDY OF CHILDREN'S STRATEGIES TO REDUCE THEIR SCREEN VIEWING**

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Introduction Screen-viewing (SV) (i.e., watching television, playing computer/video games, or using a PC, laptop or handheld console) is central to the lives of European children and has been positively associated with poor physical and mental health. Previous strategies to reduce children's SV have been developed by adults or researchers. In this study the perceptions of British children aged 10-11 in reducing SV and their self-developed SV reduction strategies were explored. Methods Ten semi-structured focus groups (Mean duration = 44 minutes) were conducted with 55 10-11 year old children (30 girls, 25 boys) from diverse socio-economic backgrounds. Topics covered children's feelings about reducing their SV, their ideas of SV reduction strategies and who would be involved. Data were transcribed verbatim and analysed using Thematic Analysis. Results Three themes were developed: (1) Reaction to Reduction; (2) Reduction: What, when and what else instead? ; and (3) Strategies to reduce screen-viewing. A range of single and multi-SV types were reported and children combined TV, computers, consoles and handheld consoles demonstrating the complexity of contemporary SV. Participants largely reacted positively to the idea of reducing SV though thought doing so would be challenging due to enjoyment, SV habits and favourite TV programmes. A range of SV types were put forward as candidates for reduction and participants believed they would replace SV time with both physically active and non-screen sedentary behaviours. Participants suggested SV could most easily be reduced after school and suggested strategies based on the provision of alternative activities, facilities and clubs. Screen-viewing guidelines delivered by adults were not supported as a strategy but peer-led educational interventions were proposed. Unexpectedly, participants reported that the focus group itself encouraged self-reflection and could be a prompt to change behaviour. A number of parent-based strategies emerged such as using rewards, charts and time limits which involved parent-child collaboration were also suggested. Discussion Children appeared open to SV reduction and offered insights into the strategies that they endorse and therefore may respond to best. The findings can inform the development of interventions designed to reduce children's sedentary SV. Reference: Marshall SJ, Gorely T, Biddle SJ. (2006). J Adolesc, 29, 333-349.

### **ADAPTATION AND VALIDATION OF TEACHERS' KNOWLEDGE OF TEACHING AND TECHNOLOGY, TECHNOLOGY INTEGRATION SELF-EFFICACY AND OUTCOME EXPECTATIONS QUESTIONNAIRES FOR PRESERVICE PE TEACHERS**

SEMİZ, K., INCE, M.L.

MIDDLE EAST TECHNICAL UNIVERSITY

ADAPTATION AND VALIDATION OF TEACHERS' KNOWLEDGE OF TEACHING AND TECHNOLOGY, TECHNOLOGY INTEGRATION SELF-EFFICACY AND OUTCOME EXPECTATIONS QUESTIONNAIRES FOR PRESERVICE PE TEACHERS Semiz, K., Ince, M.L. METU (Ankara, Turkey) Introduction As rapid and continual developments in technology have been affecting the world of education, competency and integration of technology into the teaching have been expected from Physical Education (PE) teachers. However, there is very limited number of validated data collection tools to measure the related characteristics of PE teachers in the literature. The aim of this study was to adapt and examine the validity of Preservice Teachers' Knowledge of Teaching and Technology, Technology Integration Self-Efficacy and Outcome Expectations questionnaires for preservice PE teachers. Methods Preservice Teachers' Knowledge of Teaching and Technology (TPACK) (Schmidt et al, 2009) questionnaire was translated to Turkish by experts. The original survey has 58 items on 4 subject areas (Literature, Social Studies, Math, Science). When survey was modified for PE, number of items decreased to 37. Total number of seven subscales in the original questionnaire decreased to five subscales after modification. Technology Integration Self-Efficacy (TISE) (Niederhauser & Perkmen, 2010) (16 items) and Outcome Expectations (OE) (9 items) questionnaires which are available in Turkish is used for the validation study. The questionnaires were applied to third (N= 249) and fourth grade (N= 186) preservice PE teachers from nine different Universities of Turkey. Confirmatory Factor Analysis (CFA) was administrated with AMOS and Cronbach  $\alpha$  coefficients were calculated with PASW. Results Internal consistency coefficients of TPACK subscales were 0.85 for Technological Knowledge, 0.79 for Content Knowledge, 0.89 for Pedagogical Knowledge, 0.77 for Technological Pedagogical Knowledge, 0.85 for Technological Pedagogical Content Knowledge, and lastly 0.94 for the total TPACK Survey. TISE and OE questionnaires'  $\alpha$  values were 0.95 and 0.91, respectively. The fit indexes for TPACK,  $\Delta \chi^2 (760) = 392, p < .001$ , CFI (0.94), TLI (0.94) and RMSA (0.47), were good. Also for TISE, the values that  $\Delta \chi^2 (294) = 96, p < .001$ , CFI (0.96), TLI (0.95) and RMSA (0.69) were satisfying. When one of the item with low factor loadings was excluded from the model, the CFA findings for OE were acceptable as  $\Delta \chi^2 (46) = 14, p < .001$ , CFI (0.98), TLI (0.97) and RMSA (0.72). Discussion On the basis of the findings, it is understood that the Turkish version of TPACK, TISE and OE questionnaires are valid and reliable for preservice PE teachers. They can be a powerful set of questionnaires for addressing an opportunity for future studies. References Niederhauser, D.S. & Perkmen, S. (2010). Beyond Self Efficacy : Measuring Preservice Teachers' Instructional Technology Outcome Expectations. Computers in Human Behavior 26, 436-442. Schmidt, D. et al (2009, April). TPACK: The Development and Validation of an Assessment Instrument for Preservice Teachers.

## FUNDAMENTAL MOVEMENT SKILL MASTERY IN SIX-YEAR-OLD PRE-SCHOOL CHILDREN

VANDAELE, B., COOLS, W., DE DECKER, S., DE MARTELAER, K.

FREE UNIVERSITY BRUSSELS (VUB)

Fundamental movement skill mastery in six-year-old pre-school children Vandaele, B (1,2), Cools, W (2), De Decker, S (1), De Martelaer Kristine (2) 1: Erasmus hogeschool Brussel, Departement of Teacher Training 2: Vrije Universiteit Brussel, Departement of Physical Education and Sports Training Introduction Growing evidence exists on low prevalence of fundamental movement skill (FMS) mastery of pre-school as well as of primary school children (Cools et al., 2009). Since motor proficiency is an important chain in a physical active lifestyle, the aim of this study was to examine the FMS mastery in 6 to 6 ½ year-old Flemish pre-school children. Methods Two hundred thirty six 6-year-old Flemish pre-school children (N=236) were individually assessed with the Motoriktest für Vier- bis Sechsjährige Kinder (MOT 4-6). Children's performances on 17 tasks were rated on a 3-point scale (0,1,2) and generated a Total Score (TS) of 34. Descriptive analyses were used to report frequencies and percentiles of scores. Tasks were grouped in four performance areas: Stability, Locomotion, Object control and Fine motor skills. Results Mean TS was 20.78 (SD= 5.7), without significant gender differences. A 2/2 score was obtained by more than 50% of the children in tasks of three different performance areas: stability (forward balance), fine motor skills (placing dots, grasping a tissue) and locomotion (passing through a hoop, height jump, turning jump). A 0/2 score was obtained by more than 30% of the Flemish pre-school children in tasks of two performance areas: stability (backward balance) and object control skills (throwing at a target, catching a ring). Discussion Although only few studies have explored FMS mastery at 6 years of age, results show similar trends as other studies (Okely, 2004). Considering the percentages of children in our study that perform poor on FMS, it is clear that on certain skills a lot of children still have difficulties at the age of 6. In general, prior attention should be paid to improvement of backward balance, throwing and catching skills. As object control skill proficiency, rather than locomotor skills, appear to be more crucial to predict PA in adolescence (Barnett, 2009), object control activities need to be more encouraged in early childhood. References Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O., Beard, J.R. (2009). Childhood Motor Skill Proficiency as a Predictor of Adolescent Physical Activity, *Journal of Adolescent Health*, 44: 252-259 Cools, W., De Martelaer, K., Andries, C., Samaey, C & Vandaele B. (2009). Fundamental movement skill development of four to six year-old pre-school children in Flanders. *Contemporary Sports, Leisure and Ergonomics*, (eds.) Thomas Reilly and Greg Atkinson, Routledge: London, 25, 335-352 Okely, A.D., Booth, M.L. (2004). Mastery of fundamental movement skills among children in New South Wales: prevalence and sociodemographic distribution, *Journal of Science and Medicine in Sport*, 7(3): 258-372

## FUNDAMENTAL MOVEMENT SKILL PERFORMANCE IN RELATION TO SEX, WEIGHT, HEIGHT AND PHYSICAL ACTIVITIES IN PRESCHOOL CHILDREN

COOLS, W.1,3, DE MARTELAER, K.1,3, SAMAAY, C.1, ANDRIES, C.2.

1 VUB LK (BRUSSELS, BELGIUM) 2 VUB PE (BRUSSELS, BELGIUM), 3 VUB IDLO (BRUSSELS, BELGIUM)

Introduction As the development of fundamental movement skills is crucial to evolve a fit and healthy lifestyle, it is important to understand the factors related to this development. Therefore, the purpose of this study was to investigate gender differences in movement skill competence among 4 to 6-year-old preschool boys and girls and to investigate main effects of child specific characteristics (height, BMI and weight), past experiences (formal, informal and outdoor play activities) and socializing agents (siblings, pets) on their movement skill performance. Methods Subjects included 846 preschool children (471 boys, 375 girls) between 4 and 6 years of age. Children's FMS performance was assessed with the Motoriktest für Vier- bis Sechsjährige Kinder [MOT4-6]. Children's characteristics and physical activity (PA) were measured by self-administered parental surveys. A moderated multiple regression analysis was executed to investigate whether gender moderated the association between preschool children's movement skill performance and child individual factors. Results There were no significant differences in general movement skill and locomotor skill between boys and girls. Girls showed significantly better balance skill than boys ( $p < .01$ ) and boys showed significantly better object control skill than girls ( $p < .001$ ). Preschool children's higher movement skill was significantly predicted by a lower BMI z-score ( $p < .001$ ), by a higher height z-score ( $p < .001$ ), higher formal activity participation ( $p < .001$ ), higher outdoor play ( $p < .01$ ) and higher sports week participation ( $p < .01$ ). Additionally, lower pet interaction ( $p < .05$ ) significantly predicted higher locomotor skill in preschool children. The children's movement competence did not depend on the interaction between the child's gender and the entered child individual factors. Discussion This study has shown that 4 to 6-year-old preschool children's movement skill competence was positively correlated with growth, formal activities, outdoor play and sports week participation. The study also demonstrated that heavier children are less competent. Also gender differences appeared in children's movement skill competence. When organizing physical activities for children, it may be useful to offer different opportunities for boys and girls.

## THE ROLE OF THE COMMUNITY COACH IN ENABLING HEALTHFUL CHANGE THROUGH A PREMIER LEAGUE COMMUNITY FOOTBALL PROGRAMME

PARNELL, D., STRATTON, G., DRUST, B., RICHARDSON, D.

LIVERPOOL JOHN MOORES UNIVERSITY

Introduction There is little research attending to the working practices of Football in the Community (FitC) schemes and/or the role of the coaches that operate within them (Watson, 2000). The coach can play a significant developmental role within an individual's life (Wylleman, Alfermann, and Lavallee, 2004). This study examines the effectiveness of community coaches in enabling positive healthful changes. Methods The principles of ethnography guided the 1st author's fieldwork and observational engagement. This 10 month reconnaissance phase included a 16-week long community coaching initiative for primary school children (aged 7-11 years) (n=57). The 1st Author was immersed in the day-to-day working practices of the FitC scheme, (typically) 1-2 days per week. Informal data collection techniques were employed throughout (i.e., informal interactions) and recorded through a reflective diary and field notes. Participant focus groups were undertaken during and post initiative (week 8, n=10, week 16, n=10). Results Focus group data showed that most of the children were already 'active' and engaged in regular physical activity. The majority highlighted that the sessions provided fun and enjoyable experiences. Despite this the initiative experienced high attrition rates (54%). Some children alluded to negative memories relating to the coaches' practice. The 1st Author observed this practice and shared similar concerns, especially the absence of any healthful behaviour change message. Specifically coaches employed practices that in some cases failed to support or create a positive developmental environment relevant for the age and (football) ability of the participants. Coaches tended to adopt a performance oriented approach to their sessions. It became apparent that coaches were required to possess a minimum of a Football Association Level 2

Coaching Qualification (which has little or no health specific content). Discussion The adoption of a performance orientated approach and the absence of any healthful sentiments or behaviour change message limited the effectiveness of the initiative. However, the coaches did (usually) provide a fun and enjoyable experience. In order, to (explicitly) promote positive healthful change, coaches require a wider skill base. Specifically, skills that enable them to understand, translate and encourage positive healthful change within a variety of populations with varying levels of ability. References Watson, N. (2000). Football in the community: what's the score? Soccer and Society, 1, 114-125. Wylleman, P., Alfermann, D and Lavallee, D. (2004). Career transitions in sport: European perspectives. Psychology of Sport and Exercise, 5, 7-20.

## 10:15 - 11:45

### Oral presentations

#### OP-SH05 Health and Paediatric Psychology

##### PSYCHOLOGICAL CORRELATES OF GIRLS' PHYSICAL ACTIVITY LEVELS DURING MIXED-GENDER PHYSICAL EDUCATION LESSONS

SLINGERLAND, M., HAERENS, L., OOMEN, J., BORGHOUTS, L.B.

FONTYS UNIVERSITY OF APPLIED SCIENCES

Psychological Correlates of Girls' Physical Activity Levels During Mixed-Gender Physical Education Lessons Slingerland, M.1 Haerens, L.2, Oomen, J.1, Borghouts, L.B.1 1Fontys University of Applied Sciences (Tilburg, the Netherlands) 2Ghent University (Ghent, Belgium) Introduction To enhance the benefits of physical education in directly contributing to physical activity levels, maximal student involvement is imperative. However, adolescent girls have lower physical activity levels in PE than boys, mainly during competitive invasion games (Laurson et al., 2008; Slingerland et al. 2011). Starting from SDT as a theoretical framework, it was hypothesized that this gender difference might be related to differences in perceived competence, self-determined motivation, and perception of the learning climate. Methods Two-hundred-and-eighteen participants (127 boys, 89 girls, age 13,1 yrs. (SD=0.98) 11-15 yrs.) wore heart rate monitors during 25 minutes of an adapted 4 on 4 basketball gameplay in mixed-gender teams. After the gameplay-session students filled in validated questionnaires assessing their perception of the learning climate (competitive vs. non-competitive), perceived competence and self-determined motivation. All questionnaires were adapted to represent the basketball gameplay session students had just received. Percentage of time spent in moderate, vigorous and moderate-to-vigorous physical activity (MVPA) was calculated from the heart rate monitor data. T-tests were used for analyzing the data. Results Girls spent a lower percentage of time in MVPA compared to boys (64% versus 73%,  $t(214)=3.9$   $p<0.0001$ ), which was caused by a difference in vigorous activity (24% vs. 36%,  $t(214)=3.9$   $p<0.0001$ ) but not in moderate activity ( $t = -1.08$ , ns). Girls compared to boys perceived the learning climate as more competitive ( $t(214)=-2.388$   $p<0.05$ ), had lower perceived competence ( $t(214)= 6.845$   $p<0.0001$ ) and lower self-determined motivation ( $t(214)=2.243$   $p<0.05$ ). Discussion During mixed competitive gameplay girls perceive the learning climate as more competitive than boys. Also, they have lower perceived competence and have lower self-determined motivation compared to boys. This could explain the lower percentage of gameplay time in MVPA. However, further study is needed to determine the casual relationships. Nevertheless, PE programs that are dominated by competitive gameplay might need to be re-evaluated in terms of suitability for girls. References Laurson, K., Brown, D., Cullen, R. & Dennis, K. (2008) Heart rates of high school physical education students during team sports, individual sports, and fitness activities. Research Quarterly for Exercise and Sport, 79. Slingerland, M., Oomen, J., Borghouts L. (2011) Physical activity levels during Dutch primary and secondary school physical education, European Journal of Sport Sciences, accepted for publication.

##### 'GO CLIMB A MOUNTAIN': THE ROLE OF USING OUTDOOR ADVENTURE ACTIVITIES IN SPORT PSYCHOLOGY INTERVENTIONS

RICHARDS, K.

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Outdoor adventure activities have a long history of application and practice in promoting psychological development and physical activity. They are often used, for example, to enhance mental well-being, promote psychological resilience, improve inter-personal relations and develop self-confidence. Sport psychologists have both capitalised on these benefits in their applied work (e.g. in the development of team cohesion) and have worked with some outdoor adventure sports (e.g. sailing). Also research has examined psychological characteristics of outdoor adventure athletes (e.g. mountaineers). However, there is limited research that examines the practical application of outdoor activities in wider sport psychology interventions, yet the growing psychotherapeutic application of outdoor adventure clearly indicates that these activities have a clinical application. Drawing upon applied research of developing outdoor adventure activities for psychotherapeutic interventions this paper will consider research and practice issues in the application of outdoor adventure activities in sport psychology (for example, the use of Interpersonal Process Recall as a research and practice strategy). This will be illustrated by examining psychological change processes in action of participants taking part in outdoor adventure interventions. In conclusion, the paper will raise critical questions about the future development of researching and using outdoor adventure activities for a range of athlete populations and psychological conditions.

##### WHAT IS THE IMPACT OF CHILDREN'S PHYSICAL EDUCATION FOR ASSURING DAILY PHYSICAL ACTIVITY RECOMMENDATIONS?

RODRIGUES, L.1,2, SOUSA, M.1,3

1: IPVC (PORTUGAL); 2: CIDESD (PORTUGAL); 3 ANTÓNIO FEUÓ BASIC SCHOOL (PONTE DE LIMA, PORTUGAL)

Introduction The benefits of regular physical activity (PA) for the health, fitness and behavior of school age children are major topics of discussion in the literature. International recommendations on this matter are for children to be physically active at least 60 minutes (1 hour), or to achieve a minimum of 12000 steps (girls) and 15000 steps (boys) each day. Since children attend school for a significant part

of their day, the expectation is that school time will have a major impact on their PA levels, and specifically that Physical Education (PE) time will significantly contribute to comply with the daily recommendations for every child. Methods A sample of 93 boys and 110 girls attending the 5th grade on a Portuguese school wore a pedometer (Silva Ex3 Connect) during five consecutive school days. BMI was used to classify each child according to IOTF cut-off values. Children self reported their participation on organized sports. A binary logistic regression was used to calculate the probability (odds ratio) for achieving the recommended number of steps on each day according to the existence of PE on that day. Results Results showed that during week days only 20% of the cases achieved the recommendations (23% for boys; 17% for girls), but when looking for school days with PE lessons (90 min or 45 min) we found a significant increase on the compliance. On a PE day, 41% and 21% (respectively on a 90 min and on a 45 min session day) of the children reached the recommended cut-off values; while on a regular (non PE) day, only 13% of the children achieved this outcome. Children on a PE day showed an odd ratio for complying with the recommendations respectively five (4.7) times higher (95%CI=3.2 to 6.8) on a 90 min PE day, and two (1.8) times higher (95%CI=1.2 to 2.8) on a 45 min PE day, comparing to a regular non PE day. This effect was independent of gender and weight status. As expected, the probability was even stronger when taking into account only children with no sports participation [8.7 (95%CI=4.7 to 13.1) for 90 min PE, and 2.6 (95%CI=1.4 to 4.7) for 45 min PE]; and remained significant for children with organized sports participation only for the 90 min PE days (2.8; 95%CI=1.5 to 5.0). Discussion Given the low percentage of children that achieve the recommended daily number of steps, it is imperative to promote opportunities for children to be more active. These results show evidence for the possible relevancy of a general approach to PA promotion based on school PE. Being the only mandatory moment were all children have the opportunity to be physically active, PE sessions showed a tremendous impact for the desirable maintenance of health related levels of PA.

### **PHYSICAL EDUCATION TEACHING AND ENERGY EXPENDITURE: A PILOT STUDY ON THE TEACHING COMPETENCES OF PRIMARY SCHOOL TEACHERS IN ITALY.**

AIELLO, P., SIBILIO, M.

UNIVERSITY OF SALERNO

International studies have showed that physical activities and sports for the development of healthy and effective motor habits in children of primary school can be supported by a professional teacher aware of the effects of used teaching methods (Carlomagno et al., 2010). The quality of physical activities and sports teaching is in fact influenced by well qualified teachers and the time devoted to them in the curriculum studies (Penney et al., 2009). The present pilot study addresses the need of evaluating as the lack of a specific formation of physical education teachers could negatively affect the didactics, realizing movement activities in which the intensity level does not correspond to the real intentions of the teacher. The research, conducted using as sample 176 students of primary school of Campania region (Italy), has required the following steps: • setting of a university-school working group made of researchers of the University of Salerno and teachers of primary school (6-11 aged students); • an integrated school-university plan ; • arrangement of an informative report to collect data on students; • training to teachers on the use of the portable multi sensor monitoring system; • request to the students to perform a physical activity of warm-up lasting 15 minutes; • collecting data of the caloric consumption of each student; As a calorimetric monitoring system was used the portable metabolic holter BodyMedia. In all classes it was found an average energy expenditure value greater than expected value in light physical activity of 15 minutes. In 6 classes out of 11 the average value was even higher than the expected value of 6 METs for moderate activities. The overall average (about 6 METs) was found to be almost twice the maximum expected (3 METs). The data collected highlighted the lack of teachers knowledge on the effects produced by their teaching methods, providing the possibility of a further deepening of the analysis of training needs of teachers that nowadays, in Italy, is still very weak in terms of methodology and assessment skills and not very interested in the physiological outcomes that contribute to the effectiveness of physical education teaching. REFERENCES 1. Arvidsson D, Slinde F, Larsson S, Hulthén L. (2007). Energy cost of physical activity in children: Validation of senseware armband. *Med Sci Sport Exercise* Nov;39 (11):2076-84. 2. Carlomagno N. et al. (2010) The assessment-prediction capacities of teachers during physical activities in the primary school in Italy: analysis of the relationship between expected energy expenditure and actual energy expenditure during a light physical activity lasting 15 minutes. *Sport Science* 3 (2010) 2: 7-10; 3. Penney D., Brooker R., Hay p., Gillespie L.(2009). Curriculum, pedagogy and assessment: three message systems of schooling and dimensions of quality physical education. *Sport, Education and Society*, 14(4), pp.421-442.

### **DEVELOPMENT AND INITIAL VALIDATION OF A PSYCHOMETRIC MEASURE OF CHILDREN'S WELL- AND ILL-BEING**

BRACEY, S.J., QUESTED, E., DUDA, J.L.

UNIVERSITY OF BIRMINGHAM

Well-being is a key outcome in research on the implications of an active lifestyle in variability of motivational processes in the physical activity domain. Yet there is a dearth of empirical work concerning physical activity and well-/ ill-being relationships with child populations and it is unclear if extant measures adequately capture children's conceptions of these experiences. Moreover, it is important to keep in mind that developmental differences are apparent within conceptualisations of such psychological constructs (Eys, et al., 2009). The aim of this research therefore was to develop and provide initial psychometric information on a multidimensional measure of children's well-and ill-being. Method Drawing from a qualitative study of children's concepts of well-/ill-being (Bracey, et al., 2010, Dec) and review of the literature, an initial item pool of 103 items was created. These items were deemed to reflect a number of emerging dimensions, e.g., vitality, lethargy. Next a rigorous process of content analyses was conducted following recommendations by Dunn et al. (1999). A panel of experts were asked to appraise the content and face validity of the scales. The items were categorised by the experts in terms of emerging sub-themes, then the extent to which they perceived the item to tap the identified construct was rated using a 5-point Likert scale (1=poor match to 5=excellent match). Analyses revealed a reduced item pool of 70 items measuring children's well- and ill-being. Further validation of the items will be conducted using an independent sample of youth team sport participants (N= 600, age 7-18 years). Exploratory and confirmatory factor analyses will be employed to test factorial validity and invariance of the scales using structural equation modelling (SEM). Results Preliminary analysis suggests the content and factor validity of the questionnaire is good. It is hypothesised that the proposed hierarchical measurement model will be supported with initial analyses supporting the predicted two high order dimensions and ten sub dimensions. Data from the CFA and analyses of reliability will be presented at the Congress. Discussion Children's perceptions of their well-and ill-being experiences in the physical activity domain hold important implications (e.g., attrition rates, overall health and development). It is hoped the emerging measure will be a useful tool in future research. References Bracey, S.J., Quested, E., & Duda, J.L. (2010, December). Children's conceptualisations of well- and ill-being. Poster session presented at the British Psychological Society's Division of Sport and Exercise Psychology biannual conference, London, UK. Eys, M. A., Loughhead, T. M., Bray, S. R., & Carron, A. V. (2009). Perceptions of Cohesion by Youth Sport Participants. *Sport Psychologist*, 23(3), 330-345. Dunn, J.G.H., Bouffard,

M., & Rogers, T.W. (1999). Assessing item content-relevance in sport psychology scale-construction research: Issues and recommendations. *Measurement in Physical Education and Exercise Science*. 3(1), 15-36.

## Oral presentations

### OP-PM11 Training and Testing

#### ADDITIONAL ENDURANCE TRAINING SUPPRESSES THE EFFECT ON MAXIMAL FORCE PRODUCTION OF SPRINT TRAINING IN RATS

FURRER, R.

RESEARCH INSTITUTE MOVE - FACULTY OF HUMAN MOVEMENT SCIENCES

Additional endurance training suppresses the effect on maximal force production of sprint training in rats R. Furrer<sup>1</sup>, R.T. Jaspers<sup>1</sup>, N. Bravenboer<sup>1</sup>, P. Lips<sup>1</sup>, A. de Haan<sup>1</sup>. <sup>1</sup> Research Institute MOVE, VU University Amsterdam, the Netherlands Introduction: Different types of mechanical loading induce different adaptations in muscle tissue. Resistance exercise (short powerful contractions) induces muscle hypertrophy and increased muscle strength whereas long duration low intensity exercise results in atrophy and increased endurance. A combination of the two types of loading, known as concurrent training, can cause conflicting situations at the molecular level (van Wessel et al., 2010). The aim of this study was to investigate whether improvement of functional performance and maximal muscle force as a result of sprint training is suppressed when endurance training is added (concurrent training). Methods: 28 female Wistar rats, 10 weeks of age, were assigned to the sprint (n=10), concurrent (n=10) or control (n=8) group. The rats were trained 5 days per week for 6 weeks on a treadmill. During the sprint training, the rats performed 10 sprints of 15 s at near maximal velocity. The training was progressive with increasing velocity and inclination of the treadmill to a maximum of 40%. In addition to the sprint training, the concurrent training group also performed progressive endurance training on the same day (8 hours rest between the two training sessions). Maximal sprint velocity at an inclination of 40% was tested every two weeks by sprints of 15 s starting at 36.6 m/min and increasing up to their maximal velocity. After completing the 6 weeks training period, maximal muscle force production of the gastrocnemius medialis muscle (GM) was measured in situ. Results: The maximal sprint velocity significantly increased (p=0.001) by 13.5%. There was no significant difference of the maximal velocity between the sprint and concurrent group (p=0.76). After 6 weeks of training the normalized maximal force production (Fmax) of the GM of respectively the sprint, concurrent and control group was 14.6 (±1.1) N, 13.9 (±0.9) N and 13.2 (±0.6) N. Fmax of the sprint group was 10.6% higher (p=0.015) than the control group, in contrast to the concurrent group which was not different from the control (p=0.30) nor the sprint group (p=0.50). Discussion: This study shows that sprint training significantly increases Fmax. The effect of the sprint training on Fmax is suppressed if additional endurance training is performed. Interestingly, despite the increase in Fmax, functional performance during the sprint test does not differ between the sprint and concurrent group. Further analyses at the molecular level will elucidate this issue. Reference van Wessel T, de Haan A, van der Laarse WJ, Jaspers RT The muscle fiber type-fiber size paradox: hypertrophy or oxidative metabolism? *EJAP* 110: 665-694, 2010.

#### DIFFERENCE IN APONEUROSIS ELONGATION DURING ECCENTRIC CONTRACTIONS BETWEEN THE FIRST AND SECOND EXERCISE BOUTS OF THE ELBOW FLEXORS

LAU, W.-Y., BLAZEVICH, A., NEWTON, M., NOSAKA, K.

EDITH COWAN UNIVERSITY (AUSTRALIA)

DIFFERENCE IN APONEUROSIS ELONGATION DURING ECCENTRIC CONTRACTIONS BETWEEN THE FIRST AND SECOND EXERCISE BOUTS OF THE ELBOW FLEXORS Lau, W.-Y., Blazeovich, A., Newton, M., Nosaka, K. Edith Cowan University (Australia) Introduction Unaccustomed eccentric exercise induces muscle damage characterised by delayed onset of muscle soreness (DOMS) and loss of muscle strength, but a repeated bout of the same exercise within several weeks results in less muscle damage, which is known as the repeated bout effect (1). It has been documented that neural, mechanical and cellular adaptations are associated with the repeated bout effect, but the underlying mechanisms have not been fully understood (2). The present study tested the hypothesis that muscle-tendon behaviours would be different between bouts such that the elongation of the aponeurosis of biceps brachii during eccentric contractions would be smaller during the second than the first eccentric exercise bout. Methods Ten untrained men (21-39 y) performed two exercise bouts consisting of 10 sets of 6 maximal isokinetic (60°s<sup>-1</sup>) eccentric contractions of the elbow flexors with the non-dominant arm separated by 4 weeks. During each eccentric contraction, the elbow joint angle was forcibly extended from a flexed (120°) to a fully extended position (180°) under maximal activation. The movements of the biceps brachii aponeurosis were recorded by B-mode ultrasonography (Aloka SSD-a10, Japan), and the movement distance of the end point of the aponeurosis origin from the beginning to the end of each contraction was calculated. Maximal voluntary isometric contraction strength (MVC), range of motion (ROM) and muscle soreness (VAS) were measured before, immediately after, 1-7 days following exercise. Changes in the movement distance together with the torque from the first to the last set, and changes in MVC strength, ROM and VAS after exercise were compared between first and second bouts by a two-way repeated measures ANOVA. Results Compared with the first bout, changes in MVC, ROM and VAS were smaller (P<0.05) following the second bout, showing the typical repeated bout effect. During eccentric contractions, the aponeurosis origin was extended, and the average distance of the aponeurosis elongation increased (P<0.05) from the 1st set (8.2 ± 4.7 mm) to the 10th set (16.4 ± 4.7 mm) for the first bout; however, no significant increases were found for the second bout (1st set: 8.4 ± 3.9 mm, 10th set: 9.3 ± 3.1 mm). Discussion These results suggest that the reduced magnitude of muscle damage in the second exercise bout compared with the first bout is associated with the smaller length changes in the aponeurosis in the second bout. It is possible that muscle fibre length changes are smaller in the repeated bout than the initial bout, which reduced the strain to the muscle fibres, resulting in less muscle damage. Reference 1. Nosaka K, Newton M. *J Strength Cond Res*.16:117-122, 2002 2. McHugh MP et al. *Sports Med*. 27:157-170, 1999

## TALENT IDENTIFICATION AMONG 14- TO 17-YEAR-OLD ELITE MALE SOCCER PLAYERS BASED ON PHYSIOLOGICAL CHARACTERISTICS

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**INTRODUCTION** Although talent identification has been a popular topic in science and soccer, there is no consensus whether future success can be predicted by physiological tests at an early age (Le Gall et al., 2010; Williams & Reilly, 2000). For this reason, the purpose of the following study was to compare physiological characteristics among 14- to 17-year-old pre-selected soccer players in terms of subsequent career success. **METHOD** In 2001, the Austrian Football Association, the Department of Sport Science (University of Salzburg) and the IMSB (Vienna) launched a project targeting the development of talented soccer players who attended youth soccer academies throughout Austria. Since then, approximately 5,000 players ranging in age from 13 to 18 years were measured biannually in straight-line sprint (5, 10 and 20 m), 5 x 10 m line-to-line sprint (LL), hurdles agility run (AR), foot tapping (FT), counter movement jump (CMJ), drop jump (DJ), reaction test (RT), 2 kg standing medicine ball throw (MBT), sit and reach test (SR) and 20 m multi-stage endurance run (ER). 359 outfield players, ages 14 – 17, remained to be analyzed in a longitudinal design. Furthermore, these pre-selected academy players were retrospectively categorized based on whether they had been drafted into a youth national team (Under 18 to 21, n = 107) or not. The differences between Group (i.e. 'selected' vs. 'non-selected') and across Age (i.e. 14, 15, 16, 17 years) were analysed using a separate ANOVA for each variable. **RESULTS** The main effect for Age was significant ( $p < .01$ ) for all comparisons. A significant main effect for Group was found in LL,  $F(1, 336) = 11.34$ ,  $p < .01$ ,  $\eta^2 = .03$ ,  $(1-\beta) = .92$ , in AR,  $F(1, 313) = 6.72$ ,  $p = .01$ ,  $\eta^2 = .02$ ,  $(1-\beta) = .73$ , in CMJ,  $F(1, 341) = 6.52$ ,  $p = .01$ ,  $\eta^2 = .02$ ,  $(1-\beta) = .72$ , and in MBT,  $F(1, 340) = 16.34$ ,  $p < .01$ ,  $\eta^2 = .05$ ,  $(1-\beta) = .98$  in favour of selected players. Furthermore, a significant Group x Age interaction was observed displaying a greater increase for selected group in 5 m,  $F(3, 1050) = 4.77$ ,  $p < .01$ ,  $\eta^2 = .01$ ,  $(1-\beta) = .90$ , in 10 m,  $F(3, 1050) = 5.19$ ,  $p < .01$ ,  $\eta^2 = .02$ ,  $(1-\beta) = .93$ , in 20 m,  $F(3, 1050) = 4.75$ ,  $p < .01$ ,  $\eta^2 = .01$ ,  $(1-\beta) = .90$ , and in MBT,  $F(3, 1020) = 3.41$ ,  $p = .02$ ,  $\eta^2 = .01$ ,  $(1-\beta) = .77$ . **CONCLUSION** Regarding talent identification, we conclude that performance in soccer specific sprint tests (LL, AR), as well as in CMJ and in MBT at a young age has a small but crucial impact on future career success of elite soccer players. Concerning talent development, selected players showed higher improvements in straight-line sprint and in MBT during 5-year-academy-delay. Further research is needed to clarify these differences in development. Le Gall F, et al. (2010). J Sci Med Sport, 13, 90-95. Williams AM, Reilly T. (2000). J Sports Sci, 18, 657-667.

## THE CONTRIBUTION OF ANTHROPOMETRIC, PHYSICAL PERFORMANCE AND COORDINATIVE CHARACTERISTICS TO FEMALE GYMNASTICS TALENT IDENTIFICATION

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**Introduction** Traditional talent identification (TID) models in female gymnastics search for young gymnasts displaying characteristics for potential success by measuring their current performance on a multidimensional test battery (Régner et al., 1993). However, little is known about the contribution of those testing procedures in predicting the gymnasts' future success. This study aimed at identifying which variables are able to discriminate between elite and sub-elite gymnasts and contribute to performance in competition two years later. **Methods** In 2008, 33 young female competitive gymnasts aged 7-8 years completed a test battery measuring anthropometric, physical performance and coordinative characteristics. Based upon a technical evaluation by expert coaches, the gymnasts were assigned to an elite (N=19) or a sub-elite (N=14) group. In 2010, the all-around competition results of the 12 elite gymnasts effectively competing at the elite level two years later were obtained. Results MANCOVA with competitive level as fixed factor and age and maturity as covariates indicated that all gymnasts measured in 2008 portrayed a similar athletic build, but the elite-level gymnasts outperformed the less gifted gymnasts on all physical and coordinative variables. Linear regression analysis revealed that only a non-sport-specific motor coordination test of the 2008 test battery significantly contributed to the all-around result in competition two years later, with 38.7% of the variation in the competition score being explained by the result on that coordination test two years earlier. **Discussion** Competitive gymnasts exhibit a homogeneous anthropometric profile, which might be attributed to previous selection since growth and maturation are not largely affected by gymnastics training (Baxter-Jones et al., 2002). Likewise, although the physical performance characteristics were able to separate the two levels of gymnasts, these variables seemed to have low predictive value due to the possible synergic influence of training, growth and maturation (Vaeyens et al., 2008). It is likely that the anthropometric and physical performance variables will identify those gymnasts who dominate at the time of testing rather than those with potential to excel. In gymnastics, the early identification of gymnasts should take a motor coordination test into account as its discriminative and predictive power might be valuable for selection within a relatively homogeneous population of gymnasts exhibiting similar anthropometric and physical profiles. **References** Baxter-Jones AD, Thompson AM, Malina RM. (2002). Sports Med Arthrosc Rev, 10(1), 42-49. Régner G, Salmela JH, Russell SJ (1993). Handbook of research on sport psychology, 290-313. Macmillan Publishing Company, New York. Vaeyens R, Lenoir M, Williams AM, Philippaerts RM (2008). Sports Med, 38, 703-714.

## NO EFFECTS OF ENDURANCE TRAINING ON SKELETAL MUSCLE FASCICLE ANGLE, ANATOMICAL CROSS-SECTIONAL AREA OR FIBER CROSS-SECTIONAL AREA

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**Introduction** Fascicle Angle (FA) is believed to increase as a result of fiber hypertrophy (2), and therefore associated with force generating capacity (3). FA has also been suggested as the explanatory link of the discrepancy observed in the relative adaptations in anatomical cross-sectional area (CSA) and fiber CSA following resistance training. However only one study has confirmed this in vivo (4). So far, no longitudinal studies have investigated the effect of endurance training on FA (1). The purpose of this study was therefore to investigate and compare the longitudinal effects of ten weeks of either progressive endurance or resistance training on FA, anatomical and fiber CSA and muscle strength. **Methods** 18 young untrained men were divided into an either endurance cycling (END) or resistance training (RT) group, with 7 subjects in each group completing the training period. Muscle morphological measures included assessment of m. vastus lateralis FA obtained by ultrasonography. Anatomical CSA was obtained by MRI of the total thigh (sum of extensor, flexor and adductor compartment). Fiber CSA was deduced from histochemical analyses of biopsy samples from m. vastus lateralis. Functional performance measures included VO2max, maximal voluntary contraction (MVC) of knee extensors and 3 repetition maximum (3RM) in knee extension (KE)

and leg press (LP). Results No changes in FA, anatomical or fiber CSA were observed for END after training. RT increased FA by  $23 \pm 8\%$  ( $p < 0.01$ ), anatomical CSA of the knee extensor muscles by  $9 \pm 3\%$  ( $p = 0.001$ ) and fiber CSA by  $19 \pm 7\%$  ( $p < 0.05$ ). END increased  $\dot{V}O_{2\max}$  by  $10 \pm 2\%$ . The RT group knee extensor MVC increased by  $19 \pm 5\%$  ( $p < 0.001$ ). RT increased 3RM in KE and LP ( $p < 0.001$ ), while END increased 3RM in LP ( $p < 0.001$ ). RT was significantly stronger than END post training in 3RM LP ( $p < 0.01$ ). Discussion 10 weeks of endurance cycling did not change FA, anatomical or fiber CSA. Nor was MVC increased. From the morphological adaptations in RT, it was validated that FA can serve as an explanatory link between the observed discrepancy between changes in anatomical and fiber CSA (4). The fact, that no increases in FA and fiber CSA were observed in response to endurance training, indirectly supports, that fiber hypertrophy and FA are interrelated. References 1. Blazevich, AJ (2006) Sports Med 36, 1003-1017 2. Blazevich, AJ, and Sharp, NC (2005) Cells Tissues Organs 181, 1-10 3. Folland, JP, and Williams, AG (2007) Sports Med 37, 145-168 4. Aagaard, P, Andersen, JL, Dyhre-Poulsen, P, Leffers, AM, Wagner, A, Magnusson, SP, Halkjaer-Kristensen, J, and Simonsen, EB (2001) J Physiol 534, 613-623

## WHOLE-BODY CRYOTHERAPY ENHANCES MUSCULAR FORCE RECOVERY AFTER A TRAIL RUNNING

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WHOLE-BODY CRYOTHERAPY ENHANCES MUSCULAR FORCE RECOVERY AFTER A TRAIL RUNNING Louis J1,2, Hausswirth C2, Pournot H1,2, Bieuzen F2, Brisswalter J1 1Laboratory of human motricity, education and health, University of Nice-Sophia Antipolis, France 2Research department, National institute of sport, expertise, and performance (INSEP), Paris, France Introduction Eccentric contractions endured in downhill segments of trail running events are well known to procure severe structural damages in muscles, affecting their contractile and recuperative properties (Nicol et al. 2006). Therapies based on temperature changes are one of the most recent strategies proposed to enhance muscular recovery from such endurance efforts (Peiffer et al. 2009). Within this context, the purpose of this study was to test the efficacy of whole body cryotherapy (WBC), far infrared (FIR) or passive (PAS) modalities in enhancing muscular recovery within the 48 hours after a simulated trail running. Methods In 3 non-adjoint weeks, 9 well-trained runners (age:  $31.8 \pm 6.5$  years; body mass:  $70.6 \pm 6.5$  kg; height:  $1.79 \pm 0.06$  m; maximal oxygen uptake:  $62.0 \pm 3.9$  ml.min.kg<sup>-1</sup>) performed 3 repetitions of a simulated trail run on a motorized treadmill, in order to generate muscular fatigue. Immediately (post), post 24h, and post 48h after exercise, all participants tested three different recovery modalities (3min exposition to WBC at  $-110^{\circ}\text{C}$ , 30min exposition to FIR, 30min exposition to PAS) in a random order over the three separate weeks. Markers of muscle fatigue (maximal isometric muscle strength, plasma creatine kinase activity and perceived sensations) were recorded before, immediately after (post), post 1h, post 24h, and post 48h after exercise. Changes in studied variables over time and between recovery modalities were assessed by using a two way (period x recovery modality) analysis of variance. Results In all testing sessions, the simulated 48 min trail run induced a similar, significant amount of muscular fatigue. Maximal muscle strength and perceived sensations were recovered after the first WBC session (post 1h), while recovery took 24h with FIR, and was not attained through the PAS recovery modality. No differences in plasma CK concentrations were recorded between conditions. Conclusion Three WBC sessions performed within the 48 hours after a fatiguing running exercise accelerate muscular recovery to a greater extent than FIR or PAS modalities. References Nicol C, Avela J, Komi PV. (2006) Sports Med, 36:977-99. Peiffer JJ, Abbiss CR, Nosaka K, Peake JM, Laursen PB. (2009) J Sci Med Sport, 12:91-96.

## Oral presentations

### OP-PM41 Muscle: Physiology

#### LOWERING OF HEART RATE AFTER EXERCISE TRAINING IS ASSOCIATED WITH ADAPTATIONS IN SKELETAL MUSCLE: INSIGHT FROM HEART RATE PACING DURING TRAINED AND UNTRAINED MUSCLE EXERCISE

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Introduction Exercise training is associated with a lowering of heart rate (HR) at the same workload. Generally, these adaptations are thought to be associated with adaptations in the central circulation. However, the signalling from contracting skeletal muscle (exercise pressor reflex) could also be dependent on the muscle training status. The aim of this study was to investigate the effect of exercise with a trained and untrained muscle on systemic and peripheral hemodynamics with and without atrial pacing. Methods 8 male subjects ( $24 \pm 2$  years,  $180 \pm 3$  cm,  $74 \pm 4$  kg,  $49 \pm 2$  mlO<sub>2</sub>/min/kg) were studied after 5 weeks of one-leg knee-extensor training (3-4 times/week) and 2 weeks of immobilization (full leg cast) of the other leg. Systemic and leg hemodynamics were measured during exercise with the: 1) untrained leg ( $19 \pm 2$ ,  $37 \pm 4$ ,  $56 \pm 5$ W), 2) trained leg ( $19 \pm 2$ ,  $37 \pm 4$ ,  $56 \pm 5$ ,  $74 \pm 7$ W) and 3) trained leg with HR pacing to untrained leg HR. Data were analyzed by repeated measures two-way ANOVA and Tukey's honestly significant difference (HSD) post hoc procedure. Results During exercise with the trained leg, HR was  $12 \pm 2$  (37W) and  $19 \pm 4$  (56W) beats/min lower than when exercise was performed with the untrained leg ( $P < 0.05$ ). However, cardiac output was similar because of a parallel change in stroke volume ( $P < 0.05$ ). MAP was lower during exercise with the trained leg ( $116 \pm 4$  mmHg (56W)) compared to the untrained leg ( $124 \pm 2$  mmHg), whereas there was no difference in central venous and pulmonary arterial pressures. Leg blood flow and plasma norepinephrine levels tended to be lower when exercise was performed with the trained leg compared to the untrained leg, whereas plasma epinephrine levels were similar. When HR was paced during exercise with the trained leg, cardiac output and leg blood flow remained unchanged, whereas stroke volume decreased ( $P < 0.05$ ) and blood pressures remained similar to control conditions. Discussion These results demonstrate that adaptations in skeletal muscle contribute to the lowering of HR after endurance training and indicate that there is a lowering of the sympathetic activation in trained muscle. The higher stroke volume after exercise training appears to be associated with an increased diastolic function and/or lowering of cardiac afterload.

#### CHANGES IN MYOELECTRICAL ACTIVITY AFTER PROLONGED MUSCLE DISUSE

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Introduction Strongly restricted muscle activity or complete immobilization result in decrease in muscle mass and force, i.e., muscle atrophy. In this study, we tested whether muscles excitability in the lower extremities is also affected through 21 day of inactivity during bed



rest (BR). As a control was used the activity in m. biceps brachii (BB). Methods Voluntary (EMG) and evoked (m-wave) muscle activity were recorded in 8 subjects before BR, at the day after the BR as well as 5 days after the BR (REG) in m. gastrocnemius (GA), m. vastus lateralis (VL) and BB. Torque and EMG were measured during sets of 3 maximum isometric contraction at different angles. During breaks m-waves were excited. The rate of the muscle fatigability was tested in VL during sustained knee extension for 30 s at 50 % MVC. Results In VL the torque decreased after the BR by about 22 % from  $261 \pm 7$  to  $205 \pm 7$  Nm, ( $P < 0.05$ ) and partly recovered during REG to  $234 \pm 7$  Nm ( $P < 0.05$ ). The median power frequency of the EMG (MF) was lower after the BR ( $84 \pm 2$  vs.  $94 \pm 2$  Hz). The duration of the m-wave increased from  $20.1 \pm 0.2$  to  $20.8 \pm 0.2$  ms ( $P < 0.05$ ) after the BR. Both parameters did not recover during REG. Signs of muscle fatigability in VL were not different before and after the BR neither for the torque nor for myoelectrical parameters. In GA decrease in torque was about 14% ( $P < 0.05$ ), the MF was not different, the m-wave duration rose from  $13.5 \pm 0.3$  to  $14.6 \pm 0.3$  ms ( $P < 0.05$ ). There were no changes in torque and properties of electrical activity in BB. Discussion One of the reasons for the loss of muscle force due to disuse should be a decrease in the protein synthesis (1). Additionally, our data show that the decrease in force in postural muscles due to BR is accompanied by signs of decrease in the muscle excitability. Thus, muscle atrophy due to disuse apparently involves not only impairment of the contractile apparatus but also the loss of sarcolemmal excitability. References Caiozzo VJ, Haddad F, Lee S, Baker M, Paloski W and Baldwin KM. Artificial gravity as a countermeasure to microgravity: a pilot study examining the effects on knee extensor and plantar flexor muscle groups. J Appl Physiol 107: 39-46, 2009.

## EFFECTS AND MECHANISMS OF STRENGTH TRAINING IN CHILDREN

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Introduction It has been demonstrated that strength training can be organized in children in a safe and effective way (Falk and Tenenbaum, 1996). However, there is limited data regarding its impact on muscle hypertrophy (Mersch and Stoboy, 1989). This study investigated the effects of a high-intensity strength training (HIS) conducted during physical education on knee extensor/flexor strength, counter-movement jumping height, postural control, soft lean mass, and muscle cross-sectional area (CSA) of the dominant leg in prepubertal children. Methods Thirty-two children (14 females, 18 males) participated in this study and were assigned to an intervention ( $n=17$ , age:  $9 \pm 1$  years, mass:  $31 \pm 5$  kg, height:  $133 \pm 4$  cm) or a control class ( $n=15$ , age:  $9 \pm 1$  years, mass:  $34 \pm 9$  kg, height:  $135 \pm 8$  cm). The intervention group participated in 10 weeks (two times per week) of progressive weight-machine based HIS (70-80% of the 1RM) integrated in physical education. Pre and post testings included the measurements of (a) peak torque of the knee extensors/flexors at  $60^\circ/\text{s}$  and  $180^\circ/\text{s}$  (Con-Trex MJ System), (b) counter-movement jumping height (SPSport), (c) postural sway (GKS 1000), (d) soft lean mass of the leg by bioelectrical impedance analysis (InBody 720), and (e) CSA (m. quadriceps) by magnetic resonance imaging (Philips Intera 1.5 Tesla scanner). Results A 2 (group: intervention, control)  $\times$  2 (test: pre post) analysis of variance with repeated measures on test revealed significant improvements in peak torque of knee extensors at  $60^\circ/\text{s}$  ( $p=0.01$ , +19% from pre to post testing) and  $180^\circ/\text{s}$  ( $p<0.01$ , +17%) as well as of the knee flexors at  $60^\circ/\text{s}$  ( $p=0.02$ , +13%) and  $180^\circ/\text{s}$  ( $p<0.01$ , +12%). However, HIS did not produce significant changes in counter-movement jumping height, postural sway, soft lean mass, and muscle CSA. Discussion Results of this study illustrate that 10 weeks of a progressive HIS conducted during physical education represents a feasible and safe training modality that produced marked improvements in peak torque of knee extensors/flexors but not in counter-movement jumping height in prepubertal children. This may imply a limited transfer to sports-related skills like jumping. Since no statistical significant changes in soft lean mass and muscle CSA of lower extremity muscles were detected. It is suggested that the observed strength gains were primarily caused by neural factors with hypertrophy playing a minor role. References Falk B, Tenenbaum G. (1996). Sports Med, 22(3), 176-186. Mersch F, Stoboy H. (1989). Children and exercise XIII, 165-182. Human Kinetics, Champaign.

## PILOT STUDY INTO THE USE OF A REPEATED JUMP TEST FOR IN-FIELD ATHLETE MONITORING

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Monitoring athlete responses to training load is important in optimising performance. A reliable test that is time-efficient and can be conducted in the field would prove valuable for coaches. Accelerometers can be used to detect landing and take-off during walking and jumping, and their miniaturisation coupled with wireless technology allows for in-field measurement. This pilot study explored the use of accelerometers for repeated jump tests as an in-field athlete monitoring tool. Ten female soccer players (age  $17 \pm 1$  yrs, height  $1.69 \pm 0.09$  m, weight  $59.9 \pm 5.6$  kg) were monitored for 15 sessions over five weeks after two weeks of testing familiarisation. Measures included pre-training POMS scales for vigour and fatigue, session-RPE and HR. A small 1000Hz wireless 3D accelerometer was strapped to the player's boot. Ten maximal repeated stiffness jumps were performed following warm-up (pre) and after training (post). Subjects jumped as high as possible, with minimal bending of the knees and minimal contact time. Contact and flight times were derived from the accelerometer data. The ratio of flight time over contact time was calculated and the average of the three best consecutive ratios was used as an indication of jump test performance. Energy index (vigour/fatigue) was calculated from the POMS data. Training load was estimated both as session-RPE  $\times$  duration and as summated-HR-load. The ratio between post and pre jump performance was also calculated. ICC for the jump ratio measured each Monday over 5 weeks was 0.89. The ratio showed a typical error (CV) of 5.9% (95% confidence limits 4.8–8.5%) and a change in the mean ranging from -4% to 3%. Correlations between variables were low, which is likely due to the small subject number in this pilot. One subject, however, reported a correlation of 0.75 between jump ratio and energy index, suggesting that she jumped well when feeling energetic. Another subject showed a correlation of -0.58 between post/pre ratio and summated-HR-load, implying that high training load may partly explain her decrease in jump ratio. Practice matches resulted in significant decreases in post/pre ratio of  $8 \pm 9\%$ , and in pre-training jump ratio of  $7 \pm 6\%$  on the next day. After two rest days a significant increase in jump ratio of  $8 \pm 8\%$  was found. It seems that high intensity activity resulted in both an acute and sustained decrease in jump ratio and rest was followed by a recovery in jump ratio. The repeated jump test appears to reflect the team's training response and has the potential to assist coaches in their team's preparation. The promising results of this pilot study warrant further research into the use of accelerometers in repeated jump tests as a time effective, in-field athlete monitoring tool.

## EFFECT OF IN-SEASON CONCURRENT SOCCER AND STRENGTH-TRAINING SEQUENCE ON MUSCLE STRENGTH AND MORPHOLOGY OF ELITE SOCCER PLAYERS

ENRIGHT, K.1,2, IGA, J.1,2, MORTON, J.2, DRUST, B.2

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**Introduction** Concurrent strength and aerobic training restricts muscular strength development (1). It is unclear how the organisation of concurrent training may influence muscle morphology in elite soccer players (2). Consequently, the aim of the present study was to investigate the effect of training organisation on the mediators of strength in elite soccer players. **Method & Results** Fifteen elite soccer players (mean  $\pm$  SD 17  $\pm$  1.8 yrs, stature, 1.82 m  $\pm$  0.06 m, body mass, 77.0  $\pm$  7.3 kg, V O<sub>2</sub> peak, 62.0  $\pm$  4.7 ml·kg<sup>-1</sup>·min<sup>-1</sup>) participated in this study. Participants completed 5 high intensity soccer-specific (HISS) and 2 strength sessions each week for 5 weeks. Strength sessions took place after a day of rest and either prior to (9am  $\pm$  15min; RT-AM, n = 8) or following (2pm  $\pm$  15min; RT-PM, n = 7) HISS training. Factorial ANOVA designs indicated significant interaction effects for training time on half-back squat (H-Bs) (RT-AM, 9.6%: RT-PM 19.6%; P = 0.001) thickness of the thigh (proximal) (P-MT), (RT-AM, 3.9%: RT-PM, 6.8% P = 0.05), fascicle angle of pennation (vastus lateralis) (AoP) (RT-AM, 17.6%: RT-PM 25.6%; P  $\leq$  0.05), 10m sprinting time (RT-AM, -0.1%: RT-PM, -6.0% P = 0.01) and quadriceps strength (60°-s-1 CONCENTRIC (CON)), RT-AM, -0.4%: RT-PM, 11.3%; 180°-s-1 CON; RT-AM, 2.5%: RT-PM, 12.9%; P = 0.038). Significant main effects for time were observed in H-Bs (P = 0.001); isometric loading rate (P = 0.016); isokinetic hamstring strength (60°-s-1 CON, RT-AM, 12.2%: RT-PM, 19.2%; 180°-s-1 CON, RT-AM, 9.5%: RT-PM, 11.2%; 120°-s-1 ECCENTRIC, RT-AM, 23.3%: RT-PM, 16.8%; P  $\leq$  0.05); jumping height (RT-AM, 8.1%: RT-PM, 4.4%; P = 0.002); P-MT and AoP (P  $\leq$  0.05). **Discussion** Five weeks of in-season strength training performed before or after HISS training significantly increased muscle size, structure, and performance of elite soccer players. The magnitudes of these improvements were significantly greater when participants engaged in strength training after HISS. It is postulated circadian rhythm factors (e.g. hormonal status and muscle temperature) and the acute variables which influence phosphorylation of signalling proteins (AMPK & mTOR activation and/or suppression) may account for optimised adaptation in RT-PM. **Conclusion** Strength training adaptations may be optimised when high intensity aerobic training precedes strength training in elite soccer players. **References** 1. Hawley, J. (2010). Appl. Physiol. Nutr. Metab. 34: 355–361. 2. Chtara, M. (2008) JSCR. 22: 1037-1045.

## EFFECTS OF STATIC AND DYNAMIC EXERCISE ON HUMAN SKELETAL MUSCLES: STUDY WITH DIFFUSION-WEIGHTED MAGNETIC RESONANCE IMAGING

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**[Introduction]** We have been quantified the increased the water in skeletal muscle caused by exercise (exercise-induced edema) using magnetic resonance imaging (MRI) techniques (Kinugasa et al. 2006, Yanagisawa et al. 2004). Also, we have shown that the level of exercise-induced edema is related to the mode of exercise, static and dynamic exercises (Yamauchi 2008). Still, it still unknown this physiological mechanism. Therefore, the purpose of this study was to investigate the effect of static and dynamic exercises on micro-movement of water molecules in human skeletal muscles of lower leg, using diffusion-weighted MRI. **[Methods]** Seven healthy subjects (age, 24.4 $\pm$ 1.0 yr; height, 173.0 $\pm$ 3.6 cm; body mass, 70.6 $\pm$ 8.4 kg, mean $\pm$ S.D.) volunteered for this study. They were examined a lower leg before and immediately after static and dynamic plantar flexion exercise on a GE 1.5 Tesla MRI scanner with a quadrature knee coil. By using diffusion-weighted MRI techniques, the apparent diffusion coefficient (ADC) value of soleus (SOL), lateral gastrocnemius (LG), medial gastrocnemius (MG) muscles was calculated. Plantar flexion exercises were performed at 20% of maximum voluntary contraction (MVC) in both left and right legs by static and dynamic exercises, respectively. During plantar flexion exercises, subjects sat with their leg on a straighten (extended knee) position. Both static and dynamic exercises consisted of 6 sets of 30-second contractions with 10-second rest intervals between exercise bouts. The dynamic exercise was performed by repetitive contraction and relaxation with full range of motion at maximum efforts. In order to determine intensity of exercises, maximum isometric plantar flexion strength of the left and right leg was measured with a dynamometer. Data are presented as mean $\pm$ S.D. **[Results]** After dynamic exercises, ADC values of LG and MG increased significantly, and these increases represent 109.5 $\pm$ 8.3% (p<0.05) and 112.5 $\pm$ 8.2% (p<0.01) of pre-exercise values, respectively; however, ADC values of SOL did not change significantly. On the other hand, ADC values of all muscles did not change significantly after static exercises. Relative change in MG after dynamic exercise was significantly higher than that after static exercise (p<0.05). **[Discussion]** The higher ADC values of LG and MG after dynamic exercise indicate increases in motion of intramuscular water molecules. This suggests the higher both water diffusion and capillary perfusion in the exercised muscles, which may cause to increased interstitial and intracellular fluid volume, capillary volume and venous volume in type II muscle fiber tissues. **[Reference]** Kinugasa R. et al. Magn Reson Imaging 24: 639-44, 2006. Yamauchi J. Eur J Appl Physiol 103: 41-5, 2008. Yanagisawa O et al. Eur J Appl Physiol 91: 737-740, 2004.

## Oral presentations

### OP-PM48 Physiology: Thermoregulation

#### SUCCESSFUL HEAT ACCLIMATION OF ELITE PARALYMPIC ATHLETES.

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Castle, P.1, Kularatne, P.2, Brewer, J.1, Mauger, A.R.1, Tuttle, J.1, Sculthorpe, N.1, Maxwell, N.3, Webborn, N.3. 1: University of Bedfordshire (UK). 2 : Disability Target Shooting Great Britain. 3: University of Brighton (UK). **Introduction** Athletes with spinal cord injury are at a greater risk of heat illness during exercise in the heat due to an inhibited thermoregulatory system that limits sweating (Webborn et al. 2005). In able body athletes, increased sweat rate and sensitivity are markers of successful heat acclimation (HA; Buono et al. 2009). Therefore, the aim of this study was to investigate the level of adaptation to eight days HA in elite athletes with spinal cord injury. **Methods** Five paralympic shooters (age 40.2  $\pm$  18 yr) with spinal cord injury (two T9/T10 complete; one C5/6 complete; one, T4 polio with no motor or sensory function; and one T6 spina bifida with no motor function) consented to take part in the study. Athletes completed seven days HA in an environmental chamber set at 33.4  $\pm$  0.6°C, 64.8  $\pm$  3.7 % relative humidity. Each HA session lasted 60 min and consisted of 20 min armcrank exercise at 50  $\pm$  5 W followed by passive rest or optional simulated shooting. Aural canal temperature (Taur), perceived ther-

mal comfort and RPE were measured at 5 minute intervals. On days 1 and 7 fingertip, blood samples were collected for analysis of Hematocrit and Hemoglobin for assessment of plasma volume. Sweat collection swabs were attached to the inferior, medial border of the trapezius muscle for assessment of sweat volume and content. Body mass was recorded by an under floor, force plate adapted for wheelchair use. Results Resting core temperature reduced from  $36.3 \pm 0.2^{\circ}\text{C}$  on day 1, to  $36.0 \pm 0.2^{\circ}\text{C}$  on day 7 ( $P < 0.05$ ). Mean Taur during the HA session on day 1 was  $37.2 \pm 0.2^{\circ}\text{C}$  and this reduced to  $36.7 \pm 0.3^{\circ}\text{C}$  on day 7 ( $P < 0.05$ ). Ratings of thermal comfort on day 1 were  $5.1 \pm 0.2$  units, and this reduced to  $4.5 \pm 0.4$  units on day 7 ( $P < 0.05$ ). Ratings of perceived exertion during the 20 min exercise bout on day 1 were  $12.6 \pm 1.9$  units, and this reduced to  $11.4 \pm 0.7$  units on day 7 ( $P < 0.05$ ). Plasma volume on Day 1 was  $55.5 \pm 5.1\%$  and this increased to  $57.0 \pm 6.0\%$  on day 7 ( $P < 0.05$ ). No sweat response or changes in body mass were observed. Discussion To our knowledge this is the first study to show successful HA of elite athletes with spinal cord injury. Although no sweat response was observed, plasma volume expansion occurred indicating a fluid retention adaptation (Francesconi et al. 1983) which lowered Taur, improved thermal comfort and RPE. Elite athletes with spinal cord injury can HA to reduce the risk of heat illness. References Buono MJ, Numan TR, Claros RM, Brodine SK, and Kolkhorst FW. (2009) *Am J Physiol Regul Integr Comp Physiol*. 2009; 297: R1082-R1085. Francesconi RP, Sawka MN and Pandolf KB. *J Appl Physiol*, 1983; 55(6): 1790-1794. Webbhorn N, Price, MJ, Castle PC, and Goosey-Tolfrey V. (2005) *J Appl Physiol*, 98, 2101-2107.

## EFFECT OF COLD WATER IMMERSION ON REPEAT CYCLING PERFORMANCE AND THERMOREGULATION IN THERMO-NEUTRAL CONDITIONS

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Introduction Cold water immersion (CWI) is an effective recovery procedure between exercise bouts in hot conditions (Vaile et al., 2008 and 2010), but any effects on thermoregulation and performance in thermoneutral conditions remain to be investigated. The aim of this study was to assess the effect of CWI, active (ACT) and passive recovery (PAS) on thermoregulation and repeat cycling performance in cool conditions in trained male cyclists ( $n=12$ ). Methods In  $20^{\circ}\text{C}$  and 40% relative humidity, cyclists completed 6 trials, each separated by one week. Each trial consisted of a 30 min exercise task (EX1), then one of six 15 min recovery interventions (intermittent CWI in either  $10^{\circ}\text{C}$ ,  $15^{\circ}\text{C}$ ,  $20^{\circ}\text{C}$  water, continuous CWI in  $20^{\circ}\text{C}$  water, ACT or PAS), followed by 40 min rest recovery, before repeating the exercise task (EX 2). Exercise involved 15 min at 75% peak power output, then a 15 min time trial. Recovery effectiveness was assessed via changes in total work in EX 2 compared to EX 1. Core temperature (rectal) RPE, HR, La and thermal comfort were also recorded. Results Performance in EX2 was significantly lower ( $p<0.05$ ) after ACT when compared to all CWI interventions, but ACT was not different to PAS. After 40 min of rest, core temperatures were significantly lower after CWI 10, 15 and continuous CWI compared to ACT and PAS ( $p<0.05$ ), with these differences sustained during the warm up period prior to EX2. Midway through EX2, core temperature was significantly lower ( $p<0.05$ ) with all CWI interventions than after PAS, and also after ACT (CWI 10 and 15 only). At the end of EX2 only CWI 10 recorded a significantly lower core temperature than all other interventions. Heart rate, La and RPE were not different between any recovery interventions after EX1 and EX2, but La was significantly lower immediately after ACT and at the end of the 40min rest. Thermal comfort was not different for any recovery intervention at the end of EX1 and EX2, but between exercise bouts was generally significantly lower ( $p<0.05$ ) after CWI 10 and 15 compared to ACT and PAS. Discussion These results show that CWI, whether applied intermittently or continuously, can benefit repeat cycling performance in thermoneutral conditions and generally results in lower core temperature values and thermal sensation responses than either ACT or PAS recovery interventions. References Vaile, J, Halson S, Gill N, Dawson B. (2008). *J Sports Sci* 26 (5): 431-40 Vaile J, O'Hagen C, Stefanovic B, Walker M, Gill N, Askew C.D. (2010). *Br. J. Sports Med* Mar 16 doi 10.1136/bjism2009.067272.

## PASSIVE HYPERTHERMIA IMPOSES A LOAD ON COGNITIVE CAPACITY

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Introduction: Passive hyperthermia limits complex cognitive task performance. These decrements occur when the total cognitive resources are insufficient for both the task and the thermal stress. EEG has been suggested to be the best tool to non-invasively measure cognitive load in real time. Aim: To investigate the neurophysiologic correlates of cognitive deficits during exposure to hot environmental conditions. Methods: To date 6 subjects performed a planning task with two levels of complexity (simple: OTS-4 and complex OTS-6) under hot (HOT:  $50^{\circ}\text{C}$ , 30% rH) and control (CON:  $24^{\circ}\text{C}$ , 30% rH) conditions. Subjective measures of thermal comfort (TC) and thermal sensation (TS) were recorded in each condition. Central (Tcore) and average skin (Tskin) temperatures were recorded prior to the cognitive testing by telemetric ingestible pills and patches. In each condition, testing started after a 10 min walk and 60 min of rest. EEG was recorded from the Fz electrode site with additional ground and linked ear references. Quantitative EEG was computed using Fast Fourier Transformation for activity in theta (4-8Hz), alpha-1 (8-10Hz), and alpha-2 (8-10Hz) bands. Results: Both Tskin (CON,  $31.7 \pm 0.63^{\circ}\text{C}$  vs. HOT,  $39.53 \pm 0.27^{\circ}\text{C}$ ) and Tcore (CON,  $36.92 \pm 0.22^{\circ}\text{C}$  vs. HOT,  $38.96 \pm 0.24^{\circ}\text{C}$ ) were higher in HOT than in CON (both,  $p<0.001$ ). Subjects felt hotter (TS) and less comfortable (TC) in HOT (both,  $P < 0.05$ ). No significant difference was observed in reaction times between conditions in both levels of OTS complexity. Accuracy on the OTS-4 task was comparable between conditions but was significantly reduced on the OTS-6 task in HOT ( $p<0.005$ ). There was a significant temp x task interaction in theta power; baseline theta in HOT ( $2.4 \pm 0.67$ ) was greater than in CON ( $1.8 \pm 0.28$ ,  $p<0.05$ ); therefore in CON only theta in OTS-6 ( $2.4 \pm 0.15$ ) was greater than theta in OTS-4 ( $1.9 \pm 0.28$ ,  $p<0.02$ ). Discussion: Given current theory on the role of theta oscillations during working memory tasks, the present data indicate that working memory capacity was at threshold prior task engagement during passive hyperthermia. Conclusion: The cognitive load imposed by passive hyperthermia limits performance on complex cognitive tasks.

## COLD WATER IMMERSION AUGMENTS THE EXERCISE-INDUCED EXPRESSION OF PGC-1 $\alpha$ IN HUMAN SKELETAL MUSCLE

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Introduction Cold water immersion (CWI) enhances post-exercise recovery (Vaile et al., 2007), however, the mechanisms underpinning these responses have yet to be elucidated. The expression of peroxisome proliferator-activated receptor  $\gamma$  co-activator-1  $\alpha$  (PGC-1 $\alpha$ ), a key regulator of mitochondrial biogenesis, is increased in animals following chronic whole body cooling (Puigserver et al., 1998). However, it

is currently unknown whether post-exercise CWI influences the expression of PGC-1 $\alpha$  in human skeletal muscle. The aim of the present study was to therefore test the hypothesis that post-exercise CWI increases PGC-1 $\alpha$  mRNA expression in human skeletal muscle following acute exercise. Methods Eight healthy males ( $25 \pm 4$  years) performed high-intensity interval running (8x3-min bouts at 90% VO<sub>2</sub>max interspersed with 3-min recovery) on two separate occasions in a counterbalanced randomised crossover design. On each occasion, subjects rested passively (CON) or undertook 10-min of CWI (80°C) immediately after exercise. Muscle biopsies (vastus lateralis), rectal, muscle and skin temperature were taken at regular intervals during the 3h recovery period. All data were analysed using a two-factor (condition x time) within participants general linear model (GLM). Results Rectal temperature was similar between conditions during the 3h recovery period ( $P=0.17$ ), however, reductions in thigh skin and muscle (CON,  $-3.0 \pm 0.9^{\circ}\text{C}$ ; CWI,  $-4.6 \pm 1.0^{\circ}\text{C}$ ) temperature were significantly greater in the CWI condition compared to CON ( $P<0.05$ ). PGC-1 $\alpha$  mRNA expression did not change immediately post-exercise under both conditions (CON,  $0.9 \pm 0.7$ ; CWI,  $1.0 \pm 0.5$  fold;  $P>0.05$ ). However, its expression was significantly increased 3h post-exercise under both conditions ( $P=0.01$ ) with greater expression observed in CWI ( $5.6 \pm 3.4$ -fold) compared to CON ( $3.3 \pm 2.6$ -fold;  $P<0.01$ ). Discussion Data indicate that post-exercise CWI augments the exercise-induced expression of PGC-1 $\alpha$  mRNA. These data suggest that post-exercise CWI immersion may enhance the upstream signaling pathways associated with mitochondrial biogenesis and as such, our data have practical applications for athletes wishing to maximise training adaptations. References Vaile J., Halson S., Gill N. and Dawson B. (2007). Effect of hydrotherapy on recovery from fatigue. *Int J Sports Med*, 29, 539-544. Puigserver P, Wu Z, Park CW, et al., (1998). A cold-inducible coactivator of nuclear receptors linked to adaptive thermogenesis. *Cell*, 92, 829-839.

## DEHYDRATION DURING WHOLE-BODY HEAT STRESS CONTRIBUTES TO SUBSEQUENT REDUCTIONS IN LOWER-BODY NEGATIVE PRESSURE TOLERANCE

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Introduction The independent effects of dehydration and heat stress on blood pressure control during simulated hemorrhage are unknown. This study tested the hypothesis that dehydration, which accompanies heat stress, further compromises the maintenance of blood pressure during a simulated hemorrhagic challenge via LBNP. Method Seven individuals ( $34 \pm 9$  y;  $77 \pm 4$  kg) completed two passive heat trials on two separate days (randomized) either with (infusion trial) or without (dehydration trial) intravenous infusion of heated Lactated Ringers solution sufficient to replace sweat loss. Hemorrhage was simulated via progressive LBNP to pre-syncope. LBNP tolerance was quantified with a cumulative stress index (CSI; sum of LBNP level x minutes at each level). Body core temperature (intestinal pill), mean middle cerebral artery blood velocity (MCAvmean, transcranial Doppler), arterial blood pressure (Finometer®) and end-tidal carbon dioxide (PETCO<sub>2</sub>, nasal cannula) were measured continuously throughout each trial. Blood samples were obtained before heating and just prior to LBNP to estimate relative changes in plasma volume during heat stress. Results The increase in body core temperature (infusion trial:  $1.4 \pm 0.2^{\circ}\text{C}$ ; dehydration trial:  $1.4 \pm 0.1^{\circ}\text{C}$ ) and whole-body sweat loss (infusion trial:  $1.8 \pm 0.6\%$ ; dehydration trial:  $1.6 \pm 0.4\%$  body mass deficit) were similar between trials ( $P>0.05$ ). Intravenous infusion ( $1.3 \pm 0.5$  L) prevented the reduction in plasma volume that occurred during the dehydration trial (infusion trial:  $+3.1 \pm 7.1\%$ ; dehydration trial:  $-6.5 \pm 5.5\%$ ,  $P=0.01$ ). LBNP tolerance during the dehydration trial ( $407 \pm 126$  CSI units) was lower compared to the infusion trial ( $641 \pm 64$  CSI units,  $P<0.01$ ). MCAvmean was equivalent between dehydration and infusion trials during heat stress immediately prior to LBNP and at presyncope. However, when dehydrated MCAvmean was  $\sim 10$  cm/s lower during the initial LBNP stages (e.g., 20 mm Hg LBNP, infusion trial:  $63 \pm 10$  cm/s; dehydration trial:  $53 \pm 10$  cm/s,  $P=0.02$ ). Heat and LBNP related changes in MAP and PETCO<sub>2</sub> were similar ( $P>0.05$ ) between the dehydration and infusion trials. Conclusion These data indicate that dehydration during heat stress initially lowers cerebral perfusion during a hemorrhagic challenge, reducing an individual's tolerance and therefore, increasing the likelihood of syncope. Supported by NIH Grant HL061388

## Oral presentations

### OP-PM31 Physical Activity: Adapted

#### RELATIONSHIP BETWEEN LEG MUSCLE STRENGTH, SPRINT POWER AND AEROBIC POWER OUTPUT IN ADULTS WITH CEREBRAL PALSY

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Introduction Adults with cerebral palsy (CP) are at risk for an inactive lifestyle and low fitness levels. However, given the nature of the physical disability, there is no reason to expect that persons with CP cannot benefit from a regular exercise program. Not much information is available about the physical capacity of adults with CP. In this group, maximal aerobic power might be limited by peripheral factors such as muscle strength. The relationship between muscle strength, sprint power and maximal power output may consequently be stronger than in individuals without CP. The purpose of the study, therefore, was to investigate whether the relationship between muscle strength of the lower extremities, sprint power and maximal power output during ergometer cycling in adults with CP is different from the relationships in adults without CP. Methods In this cross-sectional study, 20 adults with CP (18-49 yrs, GMFCS I (n=15) and II (n=5), unilateral (n=10) and bilateral CP (n=10)) and 24 individuals without CP (19-55 years) were tested in a rehabilitation center. Isometric and isokinetic knee extension strength, sprint power and maximal power output were determined using an isokinetic dynamometer, a Wingate cycling test and a graded exercise test on a bicycle ergometer, respectively. Regression analysis was used to investigate relationships between parameters in adults with and without CP. Results In the participants without CP the relationship between sprint power and isometric ( $R=0.53$ ) or isokinetic knee extension strength ( $R=0.45$ ) was weak. A moderate relationship was found between sprint power and maximal power output ( $R=0.60$ ). In contrast, a strong relationship was found in the group with CP between sprint power and isometric ( $R=0.79$ ) and isokinetic extension strength ( $R=0.81$ ) of the least impaired leg as well as between sprint power and maximal aerobic power output ( $R=0.98$ ). Discussion Stronger relationships were found between muscle strength and sprint power and between sprint power and maximal power output in adults with CP compared to adults without CP. These results suggest that in this population muscle strength might be the limiting factor for lower-extremities activities such as cycling. Acknowledgements This study was supported by the Dr. W.M. Phelps-Stichting voor Spastici.

## BIOMECHANICAL DIFFERENCES BETWEEN PUBERTAL MALES WITH MENTAL RETARDATION & NORMAL INTELLIGENCE QUOTIENT DURING LANDING

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**Introduction** Studies in the past have shown that individuals with MR present low performance in physical conditioning and motor skills (Shephard 1994; Angelopoulou 1999). Landing from a height is a common everyday task that is poorly controlled in people with MR compared to nIQ population, leading to increased risk for falls and injuries. Despite of these there are no available data in the literature concerning the biomechanical and neuromuscular differentiations in people with MR. Therefore, purpose of this study was to examine the differences in kinetic, kinematic and electromyographic (EMG) properties in pubertal males with MR and with nIQ during landings. **Methods** Twenty six untrained pubertal males (mean age: 15,5y for both groups), 13 with nIQ and 13 with MR (mean IQ:  $55,6 \pm 11,2$ ) participated in the study. The kinematic data, vertical ground reaction force (vGRF) and surface EMG of the vastus lateralis (VL) and biceps femoris (BF) was recorded. vGRF was normalized to body weight and EMG activity to the maximum EMG during each landing trial. All subjects performed 6 landings from 20 cm height (3 for familiarization and 3 for evaluation which were averaged). Each trial was separately analyzed to the pre-activation and braking phase. T-test for independent groups was used for the statistical analysis with level of significance was set at  $p < 0.05$ . **Results** When comparing the MR with the nIQ group, the former expressed significantly greater vGRF ( $p < 0,05$ ) and significantly less knee flexion ( $p < 0,05$ ) during preactivation, at touchdown and at the deepest point (maximum knee flexion). Furthermore, the EMG activity was significantly smaller in the individuals with MR for both muscles and in both phases ( $p < 0,05$ ). **Discussion** The obtained findings indicate that individuals with MR showed reduced neuromuscular activation, lower knee flexion and higher vGRF during landing. This suggests that people with MR adopt a stiffer technique for landing which in long-term could increase the potential for injuries. This difference could be attributed to learning factors and it seems that the task of landing is more unfamiliar to individuals with MR. **References** Angelopoulou N, Tsimaras V, Christoulas K, Kokaridas D, & Mandroukas K (1999). Perceptual and Motor Skills, 88, 849-855. Shephard RJ (1994). Phys Educ Rev, 17, 33-44.

## MOTOR DEVELOPMENT AND THE RELATIONSHIP WITH EXECUTIVE FUNCTIONING IN CHILDREN WITH INTELLECTUAL DISABILITIES.

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**Introduction** Children with intellectual disabilities (ID) have problems with their motor performance which may be related to their higher-order cognitive functions, especially executive functioning (EF; Diamond et al., 2000). The developmental skill-learning gap hypothesis assumes that, as children with less motor proficiency grow older, the gap between them and their peers becomes wider (Wall, 2004). The aim of the present study was to model the development of motor performance of 7-12 year-old children with ID in comparison with norm scores. Secondly, we examined the possible relationship between motor performance and EF in these children. **Methods** From 2009 until 2011, 48 children with ID from a special-needs school (34 boys, 14 girls; age range 7-10 in the year of enrollment; IQ range=53-79) participated in a longitudinal study. Measurements with the Movement ABC-2 for children were taken annually for three consecutive years. In the second year, EF was assessed with the Tower of London (TOL; i.e. planning, problem solving, and decision making). Data were analyzed with SPSS and MLwiN. The development of the children's raw motor scores was examined by comparing the likelihood ratio test statistic of a model with and a model without age. Analogously, the development of the children's standard scores (for comparison with the normative sample) was examined. **Results** In the year of study enrollment, the children with ID had significantly more definite motor problems (manual dexterity: 79%; ball skills: 44%; balance skills: 67%) than the normative sample (5%). All raw motor performance scores of the children increased significantly with age ( $p < .05$ ). The analysis of the standard scores showed that the gap between the normative sample and the children with ID remained stable over time (manual dexterity,  $p = .317$ ; ball skills,  $p = .157$ ; balance skills,  $p = .221$ ). Significant partial correlations (controlling for age and sex) with medium effect sizes were found between the manual dexterity scores ( $r = .34$ ,  $p = .049$ ), the ball skill scores ( $r = .36$ ,  $p = .046$ ) and the TOL scores 1 year later. The correlation between balance skills and the TOL score did not reach significance. **Discussion** The consistent gap in motor performance between children with ID and their peers underscores the importance of early motor interventions in order to stimulate the motor and cognitive development in this vulnerable population. Diamond A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. Child Dev, 71, 44-56. Wall AET. (2004). The developmental skill-learning gap hypothesis: implications for children with movement difficulties. Adapt Phys Act Q, 21,197-218.

## EFFECT OF A MOTOR SKILL PROGRAM ON THE BALL SKILLS OF CHILDREN IN DUTCH SPECIAL EDUCATION

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**Introduction** Well-developed gross motor skills are important, because they may boost children's participation in physical activities and sports (Wall, 2004) as well as their cognitive abilities (Piek et al., 2008). Children in special education (i.e. children with learning or intellectual disabilities) have poor gross motor skills compared to typically developing children (Westendorp et al., in press). The aim of the present study was to examine the effect of a 16-week motor skill program, based on Newell's constraints model, on the ball skills of these children. **Methods** The study population included 96 children (aged 7-11), divided in 6 classes from a primary special-needs school located in the northern Netherlands. The 6 classes were randomly assigned to the experimental (47 children) and the control group (49 children). The intervention consisted of 32 lessons, twice a week (35 min. per lesson), during 16 weeks. The experimental group performed different exercises focused on improving ball skills. Based on Newell's constraints model, the skills were practiced under different conditions with the manipulation of task factors, for example different distances to the basket and exercising alone or with two or more children. The control group attended regular physical education lessons. Pre- en post intervention motor scores were obtained for the experimental and control group using the TGMD-2. For statistical analysis, ANCOVAs with repeated measures with group as the between factor, the locomotor and ball skill scores at pre and posttest (time) as the within factors, and IQ as the covariate. **Results** A significant group by time interaction for the ball skills was found ( $F=18.261$ ,  $p=.000$ ). The experimental group had significantly better ball skills after the motor skill program compared to the control group. No group by time interaction was found for the locomotor skill scores ( $F=1.386$ ,  $p=.243$ ). **Discussion** This study shows that the ball skills of a heterogeneous group children in special education improved after motor skill training. Further analyses will reveal whether or not the motor program has effect on children's participation in physical activity and child-

ren's cognitive skills. References Piek JP, Dawson L, Smith LM, Gasson N (2008). The role of early fine and gross motor development on later motor and cognitive ability. *Hum Movement Sci*, 27, 668-681. Wall AET (2004). The developmental skill-learning gap hypothesis: implications for children with movement difficulties. *Adapt Phys Act Q*, 21, 197-218. Westendorp M, Houwen S, Hartman E, Visscher C (in press). Are Gross Motor Skills and Sports Participation Related in Children With Intellectual Disabilities? *Res Dev Disabil*.

### THE EFFECT OF WHOLE BODY VIBRATION ON BALANCE AND WALKING SPEED IN ADULTS WITH LEARNING DISABILITIES - A PRELIMINARY STUDY

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The effect of whole body vibration on balance and walking speed in adults with learning disabilities - a preliminary study 1Jeff Bartley, PhD; 2Francis Fatoye, PhD 1Community Health Team, North Lancashire Primary CareTrust, UK 2Physiotherapy of Health Professions, Manchester Metropolitan University, Manchester, UK Jeff.bartley@northlancs.nhs.uk Introduction Impaired balance and walking ability are common features associated with learning disabilities. Whole body vibration (WBV) has been used to improve balance and walking speed. The effectiveness of WBV has not been reported in people with learning disabilities. This study investigated the effect of WBV on balance and walking speed in adults with learning disabilities. Methods Twelve adults with learning disabilities (mean age + SD = 43.92 + 9.6 years) participated in the study. Following approval from the Local Housing Scheme participants were randomly allocated into a WBV intervention group and a non WBV control group. WBV was performed on a Galileo Advanced Plus. Intervention took place at a day centre for people with learning disabilities in the North West of England. Twelve WBV sessions were performed at a frequency of 12 Hz for 7 minutes three times a week. Balance was examined with the Berg balance scale while walking speed was assessed using 6 minutes walk test. Independent and Mann-Whitney U t-tests analyses were performed to examine between group differences for the 6 minutes walk test and balance test respectively. Paired t and Wilcoxon signed rank tests were used to examine within group difference between pre and post intervention for the 6 minutes walk and balance tests respectively. Statistical significance was set at  $p < 0.05$ . Results There was no significant difference ( $p = 0.631$ ) in balance test and walking speed ( $p = 0.733$ ) between the control and experimental groups. In addition, there was no significant difference ( $p = 0.068$ ) in balance test before and after whole body vibration. However, there was a significant difference ( $p = 0.048$ ) in walking speed before and after whole body vibration. Discussion The results of this study showed that there was no significant difference in balance and walking speed between WBV and the control groups in adults with learning disabilities. However, it showed that walking speed improved following the use of WBV in adults with this condition. This finding therefore suggests that WBV may be a useful modality for improving gait speed in individuals with learning disabilities. The findings of the present study should be interpreted with caution due to small sample. References Sackley et al (2005) *Clin Rehabil*. Vol. 19:216-23 Palsbo et al (2011) *Disabil Rehabil*. Vol. 33:73-85

### AN INTERNET-BASED AT HOME TRAINING PROTOCOL ENHANCES MUSCLE STRENGTH AND LUNG FUNCTION IN MULTIPLE SCLEROSIS PATIENTS

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Background: Numerous studies have shown beneficial effects of exercise in Multiple Sclerosis patients. As shown recently (Motl et al. 2010) using internet technology might treat and supervise patients more economically and more individually than conventional interventions, but systematic studies are lacking. Objective: To assess the feasibility and effectiveness of an internet-based at home physical training protocol (e-Training) in MS patients (EDSS 0-4). Design/Methods: We present data from an ongoing randomized controlled trial (study duration 9/2009 - 9/2011, required sample size:  $n=102$ ). Patients are allocated to either control group (CG; no treatment) or training group (TG). The TG receives internet-based strength and endurance training: patients exercise at home and document their training sessions via internet. Training protocols are supervised and adjusted by sports therapists. Assessments at baseline and after 3 months of training include: Isometric muscle strength (trunk flexion/extension), aerobic capacity ( $VO_{2max}$ ), lung function (peak expiratory flow PEF), Quality of Life (HAQUAMS) and Fatigue (WEIMuS). Outcomes are analysed using MANOVA with the factors time (within-subjects) and group (between-subjects). Results: Until December 2010, 32 patients completed the intervention and were analysed (age  $42 \pm 8.5$ ; EDSS  $2.9 \pm 0.8$ ). Patients in the TG showed significant improvements in trunk flexion/extension compared to the CG (flexion (in Newtonmeter, T1/T2): TG  $79.0/84.7$ , CG  $85.2/79.8$ ,  $p = .038$ ; extension: TG  $151.8/170.4$ , CG  $150.5/146.7$ ,  $p = .049$ ). Lung function also increased significantly (PEF (l/sec, T1/T2): TG  $5.2/6.0$ , CG  $6.4/5.83$ ;  $p = .005$ ). Results for aerobic capacity, fatigue and quality of life were all in favour of TG but non-significant ( $p = .124$ ;  $p = .215$ ;  $p = .170$ ). Conclusions: Although we only analysed one third of the required sample size yet, we discovered significant intervention effects concerning lung function and muscle force, the latter similar in magnitude to conventional exercise interventions. We conclude that internet-based exercise interventions are feasible and effective to enhance the health status of MS patients.

## Oral presentations

### OP-PM02 Lipid Metabolism

#### EFFECTS OF AEROBIC TRAINING AND RESISTANCE TRAINING ON VISCERAL AND ECTOPIC FAT AS MEASURED BY MAGNETIC RESONANCE IMAGING IN SUBJECTS WITH TYPE 2 DIABETES

BACCHI, E.1, NEGRI, C.1, FACCIOLO, N.2, DI SARRA, D.1, TARPERRI, C.3, MILANESE, C.3, BARALDO, A.3, SCHENA, F.3, CEVESE, A.3, LANZA, M.3, MOGHETTI, P.1

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Introduction Non-alcoholic fatty liver disease is an independent predictor of incident cardiovascular events in type 2 diabetes patients (DM2). Previous studies evaluated the effects of aerobic and resistance training on glycaemic control in DM2 (Sigal, 2007), but there are no data comparing the effects of these different types of exercise on ectopic fat and visceral adipose tissue in these patients. Methods 38 DM2, 11 females and 27 males (mean $\pm$ SD: age  $56 \pm 7$  years, BMI  $29.4 \pm 4.6$  kg/m $^2$ , HbA1c  $7.3 \pm 0.7\%$ ) were randomized to aerobic (AER,

n=20) or to resistance (RES, n=20) training. In both groups exercise was performed 3 times weekly, for 4 months. The AER group exercised for 60 minutes at 60-65% heart rate reserve. The RES group performed 3 series of 8-10 repetitions of 8 different exercises on weight machines each session, at 70-80% 1RM. Before and after the intervention programs visceral adipose tissue (VAT) and fat accumulation in the liver were measured using Magnetic Resonance Imaging. In addition, the following were assessed: fat mass (FM, by DEXA Total Body), metabolic features, insulin sensitivity (by euglycemic hyperinsulinemic clamp), peak oxygen uptake (VO<sub>2peak</sub>), leg and arm muscle 1RM tests (leg extension, LE; and chest press, CP). Results The two groups had similar baseline characteristics. After 4 months of training HbA<sub>1c</sub> and triglycerides were significantly reduced in both groups. Changes in VO<sub>2peak</sub>, as well as in leg and arm strength showed significant differences between AER and RES groups (VO<sub>2peak</sub>\*kg<sup>-1</sup> 15±10 vs 8±10%, p=0.04; LE 4±11 vs 19±10%, p<0.0001; CP 4±8 vs 24±11%, p<0.0001). AER and RES groups showed similar changes in total fat mass (-2.2±1.7 vs -1.7±1.3 kg). VAT and fat accumulation in the liver were also reduced to a similar extent in the two groups (-58±68 vs -30±40 cm<sup>2</sup>, and -8±18 vs -9±18%, respectively). Insulin sensitivity was significantly increased in both groups (by 30% and 19%, respectively). In the whole population, the change in VAT negatively correlated with change in insulin sensitivity (r=0.39, p<0.05). Discussion These data show that aerobic and resistance exercise can exert beneficial effects on both visceral adipose tissue and fat accumulation in the liver in subjects with DM2, with attenuation of insulin resistance and improved metabolic features. References Sigal RJ et al. Ann Intern Med 2007; 147:357-69.

### EXERCISE FOR FATTY LIVER DISEASE: IMPACT ON VASCULAR HEALTH AND HEPATIC FAT

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Introduction Non-alcoholic fatty liver disease (NAFLD) is characterised by the accumulation of fat in the liver and is associated with liver-related morbidity and mortality. Nevertheless, the leading cause of death in these patients is cardiovascular disease (CVD). Flow mediated dilation (FMD) provides information regarding endothelial cell health and is an early marker of CVD which is directly linked to the risk of myocardial infarction. The efficacy of exercise training is poorly characterised in NAFLD patients and impacts on hepatic fat and vascular function have not previously been reported. We hypothesised FMD would be impaired in NAFLD and that exercise would reduce hepatic fat and improve FMD. Methods Eleven NAFLD patients and ten healthy controls volunteered. Whole body magnetic resonance imaging quantified visceral and subcutaneous fat and <sup>1</sup>H magnetic resonance spectroscopy determined hepatic fat. Brachial artery FMD, cardiorespiratory fitness and fasting glucose, lipids and alanine transaminase (ALT) were assessed in all subjects. All NAFLD patients underwent a 16-week supervised exercise intervention (moderate intensity, 30-45 min, 3-5 times per week) after which all assessments were repeated. Differences between NAFLD and controls, and the changes with exercise were analysed using t-tests. Data are presented as mean±SE. Results NAFLD and controls were matched for age (49±4 vs 46±3 yrs; P=0.50) and BMI (30±1 vs 29±1 kg/m<sup>2</sup>; P=0.50). FMD was impaired (5.2±0.8 vs 9.1±1.0%; P=0.01) and hepatic fat was elevated (22.3±5.1 vs 2.6±0.7%; P=0.003) in NAFLD patients, but abdominal subcutaneous fat did not differ. Overall hepatic fat decreased by 30% (22.3±5.1 vs 15.7±3.6%) and fitness improved by 29% (25.8±2.0 vs 33.3±2.9 ml.kg<sup>-1</sup>.min<sup>-1</sup>) following exercise in NAFLD (P<0.004). This was accompanied by a reduction in abdominal subcutaneous fat (8.0±0.8 vs 7.6±0.8 l; P=0.02) and improvement in FMD (5.2±0.8 vs 8.0±0.6%, P=0.002). ALT, BMI, body mass, hip and waist circumference all decreased with exercise (P<0.003). No changes were evident in lipid profiles, visceral or total subcutaneous fat. Discussion This is the first study to demonstrate the therapeutic effects of exercise training on hepatic fat and vascular health in NAFLD patients. Currently, there is no effective pharmacological treatment to decrease hepatic fat in this group at high risk of CVD. Therefore, these data strongly support the efficacy of exercise training as a leading preventive strategy in NAFLD.

### ACUTE EFFECT OF FATMAX EXERCISE ON GLYCAEMIA, INSULINAEMIA AND FAT OXIDATION IN OVERWEIGHT AND NON-OVERWEIGHT ADOLESCENT GIRLS

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*LOUGHBOROUGH UNIVERSITY*

ACUTE EFFECT OF FATMAX EXERCISE ON GLYCAEMIA, INSULINAEMIA AND FAT OXIDATION IN OVERWEIGHT AND NON-OVERWEIGHT ADOLESCENT GIRLS Zakrzewski, J.K., Tolfrey, K. Loughborough University Introduction Exercise training at the intensity corresponding to maximal fat oxidation (Fatmax) increases insulin sensitivity and fat oxidation in obese adolescents (Ben Ounis et al. 2008). However, improvements in glycaemia, insulinaemia and fat oxidation the day after a single bout of exercise may occur in adults (Mitchell et al. 2008; Newsom et al. 2010). Findings from our laboratory indicate that postprandial glycaemia is particularly high following high glycaemic index (HGI) breakfast consumption in overweight adolescent girls, suggesting strategies to improve this response are required. The aim of the present study was to examine the acute effect of Fatmax exercise on glycaemia, insulinaemia and fat oxidation following a HGI breakfast in overweight and non-overweight adolescent girls. Methods Participants completed two 2-day trials in a counter-balanced order. On day 1, participants either performed 500 kcal of treadmill exercise at Fatmax (62(14) min at 61(8)% VO<sub>2peak</sub>) or rested. On day 2, a blood sample was taken in the fasted state and at 15, 30, 45, 60, 90 and 120 min following HGI breakfast consumption for the determination of blood glucose and plasma insulin. Fat oxidation was estimated in the fasted state and every 30 min during the postprandial period. Participants replicated their diet and minimised physical activity in the 48 h prior to main trials. Results Data for 10 girls (2 overweight, 8 non-overweight) are currently available for analysis. Postprandial absolute fat oxidation was higher the morning after Fatmax exercise compared with rest (P=0.026; ES: 0.66). Furthermore, both fasted (P=0.048; ES: 0.61) and postprandial (P=0.061; ES: 0.58) fat oxidation expressed as a percentage of total energy expenditure were higher the morning after Fatmax exercise. Blood glucose and plasma insulin concentrations will be analysed when the full sample is complete (n=24) to reduce inter-assay variation. Discussion Preliminary findings suggest fat oxidation is increased following Fatmax exercise performed ~16 h prior to HGI breakfast consumption in adolescent girls. This, along with potential benefits relating to glycaemia and insulinaemia, may have clinical relevance. The results from our complete study will allow an examination of these relationships in a larger group of ten overweight and fourteen non-overweight girls and to examine potential between-group differences. References Ben Ounis O, Elloumi M, Amri M, Zbidi A, Tabka Z, Lac G. (2008). J Sports Sci & Med, 7, 437-45. Mitchell JB, Rowe JR, Shah M, Barbee JJ, Watkins AM, Stephens C, et al. (2008). Int J Sport Nutr Exerc Metab, 18, 49-65. Newsom SA, Schenk S, Thomas KM, Harber MP, Knuth ND, Goldenberg N, et al. (2010). J Appl Physiol, 108, 554-60.

## HIGH-FAT DIET OVERRULES THE EFFECTS OF TRAINING ON FIBER-SPECIFIC INTRAMYOCYELLULAR LIPID UTILIZATION DURING EXERCISE

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**Introduction** Training in the fasted state can stimulate adaptations in muscle cells to facilitate energy production via fat oxidation (Van Proeyen et al., 2010; Van Proeyen et al., 2011; Stannard et al., 2010). Therefore, in this study we compared the effects of endurance training in the fasted state versus the fed state, on exercise-induced intramyocellular lipid (IMCL) and glycogen utilization during a 6-week period of hypercaloric fat-rich diet (HFD). **Methods** Healthy male volunteers (18-25 yrs) received hypercaloric (~+30% kcal/day) HFD (50% of kcal) in conjunction with endurance training (4 times 60-90 min per week) either in the fasted state (F; n=10), or with ample carbohydrate intake before and during exercise sessions (CHO; n=10). The control group (CON; n=7) received HFD without training and increased body weight by ~3kg (P<0.001) (Van Proeyen et al., 2010). Before and after HFD, the subjects performed a 2-hr constant-load bicycle exercise test in the fasted state at ~70% VO<sub>2</sub>max. **Results** HFD, both in the absence or presence of training (F or CHO), elevated basal IMCL content by ~50% in type I and by ~75% in type IIa fibers (P<0.05). Independent of training in F or CHO, HFD as such stimulated exercise-induced net IMCL breakdown by ~2-fold in type I and by ~4-fold in type IIa fibers. Furthermore, basal muscle glycogen level was well maintained and exercise-induced net glycogen breakdown was not significantly affected by HFD. **Conclusion** It is concluded that HFD, by increasing basal IMCL content, stimulates net IMCL degradation during exercise in type I, but even more in IIa fibers. This dietary effect even overrules the effects of training, independent of whether the training is performed in the fasted or the fed state. Furthermore, a HFD, which also provides adequate amounts of carbohydrates to preserve high muscle glycogen content during training, does not impair exercise-induced glycogen breakdown. **References** Stannard SR, Buckley AJ, Edge JA, & Thompson MW (2010). Adaptations to skeletal muscle with endurance exercise training in the acutely fed versus overnight-fasted state. *Journal of Science and Medicine in Sport* 13, 465-469. Van Proeyen K, Szlufcik K, Nielens H, Pelgrim K, Deldicque L, Hesselink M, Van Veldhoven PP, & Hespel P (2010). Training in the fasted state improves glucose tolerance during fat-rich diet. *The Journal of Physiology* 588, 4289-4302. Van Proeyen K, Szlufcik K, Nielens H, Ramaekers M, & Hespel P (2011). Beneficial metabolic adaptations due to endurance exercise training in the fasted state. *J Appl Physiol* 110, 236-245.

## VISUALISATION OF ADIPOSE TRIGLYCERIDE LIPASE AND ITS ACTIVATOR CGI-58 IN HUMAN SKELETAL MUSCLE

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**Introduction** Lipid droplets are present in skeletal muscle and the fatty acids liberated through lipolysis are utilised as a readily available fuel source during exercise in lean trained individuals. Adipose triglyceride lipase (ATGL) is responsible for the first step of lipolysis in human skeletal muscle; the removal of a FA from triacylglycerol to form diacylglycerol (DAG). Comparative gene identification-58 (CGI-58) is required for full activation of ATGL, increasing its activity up to 20 fold in a cultured kidney cell line however it is currently not known if, and under which conditions, it activates ATGL in human skeletal muscle. The aim of the present study was to develop immunofluorescence methodology to visualise ATGL and its activator CGI-58 in human skeletal muscle. This is the first time that CGI-58 has been visualised in sections of human skeletal muscle. **Methods** Percutaneous muscle biopsies were obtained from the vastus lateralis of 6 lean, physically active and insulin sensitive males. 5 µm cryosections were stained using antibodies targeting ATGL and CGI-58. Lipid droplets were stained using the neutral lipid dye oil red O and nuclei were stained using the DNA stain, DAPI. Images were viewed using wide-field fluorescence microscopy. **Results and Discussion** The acquired images reveal that neither ATGL nor CGI-58 colocalise fully with lipid droplets in human skeletal muscle. ATGL staining revealed a strong plasma membrane stain and a weak diffuse intracellular stain. CGI-58 showed diffuse intracellular staining with some more intense regions of staining in regions which colocalise with myonuclei. ATGL and CGI-58 partially colocalised, however neither ATGL nor CGI-58 colocalised with lipid droplets in the overnight fasted resting state. There was an intense staining of CGI-58 in the myonuclei suggesting that the protein either has an important role in the local DAG generation at this site or an alternative role in other metabolic processes. In future studies we will explore whether known lipolytic stimuli such as adrenaline and exercise and life-style interventions involving diet and exercise lead to a spatial redistribution of ATGL and CGI-58.

## ENHANCED INTRAMUSCULAR TRIGLYCERIDE METABOLISM AND IMPROVED INSULIN SENSITIVITY IN RESPONSE TO TRADITIONAL ENDURANCE AND HIGH INTENSITY INTERVAL TRAINING

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Common adaptations to traditional endurance training (ET) are an increased mitochondrial density and a greater intramuscular triglyceride (IMTG) content that is accessible for oxidation during exercise. Both adaptations are fundamental to training-induced improvements in insulin sensitivity. However, little is known about the mechanism that makes IMTG accessible for oxidation and whether a more time efficient approach of high intensity interval training (HIT) can induce similar adaptations to ET. Therefore, we aimed to investigate the effect of 6 weeks of either HIT or ET on IMTG metabolism, content of the lipid droplet protein perilipin 2 and insulin sensitivity in sedentary males. Sixteen participants (22 ± 1 years, BMI 23.7 ± 0.8 kg.m<sup>-2</sup>, VO<sub>2</sub>peak 3.03 ± 0.16 l.min<sup>-1</sup>) were randomly assigned to either HIT (performing 4-6 Wingate tests per session, 3 times per week) or ET (performing 40-60 min of moderate-intensity cycling, 5 times per week). Prior to and following training, aerobic capacity and insulin sensitivity (oral glucose tolerance test) were assessed. In addition, muscle biopsies were taken before and after 60 min steady state cycling exercise at ~65% pre-training VO<sub>2</sub>peak. Immunofluorescence microscopy was used to assess fibre type-specific training-induced changes in mitochondria, IMTG and perilipin 2. Training improved aerobic capacity (HIT 7 ± 2%, ET 15 ± 3%; main effect P < 0.01) and induced similar increases in mitochondrial density (HIT 39 ± 4%, ET 48 ± 14%; main effect P < 0.01). Training also increased resting IMTG content (HIT 1.7-fold, ET 2.4-fold; P < 0.05) and perilipin 2 content (HIT 2.1-fold, ET 3.4-fold; main effect P < 0.05). Before training, a decrease in IMTG content in type I fibres was observed in response to 60 min cycling with no difference between groups (HIT 17 ± 10%, ET 15 ± 12%; main effect P < 0.05). In comparison, training induced a significantly greater breakdown of IMTG in type I fibres during exercise (HIT 27 ± 13%, ET 43 ± 6%; P < 0.05), with no significant difference between groups. Insulin sensitivity, assessed using the Matsuda index, was also greater after training (HIT 56 ± 15%, ET 29 ± 12%, main effect P < 0.05). The results obtained suggest for the first time that the enhanced insulin sensitivity observed after both HIT and ET may be explained by similar increases in mitochondrial density coupled with greater IMTG metabolism. Increased perilipin 2 content also provides a potential mechanism through which IMTG becomes more accessible for oxidation. Thus, HIT is a time efficient intervention and induces similar metabolic and health adaptations as ET.



## Oral presentations

### OP-BN01 Motor Learning 1

#### CODING OF BIOLOGICAL KINEMATICS DURING ACTION-OBSERVATION

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**Introduction** Biological motion is suggested to be mapped onto a representation during action-observation. This process occurs within the 'mirror neuron circuit' and is known as the 'direct-matching hypothesis'. To date, it is unclear whether biological motion is processed by coding goal-directed information or the movement kinematics. To examine this question we instructed participants to learn a novel timing sequence by observing different types of visual stimuli (Exp. 1). **Experiment 1 Method** Forty-four participants were randomly allocated to four groups; natural biological motion (NT-BM); unnatural biological motion (UN-BM); non-biological motion (NBM); and control (CTL). To examine the contribution from biological motion, we created two models that displayed the same timing information but with different movement kinematics. The NT-BM model contained a typical peak velocity profile (i.e., early-to-mid trajectory) while the UN-BM model contained an atypical delay in time to peak velocity. The NBM group observed a computer-generated constant velocity model and the control group observed a blank screen. After action-observation all participants attempted to reproduce the timing sequence. **Results and Discussion** There was a significant decrease in relative timing error for all experimental groups ( $p < 0.05$ ). Moreover, for the kinematic data there was a significant difference between the UN-BM and all other groups. In support of the 'direct-matching' hypothesis, the UN-BM group significantly increased proportion of time-to-peak velocity and displacement at peak velocity to resemble the observed UN-BM model. These data indicate that biological kinematics are coded, possibly through the mirror circuit or a higher-order cognitive system. To examine the locus of this coding, we replicated Exp. 1 but added a secondary motor task designed to interfere with the motor system (i.e., lower-order system) during action-observation. **Experiment 2 Method** Forty-four new participants were randomly allocated to a NT-BM, UN-BM and CTL groups. During action-observation all participants observed the same models as presented in Exp. 1 but performed a secondary movement task that involved randomly moving a stylus through a spatial maze. **Results and Discussion** As per Exp. 1, all experimental groups learned relative timing ( $p < 0.05$ ). The kinematic data indicated that there was no difference between the groups in proportion of time-to-peak velocity and displacement at peak velocity. Therefore, and unlike Exp 1, when the motor system (lower-order system) is engaged in a secondary task the biological kinematics were not reproduced. These findings provide direct evidence that action-observation involves the coding of biological kinematics through the mirror circuit and primary motor cortex.

#### CONSCIOUS INFORMATION ABOUT THE TYPE OF FEEDBACK CAN CHANGE THE PROCESSING WITHIN THE PRIMARY MOTOR CORTEX DURING IDENTICAL TASK EXECUTION

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UNIVERSITY FREIBURG

**Introduction** The coding of force- and position-related information in the primary motor cortex is of fundamental importance when transforming planned movement intentions into action. One recent behavioral study proposed that position feedback is weighted heavier on soft objects (large deflections), while force feedback is weighted heavier on stiff objects (small deflections) (Mugge et al. 2009). However, a previous experiment of our group showed that force and position feedback of one and the same task resulted in differential motor cortical activity despite the same stiffness and compliance (Lauber et al. in revision). Therefore, we hypothesized that another factor may be important for the control of force- and position-related tasks: the conscious interpretation (or conscious sensory weighting) of the feedback itself. **Methods** To test whether the conscious interpretation of the feedback may be crucial in determining the motor cortical activity, we instructed subjects ( $n = 10$ ) to perform submaximal (20% MVC) muscular contractions of the first dorsal interosseus muscle (FDI). Subjects were told that they receive either position feedback about the position between thumb and index finger or feedback about the produced force by pressing a force transducer. However, in reality, subjects always received feedback about their force and never about their position. In order to highlight differences in motor cortical control, subthreshold TMS (subTMS) was applied during the tasks (position ("cheating task") and force task). **Results** SubTMS resulted in a suppression of the ongoing FDI EMG activity in both tasks. However, the mean suppression was significantly greater (force  $23.58 \pm 9.95\%$  versus position  $31.35 \pm 7.71\%$ ,  $P = 0.001$ ) and had a greater maximum amplitude during position control (force  $50.41 \pm 13.30\%$  versus position  $59.36 \pm 12.86\%$ ,  $P = 0.022$ ). The FDI background EMG obtained without stimulation showed no difference between the two tasks. **Discussion** The results of the present study reveal that neither the properties of the object (stiff versus soft/compliant) nor the feedback itself are crucial in modulating the neural activity. Differential conscious interpretation/sensory weighting of the feedback leads to changes in cortical processing. In this way, the current study further underlines that force and position control are differently coded within the primary motor cortex. **References:** Lauber B, Leukel C, Gollhofer A, Taube W. (2011). J Neurophysiol (in revision). Mugge W, Schuurmans J, Schouten AC, van der Helm FCT. (2009). J. Neurosci., 29, 5476–5482.

#### INVESTIGATING THE EFFECT OF A VARIABILITY CONSTRAINT ON RUNNING KINEMATICS AND EMG

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**Introduction:** The complexity of sport behavior, especially the assembly of the different components and levels in order to achieve a coordinated behavior, has gained much attention. Since variability within and across levels affords the athlete's sensorimotor system the required adaptability and flexibility for a coordinated behavior under changing constraints, an elastic constraint was used to influence variability (e.g., in reactive phenomena) in a task specific manner to enforce permanent adaptation. The present study examined the effect of variable training with elastic constraints (i.e., tubes) on the variability of running kinematics and EMG. **Methods:** Whole body 3D-kinematics and lower extremity EMG (rectus femoris, tibialis anterior and lateral gastrocnemius) of ten male participants were recorded during pre- and post-tests. Both tests consisted of two treadmill-running intervals. One was performed with and one without the constraint with the order of situations being counterbalanced across runners. Participants performed 18 training sessions within 8 weeks. Kinematic and EMG variability within and between strides was analysed. Variance ratio (Hershler & Milner, 1978) of hip, knee and ankle angles, as well as of EMGs was calculated. **Results:** Repeated measures ANOVAs showed no significant differences between both situations for kinematic total stride data during pre- or post-test. With respect to EMG variability, however, an increase for all muscles was evidenced for the pre-test results ( $p < .01$ ,  $ES > .65$ ) in the constrained situation that was interestingly reversed after the intervention in the

more distal tibialis ( $p < .001$ ,  $ES = .67$ ) and gastrocnemius ( $p < .001$ ,  $ES = .75$ ) as variability was higher during normal running. Within stride analyses unveiled somewhat different results. Pre-test EMGs showed higher variability for tibialis ( $p < .05$ ,  $ES = .47$ ) and gastrocnemius ( $p < .01$ ,  $ES = .72$ ) during stance but only for tibialis ( $p < .05$ ,  $ES = .51$ ) during swing phase. For the post-test, no significant differences were found. The kinematic data at least demonstrated small effects on the more distal knee and ankle angles for swing phase ( $ES > .15$ ). Discussion: The different results obtained by using different levels of observation (kinematics vs. EMG) support the assumption that the variability on sublevels provides flexibility to adapt to a variable constraint primarily at the first exposure to new constraints. Moreover, it is likely that such intervention may still encourage an exploratory behavior that influences the interplay of the components involved due to an increased variability even in a routine behaviour like running. Hershler, C. & Milner, M. (1978) IEEE Trans Biomed Eng 25 (5) 413–420

### THE DELIBERATE PRACTICE CHARACTERISTICS OF SKILLED VERSUS LESS-SKILLED ATHLETES

COUGHLAN, E.K., FORD, P.R., MCROBERT, A.P., WILLIAMS, A.M.

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**Introduction** Deliberate practice is activity designed to improve current aspects of an individual's performance. It is characterized as being mentally and physically effortful, highly relevant to improving performance, and not immediately rewarding or inherently enjoyable (Ericsson et al., 1993). However, when athletes retrospectively recall their practice histories they rate these activities as enjoyable, rewarding, and as less relevant (e.g., Ward et al., 2007), which they might not have done during the activity itself or else the practice might not have been deliberate. When left to their own devices, skilled athletes may engage in deliberate practice activity that contains its predicted characteristics so as to improve their performance and rectify weaknesses. We test this hypothesis in a controlled environment using skilled and less-skilled Gaelic football players as they practice two different free-kick tasks. **Methods** Forty-five adult Gaelic football players were divided equally into three groups: skilled (SK), less-skilled (LSK) and control-skilled (CSK). Players completed pre-, post- and retention tests involving two free-kick shots at goal (out of hands, off ground). The SK and LSK groups practiced the two shots over four 30 min practice sessions between the pre- and post-tests, whereas CSK did not. Participants were free to self-select their activities during practice. The characteristics of deliberate practice were examined during practice using established measures of mental effort, physical effort, motivation and enjoyment. **Results** The SK group practiced the shot they were weakest on from the pre-test on 66% of the practice trials compared to 27% for the LSK group. SK rated their practice as 31% less enjoyable, 22% less motivating, 20% more physically exertive and 47% more mentally effortful compared to the LSK group. Although both groups improved their overall outcome scores for kicking from pre- to post-test, the SK group improved more on their weakest compared to strongest shot type, whereas the LSK improved more on their strongest compared to weakest shot. The CSK group showed no improvement on either shot type from pre- to post-tests. **Discussion** Findings support the prediction that experts when left to their own devices engage in deliberate practice activity (Ericsson et al., 1993), whereas less skilled individuals do not. Skilled Gaelic football players engaged in practice activities that contained the characteristics of deliberate practice, which may be a reason for their superior performance, whereas less-skilled players did not. **References** Ericsson, K. A. et al. (1993). *Psych Rev*, 100 (3), 363–406. Ward, P. et al. (2007). *High Ability Studies*, 18 (2), 119–153.

### CEREBRAL ASYMMETRY DURING EXERCISE USING NEAR INFRARED SPECTROSCOPY : AN EXAMINATION OF SELF-REPORTED TOLERANCE.

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**Introduction** Grounded in the Dual-Mode Theory (Ekkekakis 2003) self-reported tolerance of exercise intensity is a dispositional trait, with a biological basis, which may account for inter-individual variability in affective responses to exercise (Ekkekakis et al. 2005). Research has implicated frontal cortex (FC) asymmetry in the awareness of the physiological condition (Craig 2009, 2003) and should reflect self-reported tolerance. The objective of this study is to examine the activity of the FC during exercise to investigate asymmetry and the impact of the dispositional trait of self-reported tolerance using NIRS. **Methods** Based on tolerance scores assessed by the Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q; Ekkekakis et al. 2005) subjects were selected to a High Tolerance (High;  $n=7$ ) or Low Tolerance (Low;  $n=7$ ) condition. Subjects completed a cycling ramp protocol to volitional exhaustion and exercise intensity was standardized against metabolic processes as recommended by Ekkekakis et al. (2009) and Rooks et al. (2010). Changes in Deoxyhaemoglobin (HHb), Oxyhaemoglobin (O2Hb), Total Haemoglobin (tHb) and Tissue Oxygenation Index (TOI) were measured from the left and right FC using 2-channel NIRS. The average change from ventilatory threshold (VT) to respiratory compensation point (RCP) and RCP to exhaustion (end) were recorded. **Results** A significant condition (High, Low) by time (VT to RCP, RCP to end) interaction ( $p < .05$ ) on changes in TOI was recorded. This was due to an increase in TOI in the High condition from VT to RCP but a decrease in the Low condition. Both conditions decreased in TOI from RCP to end. A significant condition by FC (Left, Right) by time interaction ( $p < .05$ ) on HHb was also recorded. A crossover interaction with a disproportional split in HHb between the Left ( $3.96 \pm .77$ ) and Right ( $1.45 \pm .44$ ) FC in the High condition at VT to RCP that reversed at RCP to end (Left =  $1.03 \pm .63$ , Right =  $3.89 \pm .79$ ) explained the effect. There were no differences in the Low condition. No other significant effects were recorded. **Discussion** These findings indicate differential patterns of activation of the FC dependent on self-reported tolerance and asymmetry of the FC at exercise intensities above VT. The results support the dual-mode theory and provide insight into underlying mechanisms of exercise-induced responses. On-going research is exploring the potential effect of intervention strategies on FC activity. **References** Craig (2008) *Curr Opin Neurobiol* 13:500-505 Craig (2009) *Nat Rev Neurosci* 10:59-68 Ekkekakis (2003) *Cognition Emotion* 17:213-239 Ekkekakis et al (2005) *J Sport Exerc Psychol* 27:350-74 Ekkekakis (2009) *J Sport Exerc Psychol* 31:505-53 Rooks et al (2010) *Prog Neurobiol* 92:134-150

### EARLY NEURAL RESPONSES TO STRENGTH TRAINING

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THE UNIVERSITY OF QUEENSLAND

**EARLY NEURAL RESPONSES TO STRENGTH TRAINING** Carroll, TJ (1), Selvanayagam, VS (1,2), Riek, SP (1) (1) School of Human Movement Studies, The University of Queensland, Brisbane, Queensland, AUSTRALIA, 4072; (2) Sports Centre, University of Malaya, 50603, Kuala Lumpur, MALAYSIA **Introduction** The neural adaptations that accompany strength training have yet to be fully determined. Here we addressed this topic by testing the idea that strength training might share similar mechanisms with some forms of motor learning. Since ballistic motor learning is accompanied by a shift in the resultant direction of muscle twitches induced by transcranial magnetic stimulation (TMS) towards the training direction (Classen et al. 1998), we investigated whether single isometric strength training sessions can induce similar

TMS-evoked twitch effects. Methods Twitch force resultant vectors and motor evoked potentials (MEPs) induced by TMS were measured before and after single sessions of strength training involving the forearm muscles. The training protocols involved either brief (less than 1s) or sustained (2s) maximal isometric contractions with an initial ballistic component, or sustained contractions (2s) with a slow, ramp onset (over 2s). Participants (n=12) each performed three training protocols (consisting of 4 sets of 10 repetitions) and served as their own control in a counter balanced order. Results All three training protocols caused a significant immediate shift in TMS-induced twitch force resultant vectors towards the training direction (30-40% of the angular difference between initial direction and training direction,  $p < 0.05$ ), followed by a gradual shift back towards the pre-training direction. The strongest effect was found when training involved both ballistic and sustained force components. There were no large or consistent changes in the direction of twitches evoked by motor nerve stimulation for any of the three training protocols. Discussion We showed that a single session of strength training shifts TMS-induced twitch force direction towards the training direction in a similar way to ballistic motor learning. The changes were at least partly due to neural adaptation as muscle responses to motor nerve stimulation were unaffected. Furthermore, the data show that while "typical" strength training involving sustained maximal force production is sufficient to induce change, the strongest early neural effects are found when both ballistic and maximum sustained force are produced. We suggest that these early neural responses to training reflect an important component of neural adaptation that summates over multiple sessions to ultimately enhance strength. References Classen J, Liepert J, Wise SP, Hallett M, and Cohen LG. Rapid plasticity of human cortical movement representation induced by practice. *J Neurophysiol* 79: 1117-1123, 1998.

## Invited symposia

### IS-PM14 Exercise Prescription in Transplant Patients

#### **PATHOPHYSIOLOGY OF EXERCISE INTOLERANCE IN HEART TRANSPLANT RECIPIENTS: ROLE OF HIGH-INTENSITY TRAINING**

HAYKOWSKY, M.

UNIVERSITY OF ALBERTA

The purpose of this presentation is to discuss the underlying mechanisms for exercise intolerance in heart transplant recipients and the role of high-intensity interval training to improve cardiovascular function and fitness.

#### **ROLE OF CARDIOPULMONARY EXERCISE TESTING IN HEART FAILURE PATIENTS BEING ASSESSED FOR CARDIAC TRANSPLANT**

SCHULTE, F.

HEART CENTRE, CHEMNITZ

Cardiopulmonary exercise testing (CPET) is a simple, reproducible and objective test for diagnosing patients with exercise intolerance. The talk describes the importance of CPET besides other diagnostic tools for assessing patients with severe heart failure and its main criteria for optimal timing of Heart transplantation. It reviews the physiological principles of exercise intolerance in cardiac patients and discusses the main CPET-criteria for risk stratification: Peak oxygen consumption, ventilatory equivalent and anaerobic threshold.

#### **EXERCISE REHABILITATION FOR PATIENTS WITH VENTRICULAR ASSIST DEVICES.**

BINDOFF, C.

ROYAL BROMPTON AND HAREFIELD NHS FOUNDATION TRUST

Once a ventricular assist device (VAD) has been implanted, specific rehabilitation exercise is crucial to prepare the patient either for cardiac transplantation, for upgrade to long-term VAD or for VAD removal following myocardial recovery. There are some specific considerations for rehabilitation of these patients which should be addressed in order to provide a safe and effective exercise programme. The considerations for exercise in both short-term and long-term VADs will be highlighted. Currently there is a lack of evidence regarding exercise training protocols for people who have either short-term or long-term VADs implanted for heart failure. The papers which have described rehabilitation regimens document cases following long-term left ventricular assist device (LVAD) insertion. Of these, some are single case studies, some have fewer than 10 subjects others are retrospective analyses. Patients with long-term VADs are being rehabilitated sufficiently well to enable discharge home or into the community setting at the majority of centres implanting VADs. The instigation of a progressive mobility programme for patients with short-term VADs is however innovative, and has gone beyond the manufacturers' original conception for these devices. The use of both short-term extracorporeal and long-term VADs has brought about new challenges for exercise prescription. Short-term VADs are being inserted more frequently and in a wide variety of clinical situations (post-cardiotomy for cardiogenic shock, post cardiac transplantation and for right ventricle support post LVAD insertion). Usually these patients are confined to bed in the intensive care unit until the device is either explanted or up-graded. There are many different versions of long-term VADs available (pulsatile and non-pulsatile devices) and the functional exercise capacity of the patient will be dependent upon the ability of the device to deliver an output which matches the intensity of exercise required. Specific exercise prescription is essential for patients requiring a VAD to combat physical deconditioning that occurs with heart failure and with prolonged periods in bed on the intensive care unit (ICU) after device insertion. Separate considerations are implicated for assisting patients with short-term and long-term VADs to exercise. The physical and psychological components of health are both much improved by early rehabilitation within the ICU setting, and establishing a positive exercise principle is vital for the long-term outcomes for a patient with an implanted VAD. We are at the beginning of a new area of scientific study with this fascinating population of pulse-less patients. New exercise protocols need to be evaluated to assess the effects on myocardial recovery and improvements in functional capacity to fully understand the potential of these evolving devices.

## Invited symposia

### IS-SH02 Morals and Ethics in Applied Sports Psychology

#### ETHICAL PRINCIPLES FOR APPLIED SPORT PSYCHOLOGISTS OF THE EUROPEAN SPORT PSYCHOLOGY FEDERATION

JOHNSON, U.

*HALMSTAD UNIVERSITY*

Introduction The term sport psychology refers to psychological aspects of sport, physical recreation, physical education, exercise, health, and related physical activities. The European Sport Psychology Federation (FEPSAC) works for the development of the field of sport psychology and exercise from a European and global perspective. Due to Sport Psychology professionals' specialised knowledge and the hypothetical potential for harm, the ethical principles are guidelines for FEPSAC professionals to act responsibly and ethically in the provision of professional services. These principles are intended to ensure the dignity and welfare of all groups, organisations and individuals with whom FEPSAC professionals may interact with and provide professional services to. Altogether seven ethical principles is stated that guides FEPSAC research and applied sport psychology. These are: a) Professional and Social Responsibility, b) Competence, c) Consent, d) Confidentiality, e) Integrity, f) Personal Conduct, g) Research. Recommendations a) FEPSAC members are responsible for safeguarding the public and the FEPSAC from members who are deficient in ethical conduct. They should uphold professional and social standards of conduct and accept appropriate responsibility for their behaviour. b) FEPSAC members should strive to maintain the highest standards of competence in their work. c) No FEPSAC members should undertake any work without first having the informed consent of all participating clients. This is done primarily, through the client signing a document setting detailing all information relevant to the proposed investigation, intervention, treatments or test. d) FEPSAC members should preserve the confidentiality of the information acquired in their work which should not be developed without prior written consent of a client. Clients should be informed that they have a right to a copy of such information relating to them if so requested. f) FEPSAC members should promote integrity in research, teaching, and practice of sport psychology. g) FEPSAC members shall conduct themselves in a manner beneficial to the well-being of their clients and in a way that brings credit to the field of sport psychology. h) FEPSAC members should comply with codes, statements, guidelines and other directives developed. Moreover, they should accurately report the data they have gathered and the results of their research, and state clearly if any data on which the publication is based have been published previously. Reference FEPSAC Position Statement 9. Ethical principles of European Sport Psychology Federation, 2011.

#### THE POTENTIAL VIOLATION OF SEXUAL BOUNDARIES IN SPORT PSYCHOLOGY CONSULTANCY: IMPLICATIONS FOR RESEARCH AND PRACTICE

HARWOOD, C.G., LITTLE, G.

*LOUGHBOROUGH UNIVERSITY*

The purpose of this presentation is to examine issues surrounding the potential violation of sexual boundaries in sport psychology consultancy and critically evaluate the current state of knowledge in the field. Limited discussion and research relating to this ethical issue exists within sport psychology; the discussion that has occurred has mainly focused on erotic transference and countertransference (Andersen, 2005). Research and knowledge from clinical psychology, counseling psychology and psychotherapy proffers ideas for discussion and research into the factors that precipitate sexual boundary violations. The relevance of the controversial practice of touch as a therapeutic tool and a stimulus for sexual boundary violations is considered, alongside implications for the training of neophyte practitioners through role playing, peer support and supervision.

#### ETHICAL CHALLENGES FACED BY SPORT PSYCHOLOGISTS WORKING WITH TALENTED AND OLYMPIC ATHLETES AND THEIR COACHES

WYLLEMAN, P.

*VRIJE UNIVERSITEIT BRUSSEL*

With the growing importance of the role of the sport psychology consultants (SPC) in elite sport, so has the need for clear boundaries of the role of the SPC and their adherence to ethical principles become much more poignant. More specifically, the SPC is required, amongst others, to have an expanded knowledge of ethical/legal guidelines based on real experiences with clients, awareness of the legal and ethical considerations and the ability of handling special situations (e.g., abuse), appreciation of the impact of one's internal states on assessment of clinical outcomes (Kenkel & Peterson, 2010). In this presentation, three case studies will be presented and used to reflect with the ethical guidelines regarding intervention by an SPC in general, and with the ethical guidelines formulated by the European Federation of Sport Psychology (FEPSAC) in particular. In conclusion, some recommendations will be formulated with regard to ethical guidelines for SPC.

## Invited symposia

### IS-PM05 DEBATE: To Screen or Not To Screen That is the Question: Europe Vs. USA (Sponsored by Philips)

#### PRE-PARTICIPATION SCREENING, IS IT WORTH IT?: EUROPE VS. NORTH AMERICA

WHYTE, G.

*LIVERPOOL JOHN MOORES UNIVERSITY*

Conversely, the European Society of Cardiology has denounced the use of questionnaires in isolation and has forcefully recommended the inclusion of a resting 12-lead electrocardiogram (ECG) as part of the screening process. These divergent opinions have generated an intense, emotive, and at times acrimonious debate among medical professionals and the lay public. Whilst the issues of sensitivity and

specificity are central to the continental divide it is cost-effectiveness that is at the heart of the pre-participation screening debate. Unfortunately, there are no direct comparisons of screening strategies with vs. without an ECG component. This lack of data is not a minor issue since estimates of the cost of implementing an ECG based screening program in the United States alone have been as high as \$2 billion. Beyond the Dollar vs. Euro debate lies perhaps the most important issue: efficacy. Do pre-participation cardiovascular screening programmes save lives? How do we deal with an athlete with known disease? What do we do with 'grey zone' athletes? What are the risks of training and competition in the presence of disease? Are we in a position to disqualify athletes from competing? These questions and more remain an area of divergent opinion with limited empirical support on either side. Given the extraordinary economic and personal cost of pre-participation cardiovascular screening programmes as well as the tragic loss of a young athlete, it is essential that high quality objective evidence rather than emotion guide policy. Pre-Participation Screening, is it Worth it?: Europe vs. North America will bring together two leading figures from across the continental divide to provide a frank and open debate on the differences that exist between the opposing communities. Following a 20 minute presentation from Professor's Whyte and Levine each presenter will be deliver a 5 minute rebuttal followed by open questions from the audience. The session will close with a vote from the floor: 'Is Pre-Participation Cardiovascular Screening Worth It?'.

#### **PRE-PARTICIPATION SCREENING, IS IT WORTH IT?: EUROPE VS. NORTH AMERICA**

LEVINE, B.

*UNIVERSITY OF TEXAS SOUTHWESTERN MEDICAL CENTER AT DALLAS*

The sudden death of a competitive athlete stirs great emotion among family, fans, and the media. Because such athletes are generally young, vigorous and apparently healthy with many years of productive life lost, these unfortunate events have generated powerful interest among the public and the medical profession regarding what could have been done to prevent such catastrophes from occurring. Despite the desire for a solution, the global debate has often stalled because of a continuing disagreement on the incidence and etiology of SCD in young athletes. This disagreement has been fuelled by a continental divide perpetuated by the polarized views emanating from North America and Europe. Whilst incidence and etiology have acted as the building block of this continental divide, it is the debate surrounding pre-participation cardiovascular screening that is perhaps the most hotly debated topic in sports medicine. The debate centres on the best paradigm to screen apparently healthy, asymptomatic young athletes. On one side of the issue, experts from the American Heart Association first in 1996 and again in 2007 recommended that a 12-point evaluation focusing on the presence of symptoms during exercise and a family history of sudden cardiac death is the most appropriate strategy.

**12:00 - 13:15**

### **Plenary sessions**

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#### **PS-PL02 NEW HORIZONS: In the Role of Exercise in the Treatment of Cardiovascular Disease**

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##### **THE ROLE OF CARDIAC STEM CELLS IN CARDIAC ADAPTATIONS TO PHYSIOLOGICAL AND PATHOLOGICAL STRESS**

ELLISON, G.

*LIVERPOOL JOHN MOORES UNIVERSITY*

In long lived organisms most somatic cells have a lifespan significantly shorter than the organism. Most, if not all, mammalian adult tissues harbour a small subpopulation of tissue-specific stem-progenitor cells that differentiate into some -or all- the parenchymal cells of their tissue of origin. Thus, adult stem-progenitor cells likely have been evolutionarily selected to maintain cellular tissue homeostasis and to repair physiological wear-and-tear throughout life, acting as a cell reservoir to replenish cycling-incompetent parenchymal cells. Cardiac resident stem-progenitor cells in the embryonic, neonatal and adult mammalian heart, including human, have been identified by different membrane markers (c-kit, Sca-1, Abcg-2, Flk-1) and transcription factors (Isl-1, Nkx2.5, GATA4). The adult c-kit positive (c-kitpos) cardiac stem cells (CSCs) are clonogenic, self-renewing and multi-potent, in that they differentiate into the 3 cardiac lineages; cardiomyocytes, smooth muscle and endothelial cells (Beltrami et al. 2003, Cell, 114, 673). They participate in adaptations to myocardial stress and have a strong regenerative capacity restoring most cardiomyocytes and small vessels lost in an infarct. These findings have not only challenged the established notion of the heart as a terminally differentiated organ but have placed it squarely amongst other organs with regenerative potential such as the liver, skin, muscle, CNS; despite the fact that the working myocardium is mainly composed of terminally differentiated contractile cells. c-kitposCSCs are activated in response to pathological or physiological stimuli, whereby they enter the cell cycle and differentiate into new myocytes (and vessels) that significantly contribute to remodelling of functional myocardium. Here, we will present data that shows exercise training results in myocardial mass remodelling through both myocyte hypertrophy as well as hyperplasia. The latter is due to the activation and ensuing differentiation of c-kitposCSCs into newly-formed myocytes and capillaries. We also show that c-kitposCSCs are indispensable but efficient to repair extensive cardiac diffuse damage, leading to complete cellular, anatomical and functional recovery. Growth factors up-regulated with physiological and pathological stress determine c-kitposCSC activation, proliferation and differentiation. The future of cardiovascular regenerative medicine is dependent on our success in dissecting the biology and mechanisms regulating CSC fate. This information will provide the tools for the design of more physiologically relevant clinical regeneration protocols. This work is supported by the BHF, FP7 EU Marie Curie (224853), CARE-MI (242038) and Endostem (241440).

##### **AEROBIC INTERVAL TRAINING: THE BEST MEDICINE FOR PATIENTS WITH CARDIOVASCULAR DISEASE**

WISLØFF, U.

*NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY*

Prospective, observational studies suggest that low aerobic fitness, measured as maximal oxygen uptake, is a strong and independent predictor for total and cardiovascular mortality in healthy individuals and in patients with cardiovascular disease. Epidemiological, clinical and experimental data support an important role for physical activity and systematic exercise training in prevention, treatment and reha-

bilitation of several life-style related conditions, such as overweight and obesity, diabetes, and cardiovascular disease. Clearly, it would be advantageous to identify the optimal exercise regimes for selected patient groups to maximize the benefit. However, no clear agreement of what constitutes the most optimal training programs with regard to intensity, frequency and duration has yet been identified, although substantial research programs have been set up to study this. The presentation will give examples of the effects of training programs that utilize a relatively high intensity of the exercise, from an epidemiological point through experimental and clinical studies. A hypothesis is that on a small and a large scale, the more beneficial effect of high intensity exercise training also translates to greater improvements in exercise capacity, quality of life, and reduced morbidity and mortality.

## 14:00 - 15:00

### Poster presentations

#### PP-BN01 Sports Biomechanics 1

##### EXAMINATION FOR CALCULATING BODY SEGMENT MASS DISTRIBUTIONS BY MEANS OF LASER 3D BODY SCANNING METHODS IN JUNIOR MALE GYMNASTS

HAKAMADA, N.1, FUNATO, K.2

1:SPORTS TRAINING CENTER, NIPPON SPORT SCIENCE UNIVERSITY (TOKYO, JAPAN), 2 :LABORATORY FOR HUMAN MOVEMENT SCIENCES, NIPPON SPORT SCIENCE UNIVERSITY (TOKYO, JAPAN)

**Introduction** In Gymnasts, body segment parameters such as location of whole body/segment mass center, segment mass and its distribution are important factors for both biomechanical research and performance assessment. Therefore, purpose of this study were to investigate validity of a whole body volume and segmental volumes using three dimensional anthropometry methods, and to estimate segment mass distribution in order to demonstrate anthropometric characteristics of elite junior male gymnast. **Methods** 7 male junior gymnasts (GM: Age=13.9±0.7yrs, BH=143.3±9.0cm, BW=39.9±5.8kg) and 7 junior high school students (NM : Age=13.7±0.7yrs, BH=157.7±10.4cm, BW=44.9±8.0kg) participated in this study. Whole body volume and each segmental volume were measured by using three dimensional whole body scanner (BLS: Hamamatsu Photonics KK). Body composition including whole body volume and lung volume were measured by using air displacement plethysmography (BODPOD:LMI ). Whole body scanning data was divided into 14 segments (SM: Head, Trunk, Upper arm, Forearm, Hand, Thigh, Shank, Foot ) in the same manner as the previous study done by C.E.Clauser,1969 according to anatomical landmark points. Trunk volume was corrected by subtracting lung volume. Each segment mass was determined by multiplying each segment volume and respective segment density reported by C.E.Clauser. Relative segment masses to whole body mass (%SM) were also calculated. **Results** Mean value of the difference(%) in whole body volume measured between ADP and BLS was 3.1%. Difference between directly measured body weight and sum of each segment mass was within 3%. There were no significant differences in segment masses between GM and NM. However, %SM for upper arm and fore-arm in GM were significantly larger than those in NM (upper arm; GM=2.82±0.15%, NM=2.56±0.12%, forearm; GM=2.07±0.08%, NM=1.81±0.08%, $p<0.001$ ). Trunk volume was almost same between GM and NM, however upper trunk volume relative to trunk volume in GM was significantly larger than those in NM. **Discussion** Present results indicate that estimation of body segment mass by using 3D laser scanning anthropometry might be valid and applicable for demonstrating segment characteristics among different athletes. With comparison to normal person, elite male junior gymnasts were anthropometrically characterized as relatively larger segment masses in upper trunk and upper limbs, indicating trainability and superiority to gymnastics movements. **References** Clauser C.E. (1969). AMRL Technical Report TR,69-70.

##### KINEMATICS OF BOOT-GROUND INTERACTION DURING SOCCER TURNING ON OUTDOOR NATURAL TURF

UNDERDOWN, T.

LIVERPOOL JOHN MOORES UNIVERSITY

**Rationale** Acquiring enough traction from boot-surface interface in soccer is a key component of the game (Grund & Senner, 2010). Inadequate grip may decrease performance and increase injury risk (Livesay et al., 2006). Player-surface interaction during tasks such as cutting and turning has not been well documented. The focus of the present study was to examine initial foot landing velocities, phase durations of ground-contact (GC) and typical slip magnitudes based on high-speed kinematics of foot-ground interaction on outdoor soccer pitches. **Method** Kinematics of 19 semi professional players aged 22±1.3 years were captured at 500Hz while performing a 135 degree V-cut with their dominant leg, using 6 infra-red cameras (Qualisys, Sweden). All players executed 5 turns on 6 different elite natural turf surfaces. A three-segment foot model (rear-foot, mid-foot & forefoot) was used to monitor 3 phases of GC (Phase 1 HS-FF, Phase 2 FF-HR & Phase 3 HR-TO, (HS=heel strike, FF=flat foot, HR=heel rise & TO=toe off). HS was determined using the vertical foot velocity (Zeni et al., 2008) and verified with force platform measures in a laboratory. Kinematic data were low-pass filtered using a 25Hz cut-off frequency except phase 1, with high frequency motion filtered using a 75Hz cut-off. **Results** Overall mean landing velocity for all pitches was 2.60±0.24m/s; the mean total turn time was 0.491s. All players landed heel first with 18 players spending 0.026±0.022s during phase 1, with one player taking 4 times as long to complete that phase (0.067±0.07s). Phase 2 took 0.324±0.084s, with individuals maintaining consistent times across pitches. Phase 3 had the majority of players spending 0.121±0.067s, although for one pitch 7 players took 0.29±0.093m/s. During phase1 the rear-foot had a consistent resultant horizontal slip of 1.7±0.3cm (1.3-2cm range). Phase2 experienced the greatest slip of 1.9±0.3cm (1.6-2.5cm range), while in Phase 3 there was minimal slip for all pitches with a range of 0.05-2mm. **Discussion** Stiles et al. (2011) found similar landing velocities (2.51-2.64m/s) for a 180 degree turn on indoor natural turf. This can be used to provide a better replication of initial impact conditions for measuring turf traction using mechanical rigs. Timings of GC phases have implications for footwear grip design and stud placement. The current group of players wore hard ground molded-stud boots: soft ground/longer stud configurations may modify GC phases. The majority of players in phase 1 have similar heel-first strategy occurring rapidly but some players spend longer in phase 2 compared to the mean. This appears to be related to greater knee flexion and shank lean into the turn but analysis of traction related movement strategies is beyond the scope of this paper. **References** Livesay, G, Reda, D, Nauman, E. (2006) J Sports Med, 34, 415-422. Stiles, V, Guisasaola, I, James, I, Dixon, S. (In Press) J App Biom. Zeni, J, Richards, J, Higginson, J. (2008) Gait & Post, 27.

## COULD A BASKETBALL TEST BATTERY BE AN APPROPRIATE MODALITY TO CLASSIFY THE PLAYERS WITH INTELLECTUAL DISABILITY IN PROMOTION CATEGORY?

FRANCIOSI, E., EMERENZIANI, G.P., PES, G., GUIDETTI, L., BALDARI, C., GALLOTTA, M.C.

UNIVERSITÀ DEGLI STUDI DI ROMA

**Introduction** The aims of this study were to verify whether the basketball test battery previously proposed for the Competitive category (Comp) could be an appropriate modality to classify the players with intellectual disability (ID) in Promotion category (Pro); to assess basketball abilities before (PRE) and after (POST) a 8-months training in players with ID in relation to Comp and Pro categories; and finally to analyse the variation of specific basketball abilities by subjects' ID levels. **Methods** Forty-one adult basketball male players with ID (15% Mild, 54% Moderate, 29% Severe, and 2% Profound ID) were divided in 17 and 24 subjects playing into Comp and Pro category, respectively. PRE and POST a 8-month specific training, all players were assessed through the basketball test battery for assessing individual global, ability level and fundamental area scores. **Results** The individual global, ability levels II and III, and all fundamental areas scores significantly affected by the Category and Intervention ( $p < 0.05$ ). The level I was significantly changed after the intervention period regardless the Category ( $p < 0.01$ ), while the shooting was affected by the interaction between Category and Intervention ( $p < 0.01$ ). The Fisher's post-hoc results showed significant differences between the categories (Comp vs Pro) in score of individual global ( $p < 0.0001$ ), level I ( $p < 0.01$ ), level II ( $p < 0.01$ ), level III ( $p < 0.05$ ), and in all fundamental areas ( $p < 0.01$ ). Particularly, the individual global score in both categories significantly increased ( $p < 0.01$ ). Principally, the players of Comp significantly improved in level III ( $p < 0.05$ ), in ball handling ( $p < 0.05$ ), reception ( $p < 0.01$ ), passing ( $p < 0.01$ ), and shooting ( $p < 0.01$ ) scores. Instead the players of Pro improved significantly in level II ( $p < 0.01$ ), in ball handling ( $p < 0.05$ ), reception ( $p < 0.05$ ), and passing ( $p < 0.01$ ) scores. Individual global, ability level I, II and III, and fundamental area scores were negatively correlated to ID level indicating that players with lower ID obtained higher ability scores. **Discussion** Both players with ID of Pro and Comp improved significantly after a 8-month basketball training in level II and III, respectively. After the intervention period, the players of Comp improved their functional abilities (total score) and achieved higher ability levels, while the players of Pro had difficulties in increasing the starting level of their specific skills in a short time, despite showing some degree of score improvement within a specific ability level.

## UNDERWATER ARM STROKE MOTION ANALYSIS: COMPARISON OF THEORETICAL MODEL AND EXPERIMENTAL DATA

SILVATTI, A.P., TELLES, T., CERVERI, P., BARROS, R.M.L.

UNIVERSITY OF CAMPINAS, POLITECNICO DI MILANO

**UNDERWATER ARM STROKE MOTION ANALYSIS: COMPARISON OF THEORETICAL MODEL AND EXPERIMENTAL DATA** Amanda P. Silvatti 1,2, Thiago Telles 1, Pietro Cerveri 2 and Ricardo M. L. Barros 1. 1 - Faculty of Physical Education, University of Campinas, Brazil 2 - Biomedical Engineering Department, Politecnico di Milano, Italy **Introduction** Swimming has been taught and trained based on some very spread theoretical model such as the described in Maglischo (1993). However, accurate experimental data of swimmers motion can now be obtained using a 3D underwater kinematical analysis system (Silvatti, et al. 2010). Such methods can provide individual and detailed evaluation of the swimmers performance. Thus, this work intends to analyze and compare the hand underwater motion kinematics in the four swimming styles with the model described in Maglischo (1993). **Methods** The DVideo kinematical analysis system (Figueroa et al., 2003; Silvatti et al. 2010) was used for underwater online data acquisition and processing. The system consisted of two gen-locked Basler cameras with wide angle lens (100Hz) enclosed in housings. The volunteers were four highly trained male competitive swimmers and they performed four tasks, one in each swimming style. The 3D hand extremity position in the underwater phase of the both arms was obtained by manual digitizing. The raw position time data was smoothed using a low pass digital Butterworth filter (cutoff 5 Hz). The following variables were calculated for each swimmer and each arm: a) hand trajectory (frontal, lateral e inferior view); b) arm stroke width (ASW); c) arm stroke length (ASL); d) arm stroke depth (ASD); e) maximum velocity (MV) and f) maximum acceleration (MA). All variables were compared among swimmers, right and left hands, swimming styles and with the models described in Maglischo (1993). **Results and Discussion** The right hand of the volunteer 2 in the breaststroke showed the longest ASL (1.42m). the greatest values of the MV was found in the butterfly (58.38m/s<sup>2</sup>), that was detected in volunteer 4 left hand. The MA greatest value was detected in the same hand and volunteer, but in backstroke (4.69m/s). The mean values of ASW, ASD and MV for both hands in all styles were in agreement with the values expected (Maglischo, 1993). The graphic plots with the hand trajectory provided the identification of the movement pattern. To improve the arm stroke analysis the air phase should be included. **Conclusion** The underwater analysis system was able to quantify the hand's trajectory and the linear kinematics variables in all swimming tasks, identifying the similarities and differences between the results and the theoretical model. **References** Figueroa, et al. (2003) A flexible software for tracking of markers used in human motion analysis. *Comput Meth Prog Bio.*, 72(2), 155-165. Maglischo, E.W. (1993) *Swimming Ever Faster*, Mountain View, CA. Mayfield. Silvatti, A.P., et al. (2010) Underwater camera calibration: an accuracy analysis, 28th ISBS, Michigan, EUA.

## EFFECTS OF CHANGES IN ANGULAR MOMENTUM ON PERFORMANCE DURING DISCUS THROWING

YAMAMOTO, D., URATA, T., TANABE, S., ISHIKAWA, M., ITO, A.

OSAKA UNIVERSITY OF HEALTH AND SPORT SCIENCE

**Introduction** Few studies about angular momentum during discus throwing have been reported (Dapena, 1993; Miyanishi, 2000). However, it is not clear whether throwing distance is related to changes in the angular momentum and throwing distance. It is necessary for providing useful information for training and instruction to clarify these relationships. In the present study, relationships between throwing distance and angular momentum in each body segment about the vertical axis (H-z) were investigated in discus throwers with extensive records. **Methods** Subjects were 19 male discus throwers (records, 38.67-68.94 m) from collegiate athletes to world level athletes. Throwing movements when each subject threw the longest distance were recorded by two video cameras (60 Hz) and digitized. The three-dimensional coordinates of the body and the discus were calculated using the direct linear transformation method. The throwing movement was divided into 5 phases, the H-z of whole body, the discus and the selected five segments of torso and head (trunk), right arm, left arm, right leg and left leg were calculated. **Results** Increment of the H-z of whole body during first double leg support phase (DS) just behind turn start and decrement of the H-z of whole body during delivery phase (DV) just before release had significant positive correlations ( $r=0.856$  and  $r=0.546$ , respectively). Significant positive correlations were found between throwing distance and increment of trunk, right arm, left arm, right leg, left leg and discus during the DS ( $r=0.523$ ,  $r=0.585$ ,  $r=0.828$ ,  $r=0.793$ ,  $r=0.509$  and  $r=0.510$ , respectively). During the DV, increment of the H-z of discus and right arm had significant positive correlations with throwing distance ( $r=0.820$  and  $r=0.735$ , respectively). In contrast, decrement of the H-z of left arm and left leg had significant positive correlations with throwing distance

( $r=0.632$  and  $r=0.510$ , respectively) Discussion Our results suggest that storing of the larger H-z into whole body using both legs during the DS is necessary for achieving higher performance. The results of changes in H-z during the DV suggest that the H-z of whole body was transferred into the discus. And when focusing on the H-z of each segment, the H-z of left arm and left leg were more transferred to the discus through the right arm in the throwers with longer distance. References Dapena, J. (1993) Track Technique, 125, 3977-3983. Miyanishi, T. (2000) Research Quarterly For Athletics, 43 (4), 29-36.

### **EFFECT OF MENTAL FATIGUE AND TOTAL SLEEP DEPRIVATION ON CYCLING BIOMECHANICAL PARAMETERS DURING A WINGATE TEST**

LERICOLLAIS, R., GAUTHIER, A., BESSOT, N., ZOUABI, A., DAVENNE, D.

UNIVERSITY OF CAEN BASSE-NORMANDIE

Introduction The movement involved during the Wingate test is recognized to be complex and requiring the use of several muscle groups based on a free pedal rate. Thus, the performance and fatigue observed during this cycling exercise are the results of a complex organization of movements. This organization might be driven by the central nervous system, in particular the brain (Raasch and Zajac, 1999). We can hypothesize that a specific perturbation of the sensorimotor mechanisms in the brain could disturb the organization of cycling movement during an anaerobic exercise. Therefore, the aim of this study was to evaluate the effects of a nocturnal mental fatigue on muscle fatigue and biomechanical cycling parameters recorded in the morning of the following day during a Wingate test. Methods Twenty active male subjects performed a 60-s Wingate test at 06h00 during 2 test sessions the day after a normal night and a total sleep deprivation night combined with a mental fatigue consisting of an 8-h simulated driving task. During each test session, the Peak Power (PP) and the Mean Power over 60 s (MP60s) were analyzed. The decrease in power output throughout the Wingate test was used to evaluate the subjects' fatigue. Kinetic (angle of peak torque and range in torque variation) and kinematic (mean angle and range of motion (ROM) of the hip, knee and ankle) variables were studied during 2 intervals of the Wingate test: I1 from the 5 to the 20th s and I2 from the 45 to the 60th s. Results The results showed that performances (PP and MP60s), fatigue, kinetic and kinematic patterns were unaltered after a total sleep deprivation night during which a prolonged sustained attention task was done in order to specifically impair the vigilance of the subjects. Discussion The stability of performances, fatigue and biomechanical patterns of movement recorded during the anaerobic cycling exercise after a perturbation in the neural system does not seem to confirm our previous assumption. It can be hypothesized that there are cerebral compensatory responses (Drummond et al., 2004) which could allow athletes to preserve the cycling patterns in order to maintain a coherent movement, and thus maintain the performance level. We can also suppose that the organisation of cycling movement could be controlled at a lower level than the brain, such as the spinal level. Thus, the motor control which is responsible for pedalling could be initialized at a supra-spinal level, but the mechanisms of movement control during the pedalling task would be regulated at a spinal level (Raasch and Zajac, 1999). References Drummond SP, Brown GG, Salamat JS, Gillin JC. (2004). Sleep, 6, 445-451. Raasch CC, Zajac FE. (1999). J Neurophysiol, 82, 515-525.

### **JOINT-SPECIFIC POWER OUTPUT OF ELITE TRACK SPRINT CYCLISTS**

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Maximal crank power is a key determinant of performance in track sprint cycling. Those athletes who are able to produce greater crank power are likely to be more successful in a sprint race. The overall purpose of this study was to understand the mechanisms underlying differences in maximal crank power production between elite and non-elite cyclists. Power delivered to the crank during cycling is generated by the muscles that span the ankle, knee and hip joints. Understanding differences in relative joint power contributions to crank power between elite and non-elite cyclists could give us hints about the factors that determine world class performance, which in turn would have implications for coaching practice. Therefore, the specific aim of this study was to quantify differences in the relative contributions of the muscles spanning the hip, knee and ankle joints between elite and non-elite cyclists. Eight elite track sprint cyclists and eight trained but sub-elite track cyclists performed seated iso-kinetic maximal cycling at 120 rpm. Two-dimensional crank forces and limb kinematics were collected over three crank revolutions. Joint-specific powers of the lower limb were calculated via inverse dynamics, averaged over extension and flexion phases, as defined by joint angular velocity, and normalized to overall crank power. Elite compared to sub-elite track sprint cyclists generated less relative hip extension power ( $0.82 \pm 0.12$  vs.  $0.94 \pm 0.10$ ; Effect Size 0.94) and more relative knee extension power ( $0.31 \pm 0.22$  vs.  $0.20 \pm 0.17$ ; Effect Size 0.54). All other relative extension and flexion powers were similar between the two groups. These results suggest that elite track sprint cyclists differ from sub-elite cyclists in their movement strategy used to generate maximal cycling power. These results suggest that a greater knee extensor contribution could be beneficial with respect to sprinting performance. This finding has practical implications for coaching practice.

### **ELEMENTS OF KINEMATIC ANALYSIS CHARACTERISTIC TO THE RUNWAY RUNNING IN THE MALE TRIPLE JUMP EVENT USING INERTIAL NAVIGATION**

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This work was supported by CNCIS-UEFISCSU, project number PN II-RU code 167/2010 Introduction Implementation of this technology in the human movement analysis enjoys a wide application in studies and research highlighting the effectiveness of this technology Bamberg, (2008); Tilmann, (2008); Hesami, (2008); Billon, (2008); Bidiugan, (2009); Kruger, (2009); Meamarbashi, (2009). The purpose of this study was to examine the speed that may occur in the triple jump event running, the body's center of mass trajectory and the trajectories of ankle and knee joints on the left and right side, using inertial navigation technology. Methods The results were determined using Moven inertial navigation equipment fitted with an inertial sensors system to capture information and send them to the two terminals Xbus through cable connectors. The wireless signal was directed to two receptors that have been connected to a laptop in order to secure the transfer of information and 3D visualization of the movement as a model of the human body consists of 23 segments, hence the data can be stored in a digital form too. Results The center of mass trajectory (as its position) achieved during running, showed values ranging between 0.91 m and 1 m with a standard deviation between 0.03 and 0.06 m. Referring to the ankle joint trajectory, its vertical position on the left versus the right side, we found differences between 0.02 to 0.04 m. In the knee joint trajectory case, the differences between the two sides (right and left) were between 0.01 to 0.02 m. Regarding the speed registered on the runway, it ranged from 7 m/s and 8.9 m/s, its value in conjunction with the center of mass trajectory showing a higher length of the triple jump than in the case of the



higher values (8.9 m/s and 1 m). Discussion Our experiment showed that, decreasing of the running speed has been accompanied by a decreasing of the value of the center of mass trajectory as its position during linear movement. On the other hand, the running speed recorded during the runway showed real influences on the final outcome and this is underlined by studies conducted by Moura (2006), Hay (1992), Jarver, Boas (1984). The small differences between ankle and knee joint position recorded between right and left side shows a good coordination of the lower limbs in the shape of their trajectory which represents a support element in ensuring optimal conditions necessary to acquire a reasonable speed running on the runway. Selective references 1. Jarver, J., Boase, G. (1984). Triple jump. *Modern Athlete and Coach*, 22, 6-7; 2. Hay, J.G. (1992). The biomechanics of the triple jump: a review. *Journal of Sports Sciences* 10, 343-378; 3. Moura, N.A., Moura, T. F. P., Borin, J. P. (2006). Approach speed and performance in the horizontal jumps: What do Brazilian athletes do?

### KINEMATICAL ANALYSIS ALONG A MAXIMAL LACTATE STEADY STATE SWIMMING TEST

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Introduction: The gold-standard methodology used to assess the athlete's aerobic capacity is the Maximal Lactate Steady State (MLSS) test. In fact, once it determines the highest workload that can be maintained over time without a continual blood lactate accumulation, it can be used to prescribe individualized aerobic training. However, even knowing that swimming performance is influenced both by bioenergetic and biomechanical factors, studies that analysed eventual kinematical changes during the MLSS test are scarce. We aimed to assess the stroking parameters, intracyclic velocity variation (IVV), propelling efficiency, trunk incline (TI) and index of coordination (IdC) along the MLSS test. Methods: A triathlete participant in the World Junior Championship (19yr, 69kg and 1.75m) performed, in subsequent days, 2-4 30min sub-maximal continuous tests at imposed swim pace, with 2.5% differences between trials, to assess the velocity corresponding to MLSS. The test was recorded with two cameras (one under and other above water). Kinematic analysis was made using digitization (APAS) for the trial corresponding to MLSS, being divided in five different points (0, 25, 50, 75 and 100% of the test). Stroke length and stroke rate were computed; swimming efficiency was obtained through IVV that was calculated by the coefficient of variation of the hip's instantaneous velocity (Alberty et al, 2005) and propelling efficiency values (Zamparo et al., 2005); TI was defined by the angle between the shoulder and the hip segment and the horizontal (Zamparo et al., 2009); inter-arm coordination was assessed using the IdC (Chollet et al., 2000). Results: Stroke rate increased (0.50-0.53Hz) and stroke length decreased (2.32-2.21m) along the MLSS test. Propelling efficiency decreased (0.45-0.42) and inter-arm coordination was adapted towards an increased along the 30min with a variation of the values between -19.5 and -13.8%. The TI, as the IVV, presented a constant behaviour along the test (~11° and ~0.26, respectively). Discussion: The inter-cycle changes occurred show the interplay between the variables studied, being self-optimized in a compensatory mechanism to maintain, not only the velocity constant throughout the test, but also the physiological parameters (blood lactate). The only parameters that did not change were the trunk incline, as expected, once it has a good relation with drag, changes on it for the same mean velocity would increase the effort, and probably imbalance the production and removal of blood lactate; and the IVV, since it was suggested that IdC change in order to maintained them (Alberty et al., 2005). Reference: Alberty M et al (2005). *Int J Sports Med* 26(6): 471-475 Chollet D et al (2000). *Int J Sports Med* 21(1): 54-59 Zamparo P et al (2005). *Eur J Appl Phys* 94: 134-144 Zamparo P et al (2009). *Eur J Appl Phys* 106: 195-205 Acknowledgement: FCT PTDC/DES/101224/2008

### COMPARISON OF STARTING TECHNIQUES IN CLASSICAL CROSS COUNTRY SKIING SPRINT RACE

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Introduction The start phase of a cross country (XC) sprint race may play a major role later in the race. Some skiers have recently begun to exclusively use double poling (DP) for sprint races enabling them to use skate skis with better gliding properties and longer poles for greater impulses (Nilsson et al. 2004). The present study examined the first 40m of the XC sprint start using the same equipment in diagonal stride (DIA), double poling (DP) or in a combination of the two. Methods After a 15 min warm-up, twelve elite skiers performed nine maximal starts in a random order separated by 4min rest using three different techniques: 1) FREE (subject's free choice), 2) DIA and 3) DP. The total distance was 37.95m, of which the first 17.95m were covered with force plates (Vähäsöyrinki et al. 2008). The horizontal (HI) and vertical (VI) impulses of force from both skis and poles were analyzed in all three conditions. Results The mean time from the start to the first measurement point (FT) was  $4.23 \pm 0.12$ s for FREE,  $4.25 \pm 0.13$ s for DIA and  $4.48 \pm 0.15$ s for DP. The mean time for the total distance (TT) was  $7.28 \pm 0.2$ s for FREE,  $7.23 \pm 0.17$ s for DIA and  $7.67 \pm 0.23$ s for DP. Both FREE and DIA were faster than DP for FT, ST (from 17.95m to 37.95m) and TT ( $p < .05$ ), whereas no significant differences were observed between FREE and DIA. There was no significant difference for the total HI (FREE  $1262 \pm 140$ Ns, DP  $1196 \pm 111$ Ns, DIA  $1295 \pm 94$ Ns) or for the total VI (FREE  $6204 \pm 792$ Ns, DP  $6634 \pm 876$ Ns, DIA  $6156 \pm 543$ Ns) between the conditions. The percentage of total horizontal over total vertical impulse (Hor/Ver) was smaller ( $p < .05$ ) in DP ( $18.3 \pm 2.7\%$ ) than in FREE and DIA ( $20.3 \pm 1.9\%$  and  $21.0 \pm 1.2\%$ ). When combining all the conditions, working contact frequency and total working time showed a negative correlation while HI per working contact time showed a positive correlation with FT, ST and TT ( $p < .05$ ). Discussion Longer poles in DP may lead to faster skiing time in sprint start (Hansen & Losnegard 2010). In the present study with similar equipment, DP was the slowest of the three start techniques. This difference was more pronounced during the first 17.95m, highlighting the importance of the initial section of the start. It seems that FREE and DIA conditions were faster due to the higher force production frequency and a higher Hor/Ver impulse ratio when compared to DP. References Hansen & Losnegard. *Sports Eng* (2010) 12:171-8 Nilsson J et al. *Sports Biomech.* 2003; 2:227-236 Vähäsöyrinki P et al. *Med Sci Sports Exerc* 2008; 40(6):1111-6

### ADOLESCENT PLAYERS SHOULDER MUSCLES ADAPTATION TO TRAINING IN HANDBALL

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Introduction Sport specializations with repeated throwing motions cause increase of the shoulder internal rotator muscles produced torques in a dominant arm, which are much higher than the shoulder external rotator muscles produced torques in comparison with a non-dominant arm muscles (Codine et al, 1997). Imbalance of the shoulder external/ internal rotators strength is the most important etiological factor of the shoulder joint instability (Fleisig et al.). The aims of our investigation were to determine the shoulder rotator cuff muscles produced peak torques values ratio specific to adolescent handball players and to determine the relationship between shoulder internal rotator muscles group's strength and throwing speed in adolescent handball players. Methods The shoulder joint motions in

internal-external rotation are investigated using dynamometers system "REV-9000" (Technogym, Italy). 16 male adolescent handball players with injury – free shoulder joints participated in the investigation. Their mean age was  $14 \pm 1$  years, height  $176 \pm 7$  cm and weight  $63 \pm 10$  kg. The shoulder internal - external rotation isokinetic movements were tested in the plane of scapula at slow ( $60^\circ/\text{s}$ ) and medium ( $90^\circ/\text{s}$ ) angular velocity. The throwing speed was measured by optical equipment "Superschus" (EDV-Beratung Arbeiter, Germany). Results and discussion The difference between the ratios of peak torque values produced by the dominant and non-dominant arms shoulders external/ internal rotator muscles is none significant. The shoulder external/ internal rotators maximal torques ratio for adult handball players is close to 80% (Pontaga, Zidens, 2004). It confirms that the strength of both muscle groups increased proportionally in the training process. This ratio for adolescent athletes is smaller – approximately 70 %. It proves, that additional exercises must be included in the training process to develop the shoulder external rotators muscles. One of the aims of handball training is to increase the throwing speed of players. Clements et al. determined positive correlation between the muscle strength and throwing speed in adolescent baseball players. Their data are in a good agreement with our results demonstrating positive correlation between the shoulder internal rotator muscles developed peak torque at slow ( $60^\circ/\text{s}$ ) and medium ( $90^\circ/\text{s}$ ) movements and the throwing speed in adolescent handball players ( $r = 0,83$  and  $0,76$ , respectively;  $p = 0,0002$ ). References Clements A.S., Ginn K.A., Henley E. (2001). *Phys.Ther.in Sport* 2, 123–131. Codine P.et al.(1997). *Med.and Science in Sports and Exerc.* 29, 1400–1405. Fleisig G.S.et al.(1995). *Am. J. Sports Med.* 23, 233–239. Pontaga I., Zidens J. (2004). *J.of Human Kinetics* 11, 75- 82.

## THE ANALYSIS OF VARIABILITY IN GOLF SWING USING TWO DIFFERENT IRON ON AMATEURS GOLFERS

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The analysis of variability in Golf Swing using two different iron on Amateurs golfers Fernandes, O.,Vaz,J.,Barreiros,J.,Andreia,P.,Bigliassi,M.,Castro,A. Évora University Introduction: Golf Swing (GS) is a complex sequential actions involving rotation of the hips, trunk, and shoulder. The key of a good movement in GS is the timing of the involvement of all body segments to produce maximum speed and accuracy of the club at impact. Many golfers' instructors and professional players refer the importance of rhythm during the GS. The elite performers have developed a pattern of movement that produces the movement at high speed. The consistence on GS is very important to accuracy and speed, and many amateur golfers' have poor consistence regarding the time on different phases in GS. Bernstein (1967) said that Human Movement presents variability from trial to trial. Variability is pervasive throughout the multiple levels of movement organization and occurs both within and between individuals. The purpose of this study was to examine the variability within and between amateur golfers performing 16 GS with two different iron clubs (Pitch and 4-iron). Methods: Ten amateurs golfers volunteered to participate in this study. All participants signed an informed consent approved by the Review Board .The subjects were asked to perform a GS using two different clubs. The pitch shots is use to produce a higher trajectory and the 4-iron is used for longer distances. All subjects repeated 10 times for each iron. To analyze the time variability we determined the time between the follow 5 instants of the GS at (sBS)– start of back swing; (sFS)–start of forward Swing; (hFS) – horizontal position of the club in forward Swing; (iB) – ball impact and (hFT)– horizontal position of the iron at follow-through. The time between those instants were measured and compared to analyze inter and intra individuals variability. Results: The results from different swing from the Pich the results shows similar variation – [sBS- sFS] -  $954,2 \pm 272,8$  ms; [sFS- hFS] -  $231,2 \pm 61,2$  ms; [hFS- iB] -  $49,9 \pm 14,1$  ms; ; [iB-hFT] -  $63,2 \pm 17,6$  ms; the 4-iron the results show the same variation [sBS- sFS] was  $969,2 \pm 294,0$  ms; [sFS- hFS] -  $230,8 \pm 60,4$  ms; [hFS- iB] was  $49,0 \pm 13,6$  ms; ; [iB-hFT] -  $72,3 \pm 81,1$  ms. The One-Way ANOVA revealed no significant difference between this two different swing. Discussion: The main aim of this study was to analyze the variability on two different iron in GS. This results show some pattern in GS Conclusion: We conclude that the amateurs golfers don't change the technique of the GS and they show the same variability pattern even they use different iron.

## DIFFERENCES IN KINEMATICS BETWEEN INDOOR AND BEACH VOLLEYBALL OVERHAND PASS

WAGNER, H., WENDLING, I., MÜLLER, E.

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DIFFERENCES IN KINEMATICS BETWEEN INDOOR AND BEACH VOLLEYBALL OVERHAND PASS Wagner, H.1,2, Wendling, I.1, Müller, E.1,2 1: SSK (Salzburg, Austria), 2: CDLBS (Salzburg, Austria) Introduction The overhand pass is the most applied passing technique in indoor volleyball. Beach volleyball players often use the forearm instead of the overhand pass because of the risk of a technical error due to an incorrect movement, although the overhand pass is more precise (Koch & Tilp, 2009). Hernandez et al. (2004) analyzed kinematics of the overhand pass in indoor volleyball; however, a kinematic analysis of the overhand pass in beach volleyball is lacking. The aim of the study was to analyze kinematic differences between the indoor and beach volleyball overhand pass. Methods Elite indoor ( $n=9$ ) and beach ( $n=9$ ) volleyball players had to perform 20 overhand passes under standardized conditions and were instructed to play the ball into a basketball basket. 3D-kinematics were measured using an 8 camera Vicon MX13 motion capture system (250 Hz) and a Basler high speed camera (125 Hz). Passing precision was determined by using a special point system (ball inside or outside the basket with or without touching the rim). Differences in kinematic parameters and passing precision were calculated with an independent t-test. Bonferroni-correction was calculated and significance was set at  $P < 0.004$  for  $n=14$  variables. Results In beach volleyball ball, contact time in the overhand pass increased (+52ms) in comparison to indoor volleyball. In the kinematic parameters, significant differences ( $P < 0.004$ ) between indoor and beach volleyball were found in the elbow flexion and shoulder abduction angle at first ball contact, the maximal elbow flexion and shoulder internal rotation angle and the shoulder abduction angle at ball release. No significant differences were found in the forearm pronation angle and passing precision. Discussion The differences between indoor and beach volleyball overhand pass can be explained by tactical components of the game. In indoor volleyball, the setter tries to mask the setting direction in the overhand pass (4-5 players could strike the ball). The ball is played over the head, with short contact time and less range of motion. In beach volleyball, it is not possible to mask the setting direction because there is only one player who can strike the ball. Therefore, it is more important to control the ball and to prevent rotation of the ball after release. The beach volleyball overhand pass is characterized by longer contact time due to a higher range of motion in the elbow flexion, shoulder abduction and shoulder internal rotation. The results of the study could assist coaches and beach volleyball players to optimize the overhand pass; however, additional training studies are warranted. References Hernandez E, Urena A, Miranda MT, Ona A (2004) *J Human Mov Stud*, 47, 285-301. Koch C, Tilp M (2009) *Kinesiology*, 19, 52-59.

## Poster presentations

### PP-BN02 Cognitive Performance

#### INFLUENCE OF ENERGETIC PHOSPHATES ON COGNITIVE PERFORMANCE

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**Introduction** The current study examined the effects of oral creatine supplementation on cognitive and psychomotor performance in the young and the elderly. Creatine supplementation is well known to enhance physical performance, and has been used successfully in the treatment of neurological and neuromuscular disease (Kreider 2003). In terms of energy turnover, the neurons of the human brain function similar to the cell in the skeletal muscle tissue. Studies have shown an increased mental fatigue-resistance after oral creatine supplementation, as well as positive effects on working memory and intelligence of young vegetarian subjects (Rae et al. 2003). These results suggest that creatine concentration in the cell might influence not only physical, but also cognitive performance. **Methods** Using a double blind placebo-controlled cross over design the subjects supplemented 5 grams of creatine-monohydrate and placebo for 6 weeks with 6 weeks wash-out period between the two treatments. 24 subjects (11 old and 13 young) volunteered to participate in the study. The old subjects (3 male and 8 female) aged  $69.5 \pm 5.8$  years, whereas the young subjects (9 male and 4 female) aged  $26.4 \pm 2.8$  years. The Vienna Test System (VTS), a computerized psychological assessment tool, was used in order to measure cognitive performance. The following components of cognition were examined: long-term selective attention (Signal-Detection Task), non-verbal intelligence and especially logical reasoning (Raven's Standard Progressive Matrices), memory performance (Continuous Visual Recognition Task) and cognitive speed concerning perception, processing and motor response (Simple Reaction Task). **Results** The serum concentration of creatine, creatinine and the creatine/creatinine quotient increased after creatine supplementation, decreased back to baseline values after the wash-out period and remained unchanged after placebo supplementation. Thus, the supplementation design used has proven itself. Statistical analyses yielded no effects of creatine supplementation on cognitive performance. **Conclusions** Combined with the literature, the results of the present study suggest that artificial creatine supplementation may play an important role for muscular and central functions. However, creatine supplementation might be less effective in healthy subjects compared to patients with cerebral abnormalities, vegetarians and/or those who suffer from low cerebral creatine concentration. **References** Kreider RB. Effects of creatine supplementation on performance and training adaptations. *Molecular and Cellular Biochemistry* 2003; 244(1-2):89-94. Rae C, Digney AL, McEwan S et al. Oral creatine monohydrate supplementation improves brain performance: a double-blind, placebo-controlled, cross-over trial. *Proceedings. Biological Sciences* 2003; 270(1529):2147-50.

#### EXERCISE AND COGNITIVE FUNCTION IN ADOLESCENT SCHOOL CHILDREN

COOPER, S.B., BANDELOW, S., NUTE, M.L., MORRIS, J.G., BOWMER, J., NEVILL, M.E.

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**Introduction** There is considerable evidence that a bout of exercise enhances cognitive function in adults (Brisswalter et al, 2002) and children (Sibley and Etnier, 2003). However, the acute effects of a bout of exercise on cognitive function in an adolescent population are less clear. **Methods** With the institutions ethical advisory committee approval, 45 male and female adolescents (12 to 13 years old) participated in the study. The study employed a randomised crossover design, with 2 main trials (exercise and resting) separated by 7 days. Participants consumed the same meal the evening before each main trial and the same, self-selected, breakfast on the morning of each trial. 60 min after breakfast, participants completed a bout of exercise (exercise trial) or continued to rest (resting trial). The exercise bout consisted of 10 repeats of level 1 of the multi-stage fitness test, with 30 seconds rest between repeats. Participants' heart rate was recorded during the rest period and if heart rate reached 190 beats.min<sup>-1</sup>, participants walked for the remainder of the exercise. A battery of cognitive function tests (Visual search test, Stroop test, Sternberg paradigm and Flanker task) were completed 30 and 120 min following breakfast. **Results** When examining response times of correct responses, there was a greater improvement in response times across the morning following the exercise bout when compared to the resting trial, on the Sternberg paradigm ( $t=2.5$ ,  $p=0.011$ ) and Flanker task ( $t=3.5$ ,  $p=0.001$ ). There was also a greater improvement in response times across the morning following the exercise on the visual search test, though this effect was specific to the more complex level ( $t=2.6$ ,  $p=0.008$ ). When examining the accuracy of responses, there was a tendency for participants to achieve a greater proportion of correct responses on the exercise trial compared to the resting trial on the visual search test ( $z=1.9$ ,  $p=0.052$ ). However, there was no effect of the mid morning bout of exercise on response accuracy during the other tests (Stroop test, Sternberg paradigm and Flanker task). **Discussion** Overall, these results suggest that a mid morning bout of exercise improves adolescents cognitive function, when compared with continuing to rest. Completing a mid-morning bout of exercise appears to have a greater effect on the speed of responses (i.e. response times), compared to the accuracy of responses. However, the improvement in response times is not to the detriment of accuracy, thus we conclude that overall there is an improvement in adolescents' cognitive function following a mid-morning bout of exercise. **References** Brisswalter J, Collardeau M, René A. (2002). *Sports Med*, 32, 555-566. Sibley BA, Etnier JL. (2003). *Ped Ex Sci*, 15, 243-256.

#### COMPENSATORY RESPONSE OF THE RIGHT PREFRONTAL CORTEX IN THE DEVELOPMENT OF EXERCISE-ENHANCED STROOP PERFORMANCES IN THE ELDERLY: A FUNCTIONAL NEAR-INFRARED SPECTROSCOPY STUDY.

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**Introduction** Recently there have been many reports stating that regular exercise enhances brain function in elderly people. However, due to several adventitious effects, the exact neural substrate behind it is still controversial. To address this issue, an acute exercise model should be established. We thus applied functional NIRS and revealed an acute bout of moderate exercise enhanced activation of the left dorsolateral prefrontal cortex (l-DLPFC) due to Stroop interference (SI) and improved the Stroop performance in young adults (Yanagisawa et al., 2010). However, it is unclear whether it is the same in the elderly. In some task situations, the elderly may recruit the contralateral hemisphere to compensate for decreased task-specific activation of brain loci (Park et al., 2009). We thus aimed to clarify whether these acute exercise effects were reproducible in the elderly, and if so, whether the activity of the l-DLPFC or compensatory function is involved in the enhanced executive function. **Methods** Sixteen healthy elderly participated in the study. Before and after 10 minutes of exercise on a cycle ergometer at a moderate intensity corresponding to their ventilatory threshold, they performed a color-word Stroop task (CWST) that

consisted of incongruent and neutral conditions. Cognitive performance was assessed by reaction time (RT). Brain activity was monitored with fNIRS during the CWST. The fNIRS probes were set to cover LPFC activation. Spatial analysis was performed by using virtual registration (Tsuzuki et al., 2007). Changes in oxy-Hb concentration were used for statistical analysis. The difference between conditions (Incongruent - neutral) was calculated as SI to determine executive control. All subjects underwent a control experiment (Con) on a separate day in which they rested instead of exercising. Results An acute moderate exercise significantly improved SI as measured by RT compared to Con. In fNIRS data, we detected brain activation due to SI in the LPFC in both hemispheres. Compared to Con, this SI-related activation was significantly enhanced in the right frontal pole (r-FP) due to the acute moderate exercise. The enhanced activation significantly coincided with improved cognitive performance. Discussion Here we found that an acute moderate exercise enhances the ability to cope with SI through the increased activation of the r-FP. In the elderly, exercise-elicited improvement of executive functions was reproduced, but the responsible brain loci were different compared to the young. The current study suggests that with aging some contralateral brain loci such as r-FP should be exercise responsive area to be involved in the development of enhanced cognitive performance for the deteriorated activities of the l-DLPFC. References Park D.C, Reuter-Lorenz P. (2009). *Annu Rev Psychol*, 60, 173-196. Tsuzuki D, Jurcak V, Singh A.K, Okamoto M, Watanabe E, Dan I. (2007). *Neuroimage*, 34, 1506-1518. Yanagisawa H, Dan I, Tsuzuki D, Kato M, Okamoto M, Kyutoku Y, Soya H. (2010). *Neuroimage*, 50, 1702-1710.

### **NORMALIZING EFFECTS OF ACUTE MODERATE EXERCISE ON DEPRESSED MOOD AND THE COGNITIVE DECLINE INDUCED BY NEGATIVE EMOTIONAL STRESS.**

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Introduction Recently, the growing number of people with mood disturbances such as depression and anxiety has become a serious social problem. In those patients, neuronal activity in the prefrontal cortex is attenuated, especially in the dorsolateral prefrontal cortex (DLPFC) involved in cognitive functions and emotion (Okada et al., 2003). However in healthy adults an acute bout of moderate exercise enhances the activity of the DLPFC (Yanagisawa et al., 2009), suggesting a possible beneficial role of moderate exercise restoring mood and cognitive functions. To test this hypothesis, we examined whether acute moderate exercise affects depressed mood and the cognitive decline induced by negative emotional stress. Methods We used young adults subjects (n=13). They are subjected to three sessions of experiments on three separate days in random order. They were given negative emotional stress for 10 minutes by visual stimulus (VS) using pictures from the International Affective Picture System and neutral VS as a control. Following the negative VS they had a five-minute rest or exercised on a cycle ergometer at a predetermined ventilatory threshold. After the rest or exercise they had another five minutes of rest or recovery and then performed a color-word Stroop task (CWST). Reaction time (RT) was examined in the CWST to assess cognitive performance. Neural activation during the CWST was evaluated by changes in oxy-hemoglobin (oxy-Hb) as determined by fNIRS. The region of interest in this study was the left DLPFC. Changes in mood were evaluated before and after VS and after exercise using a two-dimensional mood scale (TDMS). Results Mood significantly declined after viewing negative VS and it remained lower after the 10-minute rest compared to 10 minutes after the neutral stimulus. On the other hand, mood that declined after viewing negative VS was normalized after exercise. RT was significantly delayed after the 10-minute rest following negative VS compared to the other experiments while there were no significant differences between other two experiments. In the left DLPFC, oxy-Hb was significantly lower after the 10-minute rest following negative VS compared to that after the neutral VS. oxy-Hb after the exercise following negative VS was highly restored compared to that following neutral VS. Discussion We found that moderate exercise can normalize mood and cognition from a declined condition caused by negative emotional stress from negative VS. The current study is the first report showing that moderate exercise has a rescue effect on a stressful condition. This suggests that exercising at moderate intensity is beneficial for people in a stressful society to keep their mental health to be well. References Yanagisawa H, Dan I, Tsuzuki D, Kato M, Okamoto M, Kyutoku Y, Soya H. (2009). *Neuroimage*, 50, 1702-1710. Okada G, Okamoto Y, Morinobu S, Yamawaki S, Yokota N. (2003). *Neuropsychobiology*, 47 (1), 21-6

### **DECISION-MAKING AND ANTICIPATION IN SPORT: THE UNDERLYING PROCESSES OF SUPERIOR PERFORMANCE**

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DECISION-MAKING AND ANTICIPATION IN SPORT: THE UNDERLYING PROCESSES OF SUPERIOR PERFORMANCE Roca, A.1, Ford, P.R.1, McRobert, A.P.1, Williams, A.M.1, 2 1: Liverpool John Moores University, UK, 2: The University of Sydney, Australia Introduction The ability of skilled athletes to anticipate the actions of others and to make appropriate decisions under time constraints differentiates them from lesser skilled athletes (Williams, et al. 2010). These judgments are selected via underlying visual and cognitive processes, which likely differ between skill groups. The aim in this study was to examine the processes underlying superior judgment performance in soccer players using representative simulations. Skill-based differences were expected for all judgment and process measures. Methods Skilled (n = 24) and less-skilled (n = 24) adult soccer players interacted with 20 life-size, video sequences involving 11 vs. 11 soccer situations filmed from the perspective of a central defender and occluded at a key moment. Situations either started with the ball being located in the participants' offensive (i.e. far situation) or defensive half of the pitch (i.e. near situation). The ability of participants to anticipate the intentions of opponents and to select their own actions was measured across two experiments. In Experiment 1, visual search processes were examined using an eye-movement registration system. In Experiment 2, cognitive processes were examined using retrospective verbal reports. Results Skilled players anticipated the actions of opponents correctly on 69% of the situations and decided on an appropriate action to execute on 82% of occasions, compared to 36% and 50% for the less-skilled, respectively. During the far task, skilled players made an average of 15 visual fixations of 320ms duration to many locations in the display, whereas the less-skilled made fewer fixations of shorter duration (7 fixations for 792ms). During the near task, skilled players made 8 fixations of 598ms duration mainly toward the player in possession of the ball compared to the lower 6 fixations of 877ms used by the less-skilled players. Less-skilled players mostly fixated the player in possession and the ball. Skilled players made 7 verbal report statements per situation with a higher proportion categorized as predicting future events, planning future actions, and evaluating events compared to the less-skilled players, who made 5 statements per situation that were mainly categorized as monitoring events. Discussion Skilled players' superior judgment performance was underpinned by quantitatively different task-specific underlying visual and cognitive processes, which may indicate they have more advanced domain-specific memory representations, when compared to the less-skilled. A number of theoretical and practical implications are discussed. References Williams, A.M., Ford, P.R., Eccles, D.W., & Ward, P. (2010). *Appl Cogn Psychol*, n/a. doi: 10.1002/acp.1710

## THE EFFECTS OF EXERCISE INTENSITY ON CRAVING AND VISUAL ATTENTIONAL BIAS FOR SNACKS AMONG TEMPO-RARILY ABSTINENT SMOKERS

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**Introduction** Substantial weight gain after smoking cessation is partly due to increased energy intake from comfort snacking (Spring et al., 2009). Moderate intensity exercise acutely reduces food craving (Taylor & Oliver, 2009) and visual attentional bias (AB) to food images (Taylor et al., 2009) among non-smokers. It is unknown if exercise, of different intensities, acutely reduces food cravings and AB to video clips of snacks among abstinent smokers. **Methods** 15 male and 8 female regular snackers, age  $23.9 \pm 4.8$  yrs, BMI  $23.5 \pm 2.9$ , abstained from smoking for 15 hrs, and eating for 2 hrs. They were randomly assigned to engage in each of three 15 min treatment conditions (on separate days): moderate and vigorous intensity cycling and rest. AB was assessed using an eye tracker (Pan/Tilt Model 504, ASL, USA) pre and post-treatment at each session. Participants watched 8 randomly presented pairs of food/neutral 7 sec video clips and data was derived for % of first fixation (initial AB) and % of total dwell time (maintained AB) on the food image. Self-reported food craving (modified FCQ-S, Cepeda-Benito et al., 2000) was assessed pre, mid and post-treatment. Results Fully repeated ANOVAs revealed a condition x time interaction for food cravings ( $F(5, 5.5) = 10.7, p < .001$ ).  $t$  tests revealed that at mid- and post-treatment food cravings were significantly lower after vigorous exercise, compared with rest and moderate exercise. Fully repeated ANOVAs revealed condition x time interactions for the AB measures of % of first fixation ( $F(2,44) = 8.1, p < .001$ ) and % of dwell time ( $F(2,4) = 5.1, p < .01$ ). Post-hoc  $t$ -tests (with Bonferroni correction) revealed a significant reduction for % of first fixation from pre to post moderate ( $t(22) = 3.0, p = .006, 95\% \text{ CI } 6.7 \text{ to } 35.4, ES d = .77$ ) and vigorous exercise ( $t(22) = 2.6, p = .016, 95\% \text{ CI } 3.3 \text{ to } 28.5, ES d = .68$ ). Compared with the rest condition, % of dwell time was significantly lower after vigorous exercise at post-treatment ( $t(22) = 3.3, p = .003$ ). **Discussion** Research shows that exercise reduces cigarette cravings and AB (to smoking images) during nicotine abstinence. This study also shows that exercise can reduce food cravings and AB to snacking cues among abstinent smokers. Both moderate and vigorous exercise reduced initial AB, whereas only vigorous reduced maintained AB. Short bouts of exercise may be useful for abstaining smokers to self-regulate snacking. **References** Cepeda-Benito A, Gleaves DH, Fernandez MC, Vila J, Williams TL, Reynose J. (2000). *Beh Res & Ther*, 38, 1125-1138. Spring B, Howe D, Berendsen M, McFadden HG, Hitchcock K, Rademaker AW et al. (2009). *Addiction*, 104, 1472-1486. Taylor AH, Oliver A, Janse van Rensburg K. (2009). Paper at ISSP Conference, Morocco. Taylor AH, Oliver A. (2009). *Appetite*, 52, 155-160.

## IMPACT OF NON-FUNCTIONAL OVERREACHING ON COGNITIVE PERFORMANCES.

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**Introduction** Peak performance in sport requires training loads that will occasionally push human body adaptation possibilities to their limits. Overtraining syndrome (OTS) is an important menace on performances and health in athletes. OTS results when appears an imbalance between the training and/or not training stress and sufficient recovery, which could lead to an unexplained underperformance. Functional Overreaching (FOR) and Non Functional Overreaching (NFOR) are physical states reached just before OTS on the continuum, but the line between the two is very thin. It is therefore very important to validate markers to prevent the development of NFOR. It has been recently proposed that psychomotor speed might be such a marker. The aim of this study was to investigate whether cognitive performance was altered by a two-week of overload training. **Method** Twelve well-trained men participated in this study. The protocol consisted in increasing their training load of 100% for two weeks and thereafter to decrease by 50% for one week. Before and after this period of overload and after the period of taper, the participants performed a maximal graded exercise test, a constant intensity test (85% of peak treadmill speed), and a computerized version of the Stroop color word-test. They also filled out the Profile Of Mood States (POMS). During the pre and post-test evaluations, participants trained at their usual training load. Results Prior to data analysis, all the participants were qualified as overreached. After the overload period, participants decreased their physical performance ( $29 \pm 9$  to  $21.6 \pm 10$  min,  $p < .05$ ) and their "energy index" (ie. vigor – fatigue in the POMS,  $120 \pm 14$  to  $98 \pm 16$ ,  $p < .05$ ). After the taper, the physical performance and the energy index returned ( $p < .05$ ) to baseline. Regarding the cognitive performance, the same pattern was observed as participants' reaction times increased from before to after the overload period ( $816.3 \pm 30.8$  to  $892.3 \pm 40.1$ ,  $p < .05$ ) and, then return to baseline values after the taper ( $p < .05$ ). **Conclusion** An unaccustomed increase in training volume which is accompanied by a decrement in physical performance induces a decline in cognitive performance. Stroop color word-test has therefore the potential to be a valid marker of overreaching.

## EFFECT OF HIGH INTENSITY INTERMITTENT EXERCISE ON COGNITIVE PERFORMANCES.

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**Introduction** It has been proposed that psychomotor speed and cognitive performance represent a potential marker of non-functional overreaching and/or overtraining. This hypothesis has been recently confirmed in the study by Dupuy et al [1], who reported an altered cognitive performance in endurance athlete classified as overreached. It's now important to describe the effect of a single bout of exercise in order to distinguish the effect of acute fatigue to chronic fatigue on cognitive function. Indeed, acute fatigue induced by a training session and non-functional overreaching are on the same continuum. The aim of this study was therefore to evaluate the temporal effect of a high intensity intermittent exercise on different cognitive process. **Method** Twenty one healthy men participated in this study. They performed a maximal graded exercise test to determine peak treadmill speed. In a second time, the experimental group ( $n=13$ ) performed a series of six consecutive 180s runs at 95% of PTS, with 180s of passive recovery. A computerized version of the Stroop color word-test was administrated during four consecutive days, the first morning (baseline) of this protocol, 1h after the intermittent exercise, 24h, 48h and 72h after the baseline measure. The group control ( $n=8$ ) realized the same protocol without the high intensity intermittent exercise. The Stroop color word-test includes 2 conditions of non-executives function (congruent and denomination) and 2 conditions of executives functions (interference and switching). Each of the 4 blocks contained 60 trials. Results With regard to the effect of Stroop color word-test practice, a main effect of Session for both measures and for both groups,  $p < .05$ , was observed. However, no significant interactions were observed between experimental and control group at any moment during the protocol. **Conclusion** The main result was that acute fatigue induced by a high intensity intermittent exercise session have no effect on the cognitive process assessed in this study. So, in order to prevent non-functional overreaching or overtraining, the administration of cognitive task can be proposed from 1h recovery

after a training session. 1. Dupuy, O., M. Renaud, L. Bherer, and L. Bosquet, Effect of Functional Overreaching on Executive Functions. *Int J Sports Med*, 2010. 31 (9): p. 617-623.

### SPORTS VISION SKILLS AND INJURY INCIDENCE RELATION IN AMATEUR SOCCER PLAYERS

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**Introduction** The demands on the visual system during athletic performance are among the most rigorous of any activity. Because vision influences the capacity of an athlete to perform the tasks of a sport, scientific research has been performed to investigate the link between skill and vision. Visual system is highly related with proprioceptive system and these systems are affecting mechanism of injuries. **Methods** 30 subjects (15 injured soccer players and 15 non-injured soccer players) with an average of  $22 \pm 0.93$  and  $22 \pm 0.80$  respectively. We measured visual concentration (VC) with tachistoscope, eye-hand coordination (EHC) with LaFayette Eye-Hand Coordination Model 58024A, both hand coordination (BHC) with LaFayette Two-Arm Coordination Model 32532 and anticipation time (AT) with LaFayette Bassin Anticipation Timer Model 35575. Data were collected with a questionnaire named Nordic Questionnaire for the analysis of musculoskeletal symptoms in last 12 months. SPSS 14 were used for statistical measurements and correlations between incidence of injury and VC, EHC, BHC, AT. Results Injured soccer players have completed all tests with more mistakes and time scores. There were statistical significant differences of EHC, BHC and AT measurements between injured and non-injured soccer players ( $p < 0.05$ ). No statistical significant difference was observed for VC. **Discussion** All tests used in this study required several levels of visual skills and in this study we aimed to focus on early visual-processing stage of the sensory-guided behavior. In our study we revealed an association between several visio-motor tests and frequency of injuries in soccer-players. It was reported that elite athletes have better visual skills (3) and we propose that this might also be related with fewer non-contact injuries. Therefore, we are planning further studies about influence of sports vision on sports injuries. **References** 1) Agel J, Evans TA, Dick R, Putukian M, Marshall SW. (2007). Descriptive epidemiology of collegiate men's soccer injuries: National Collegiate Athletic Association Injury Surveillance System, 1988-1989 through 2002-2003. *J Athl Train*, 42(2):270-277. 2) Buys, H. (2002). The development of norms and protocols in sports vision Evaluations, Rand Afrikaans University, Unpublished master's thesis, Johannesburg, (Supervisor: Prof. JT Ferreira). 3) Hitzeman SA, Beckerman SA. (1993). What the literature says about sports vision. *Optometry Clinics : The Official Publication of the Prentice Society*, 3(1):145-169.

### EFFECT OF REACTION TIME IN VISUAL RESPONSE TRAINING

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**Purpose:** The latency of motor-evoked potentials (MEPs) reflects the neural conduction time between the motor cortex and corresponding muscle, and can be recorded using transcranial magnetic stimulation (TMS). Moreover, visuo-motor related time (VMRT) can be calculated by subtracting MEP latency from pre-motor time in simple-reaction time using electromyography (EMG) (Yotani et al., 2009). We conducted response training to visual stimulus, and assessed the effects on reaction time of different periods or frequencies of training. **Method:** Fourteen healthy male subjects participated in the present study (mean age  $21 \pm 2$ ), and were randomly divided into two training groups: 4-week training (4W,  $n=7$ ) and 8-week training (8W,  $n=7$ ). Each group conducted the same response training for 2 days/week (4W) or 1 day/week (8W), and performed the same reaction time test before (Pre-test) and after (Post-test) the training. The training and test employed a mastication task. The task comprised 10 trials performed as quickly as possible in response to visual stimulation from a flashing light, and was repeated 5 times with a 2-3 min rest between each task during training. The EMG signal was recorded from the right masseter muscle simultaneously with the light signal. MEP latency was measured from the masseter muscle using TMS. Pre-motor time (PMT), visuo-motor related time (VMRT), and MEP latency (MEPL) were measured in the tests. In addition, each group performed the same test after detraining for 8 weeks (De-test). **Results:** PMT and VMRT were in both groups significantly shorter at Post-test than at Pre-test ( $P < 0.01$ ), and the tendency toward reduction in VMRT was comparable in the 4W and 8W groups. MEPL in neither group exhibited a significant difference between the tests. After 8 weeks of detraining, PMT, VMRT, and MEPL in the 8W group did not differ significantly between Post-test and De-test. However, the 4W group exhibited significant differences in PMT, especially VMRT, between Post-test and De-test ( $P < 0.05$ ). **Discussion/Conclusion:** The results of the present study suggest that VMRT shortens equivalently between Pre- and Post-test regardless of difference in response-training frequency. Training effect was in fact maintained for a longer time in the 8W group than in the 4W group. **References:** Yotani K, Tamaki H., Sakashita I., Yuki A., Kirimoto H., Kitada K., Ogita F., Takekura H. (2009). Reaction time analysis for kendo strikes in response to light signals using electromyography and a transcranial magnetic stimulator. *Book of Abstracts, 14th Annual Congress of ECSS*: 371-372.

### EFFECTS OF ACUTE EXERCISE AND TADALAFIL ADMINISTRATION ON ATTENTIONAL PERFORMANCE

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**Introduction** Given the therapeutic and non-therapeutic use of the tadalafil, (phosphodiesterase-5 inhibitor, PDE-5i), we examined its immediate effects combined with acute exercise on mental performance, such as attention, speed and accuracy. **Methods** Twelve well-trained subjects ( $24.4 \pm 2.2$  years of age) reported to the laboratory on four occasions. They performed a maximal exercise test in normoxia and 30 min of ergometer cycling at individual anaerobic threshold, after which they received a single oral administration of tadalafil or placebo in a randomized order. Mental performance was measured prior (Pre) and immediately after (Post) the four experimental sessions using the d2-test (Brickenkamp, 2002). The total number of items processed (TN) within the d2-test, the percentage of errors (E%), and the concentration performance (CP) were calculated and used as a parameter for sustained attention and concentration. TN value was a quantitative measure of the working speed, E% was a qualitative measure of performance, representing the proportion of errors made within the area of all items processed, and CP was an objective measure of concentration, representing the number of the correct responses minus the errors. **Results** The TN and the E% absolute variation ( $\Delta$ ) with respect to the Pre values (POST value – PRE value) did not significantly change in the four experimental conditions, while the CP absolute variation was significantly higher in VO<sub>2</sub>max exercise condition than in IAT exercise condition ( $p < 0.05$ ), independently by the type of administration (tadalafil or placebo). **Discussion** The primary finding of this investigation was that the administration of a single dose of a long-term PDE-5i did not influence the mental perfor-

mance. However, results demonstrated a major increase of the concentration performance due to maximal exercise. References Brickenkamp R, Zillmer E (1998). The d2 test of attention. Seattle-Toronto-Bern-Göttingen: Hogrefe and Huber Publishers.

## COGNITIVE AND COGNITIVE-MOTOR INTERVENTIONS AFFECTING MOTOR FUNCTIONING OF OLDER ADULTS: A SYSTEMATIC REVIEW

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**COGNITIVE AND COGNITIVE-MOTOR INTERVENTIONS AFFECTING MOTOR FUNCTIONING OF OLDER ADULTS: A SYSTEMATIC REVIEW** Pichierri, G., Wolf, P., Murer, K., de Bruin, E.D. 1: IBWS ETH (Zurich, Switzerland), 2: SMS-Lab ETH (Zurich, Switzerland) Introduction Several types of isolated cognitive or combined cognitive-motor intervention types that might influence physical functions have been proposed in the past; training of dual-tasking abilities, and improving cognitive function through behavioral interventions or the use of computer games (Yogev-Seligman et al., 2008; de Bruin et al., 2010). The objective of this systematic review was to examine the literature regarding the use of cognitive and cognitive-motor interventions to improve motor skills in older adults or people with cognitive impairments. The aim was to identify potentially promising methods that might be used in future intervention type studies for older adults. Methods A systematic search was conducted for the Medline/Premedline, PsycINFO, CINAHL and EMBASE databases. The search was focused on older adults and adult patients with brain injuries or cognitive impairments. The search was restricted to English, German and French language literature without any limitation of publication date or restriction by study design. Cognitive or cognitive-motor interventions were defined as dual-tasking, mental imagery, virtual reality exercise, cognitive exercise, or a combination of these. Results 28 articles met our inclusion criteria. Three articles used an isolated cognitive intervention strategy, seven articles used a dual-task strategy and 19 applied a computerized game-like strategy. There is evidence to suggest that cognitive or motor-cognitive methods positively affects motor functions, such as postural control, walking abilities and general functions of the upper respectively lower extremities. The majority of the included studies resulted in improvements of the assessed functional outcome measures. Discussion The current evidence on the effectiveness of cognitive or motor-cognitive interventions to improve motor functions in older adults or people with cognitive impairments is limited. The heterogeneity of the studies published so far does not allow defining the training methodology with the greatest effectiveness. This review nevertheless provides important foundational information in order to encourage further development of novel cognitive or cognitive-motor interventions, preferably with a randomized control design. Future research that aims to examine the relation between improvements in cognitive skills and the translation to better performance on selected physical tasks should explicitly take the relation between the cognitive and physical skills into account. References Yogev-Seligmann G, Hausdorff JM, Giladi N (2008). *Mov Disord* 23(3), 329-342 de Bruin ED, Schoene D, Pichierri G, Smith ST (2010). *Z Gerontol Geriatr* 43(4), 229-234

## PHYSICAL ACTIVITY, PHYSICAL EXERCISE AND COGNITIVE FUNCTION

DI BLASIO, A., BUCCI, I., DI DONATO, F., IZZICUPO, P., D'ANGELO, E., TAGLIERI, M.G., RIPARI, P., NAPOLITANO, G.

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**Introduction** Cognitive performance has been shown to decline as a function of aging, as have the brain regions that support it. Menopause is linked with both hormonal and metabolic changes and with an increased risk of cerebrovascular disease, negatively affecting the structures and the functions of the brain. Both physical activity and physical exercise have positive effects on cognitive function. The aim of our study was to investigate the influencing variables of cognition and the effect of 14 weeks of aerobic training in post-menopause. **Methods** Fifty-four post-menopausal women ( $57.54 \pm 4.95$  yrs) without history of diabetes mellitus, cognitive, cardiovascular and cerebrovascular diseases were enrolled in the study. Women did not participate in physical exercise program during the two years prior to the study and nobody had hormone-replacement therapy. Digit Span Test, and both part A (TMT-A) and part B (TMT-B) of the Trail Making Test assessed cognitive performance. Body composition was assessed by electrical bioimpedance technique, while SenseWear Pro3 Armband measured daily physical activity characteristics. The device gives information about total daily energy expenditure, mean intensity of daily physical activities, and both time and energy spent on physical activities with intensity > 3 METs. By our software, we calculated the daily numbers of bouts of physical activities performed at moderate intensities and lasting almost 5 (B5) and 10 (B10) consecutive minutes. Plasma lipoproteins were also measured. A dietician assessed dietary habits. Women walked 4 days/wk, for 14 weeks, at moderate intensity. **Results** Cluster analysis, performed on basal results of forward (FW) and backward (BK) scores and on TMT-A and TMT-B, identified two sub-groups: GROUP+ (n=26) and GROUP- (n=28). GROUP+ had better cognitive performance than GROUP-. Student's t-test showed that sub-groups differed for B10 ( $p=0.012$ ), total cholesterol (TC) ( $p=0.049$ ), LDL-cholesterol ( $p=0.031$ ), triglycerides ( $p=0.011$ ) and TC to HDL-cholesterol ratio ( $p=0.011$ ). Logistic regression indicated that both B10 ( $B=-0.255$ ;  $p=0.050$ ) and TC to HDL-cholesterol ( $B=0.669$ ;  $p=0.025$ ) predicted sub-group membership. RM-ANOVA showed that after the training both sub-groups improved TMT-A ( $F=9.959$ ;  $p=0.003$ ), FW ( $F=11.176$ ;  $p=0.002$ ) and digit span score ( $F=12.615$ ;  $p=0.001$ ). **Discussion** Quali-quantitative characteristic of spontaneous physical activity (i.e. B10) is important for cognitive performance of post-menopausal women that do not engage physical exercise. Fourteen weeks of aerobic training has been found linked with the improvement of working memory and visual attention.

## Poster presentations

### PP-BN03 Biomechanics and Injury

#### THE EFFECT OF AN 8-WEEK PROGRESSIVE HIP FLEXIBILITY PROGRAMME ON RUNNING TECHNIQUE IN TRIATHLETES.

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**Introduction** When compared to runners, triathletes exhibit decreased stride length, hip range of motion (ROM) and thigh extension during running (Connick and Li, under review). The cycling training undertaken by triathletes, is carried out in a relatively flexed posture, and may result in a chronic shortening of the hip flexors. Subsequently this may account for the observed reduced static and dynamic hip ROM found in triathletes (Scarfe, 2010). It is well publicised that static ROM can be increased by a flexibility programme (Winters, 2004). The aim of this study was to test whether increasing static hip ROM can change triathlete running kinematics. **Methods** Following a 4 week control period, 9 male triathletes completed an 8-week flexibility programme specifically targeting the hip flexors. At -4, 0, 4 and 8-

weeks, static hip ROM and running kinematic data were collected during 3x2 minute bouts of treadmill running at randomly assigned speeds of 13km/h, 15km/h and 17km/h. Kinematic data were captured using a 13 camera Vicon system. Results Significant improvements in the static hip ROM [F(3, 15)=26.69,  $p=.001$ ,  $\eta^2=0.84$ ] showed that the intervention was successful. However this did not result in significant changes to running kinematics (stride length [F(3, 24)=0.41,  $p=0.75$ ,  $\eta^2=0.49$ ], thigh extension [F(3, 24)=1.49,  $p=0.24$ ,  $\eta^2=0.16$ ], dynamic hip ROM [F(1.47, 11.72)=2.40,  $p=0.14$ ,  $\eta^2=0.23$ ] and pelvic tilt [F(3, 24)=0.68,  $p=0.59$ ,  $\eta^2=0.075$ ]. Discussion It is concluded that whilst the programme was effective at increasing static ROM of motion, these changes were not reflected during running performance. Thus, results suggest that the decreased stride length, thigh extension and pelvic tilt typically exhibited by triathletes may not be solely due to tight hip flexors. Further research is required to investigate what other adaptations may be the cause of the altered running kinematics present in this group and how refining them affects performance. The lack of change in running gait could also be due to participants not knowing how to apply their new ROM nor needing to use it to perform at the velocities used in this study. Further research should be conducted as to the effect of using methods to instruct participants how to accommodate the acquired gains in flexibility. Moreover, this study indicated that participants have sufficient ROM to increase velocity but, unlike experienced runners, are not able to utilize it during slower running. This lends further support to instructing participants in future studies how to use the increased flexibility. References Connick, M.J. and Li, F.-X. (under review). The effect of running velocity on stride parameters and kinematics in runners and triathletes. Scarfe, A.C. (2010). From theory to practice: running technique in triathletes. Unpublished Thesis, University of Birmingham. Winters, M.V., Blake, C.G., Trost, J.S., Marcello-Brinker, T.B., Lowe, L., Garber, M.B. and Wainner, R.S. (2004). Physical Therapy, 84, 800-807.

### **PATIENTS WITH PATELLOFEMORAL PAIN SYNDROME HAVE WEAKNESS OF QUADRICEPS AND HIP EXTERNAL ROTATORS AND REDUCED HAMSTRING AND PSOAS FLEXIBILITY.**

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Patients with Patellofemoral Pain Syndrome (PFPS) have weakness of quadriceps and hip external rotators and reduced hamstring and psoas flexibility. 1,2Konstantinos D. Papadopoulos, 2Jane Noyes, 3Moyra Barnes, 1,3Jeremy G. Jones, 1Jeanette M. Thom 1School of Sport Health and Exercise Sciences, Bangor University 2School of Healthcare Sciences, Bangor University 3Betsi Cadwaladr University Health Board, Bangor Introduction PFPS is a common knee problem. The cause and specific treatment are debatable. Muscle weakness and tightness are considered major causes. We set out to investigate which specific muscles are affected. Methods A series of flexibility and isometric strength tests (Humac Norm Isokinetic Dynamometer) used by physiotherapists were performed in 20 patients with PFPS and 20 matched asymptomatic subjects and repeated after a week. Three tests were excluded (unreliable and not valid). The flexibility tests were Ober and Thomas tests (psoas and quadriceps components), and tests for calf and hamstring flexibility. The muscles tested for strength were quadriceps, hip abductors, hip abductors and hip abductors with external rotators (Clam position). Then a fatigue protocol (2 sets of 30 eccentric reps) of hip abduction and external rotation was carried out in the Clam position. Subjects then performed either 3 sets of 20 three stair descents or 3 sets of ten one-leg-squats. The isometric strength tests were then repeated. One week later the protocol was repeated. The first series of tests was discarded because of a learning effect. Independent t-Tests, paired t-Tests and mixed model ANOVA were applied to the second series. Results The Thomas test (psoas) (18.1%,  $p=0.001$ ) and hamstring flexibility test (18.8%,  $p=0.032$ ) were reduced in PFPS group compared to controls, with no difference in the Ober, calf and Thomas (quads) flexibility tests. Strength reduction was found for quadriceps (19.2%,  $p=0.006$ ), external rotators (28.2%,  $p=0.004$ ), hip abductors/external rotators (from clam test position) (42.6%  $p=0.001$ ) in PFPS subjects, while there was no difference in hip abductor in extension strength. The clam fatigue protocol showed more rapid and more severe fatigability in PFPS group with a 20% drop in eccentric torque ( $p<0.000$ ). After the two functional tasks, PFPS group showed reduced isometric strength in hip abductors (7.2%,  $p=0.037$ ) and quadriceps (11.3%,  $p=0.048$ ) whereas only quadriceps strength (11.7%,  $p=0.002$ ) was reduced in controls. Discussion PFPS patients have significant weakness of quadriceps and external hip rotators. Weakness of hip abduction only became apparent on fatigue testing. Flexibility of psoas and hamstrings were lower. This suggests physiotherapy should be aimed at strengthening quadriceps and external rotators, increasing flexibility of psoas and hamstrings and that the Clam test is useful to demonstrate external rotator weakness and as a therapeutic exercise. Ober test did not differentiate between the two groups.

### **LOAD APPLICATION DISTRIBUTION BETWEEN THE RIGHT AND LEFT HAND DURING CLIMBING DEPENDS ON CLIMBING ABILITY AND PRE-EXHAUSTION LEVEL: ASYMMETRY OF LOAD APPLICATION AS PREDICTOR FOR OVERUSE AND INJURY?**

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Background: The Need for systematic information on performance structure is also increasing in sport climbing. To date, cross-sectional studies on break-exertion ratios (BER) and left-right load application time and distribution of the upper extremity related to climbing ability and pre-exhausting level are lacking. Thus, the present study was conducted to evaluate symmetry of load application between right and left hand in different climbing ability groups and in different pre-exhausting conditions. This might be of even greater importance regarding high prevalent overuse and injuries of the fingers (Backe et al., 2009). Methods: 28 sport climbers (Age:  $29\pm 8$  Years; BMI:  $22\pm 2$  kg m<sup>-2</sup>; years of climbing:  $10\pm 6$  years; Ability:  $23\pm 5$  Ewbanks points (australian difficulty scale); weekly climbing frequency:  $2\pm 1$ ) were either distributed in a recreational ( $<23$  Ewbanks,  $n=14$ ) or ambitious ( $>23$  Ewbanks,  $n=14$ ) group. Then, in a randomized order, a pre-exhausted and non-pre-exhausted group has been built. The 12m testing-rout has been set in an axis-symmetric shape. Capillary blood lactate concentration and perceived exertion level (Borg-scale) has been recorded immediately at the end of one climbing attempt. Contact time for load application has been recorded by video analysis separately for the left and right hand. Additionally, symmetry of load application time has been calculated. Results: Wilcoxon signed ranks test revealed significant differences between load application time between left ( $47\pm 4\%$ ) and right ( $53\pm 4\%$ ) hand. The lower the climbing ability and the higher the pre-exhaustion level (lactate accumulation) the more asymmetric load application shifts to the handedness site has been observed. The analysis of variances did not revealed a group effect concerning lactate and heart rate kinetic for recreational as well as ambitious climbers. In this regard, Differences merely occur between the pre- and non-pre exhausted group. Conclusion: The load application time for the handedness hand (right) prevails significantly. This dominance interacts with climbing ability and pre-exhaustion level (lactate accumulation). Further longitudinal studies should investigate, whether asymmetric load application time potentially predicts overuse and climbing injuries. References:



Backe, S., Ericson, L., Janson, S., & Timpka, T. (2009). Rock climbing injury rates and associated risk factors in a general climbing population. *Scandinavian journal of medicine & science in sports*, 19(6), 850-856.

## **ELECTROMYOGRAPHIC AND MECHANICAL RESPONSES TO A SPINALLY INDUCED BALANCE PERTURBATION OF THE PLANTAR FLEXORS**

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Electromyographic and mechanical responses to a spinally induced balance perturbation of the plantar flexors Cattagni, T., Scaglioni, G., Martin, A. INSERM U887 Motricite Plasticite, University of Burgundy, France Introduction Dynamic posturography associated with electromyography (EMG) recording of lower limb was traditionally used to study muscular and biomechanical reaction to an unpredictable postural perturbation in standing position (De Freitas et al. 2010). However, the methodologies proposed in the literature generally employ exogenic postural disturbance which does not allow perturbing subjects according to their relative abilities. This study, therefore aimed, to establish a method for which the balance disturbance is endogenic and its intensity is related to the physiological capacity of each subject. Methods The soleus H-reflex was used as the source of spinal balance perturbation. Experiments were performed on ten healthy males (age 24.4, SD 2.3 yr) which were perturbed in their standing position by bilaterally applying an electrical stimulation to the tibial nerve. Four different intensities were used. They were the intensities that allowed us to evoke: i) 50% of maximal H-reflex (Hmax) in the ascending phase, ii) Hmax; iii) 50% of the Hmax in the descending phase and; iv) the maximal M-wave. The EMG response of the soleus (SOL), medial gastrocnemius, lateral gastrocnemius and tibialis anterior were recorded simultaneously with the center of pressure (CoP) displacements. A total EMG response to the postural perturbation was calculated as the sum of the peak to peak amplitudes of the H reflex + the M wave of each muscle. The corresponding mechanical perturbation was quantified as the peak to peak amplitude of the CoP displacement in the anteroposterior direction. Results A linear relationship was found between the peak to peak amplitudes of CoP displacements and the amplitudes of the corresponding total EMG responses. ( $R^2=0.83$ ,  $P<0.05$ ). Discussion These results showed that there is a direct link between the endogenic perturbation (i.e. EMG input onto the neuromuscular system) and the postural response. This methodology enables us to perturb the equilibrium of subjects according to their relative ability and thus to determine if the strategy adopted by each individual to re-equilibrate is in accordance with their maximal neuromuscular capabilities. Reference de Freitas P.B., Knight C.A., and Barela J.A.(2010). *J Electromyogr Kinesiol*. 20, 693-700.

## **A WIDE NUMBER OF TRIALS ARE REQUIRED TO ACHIEVE ACCEPTABLE RELIABILITY FOR MEASUREMENT PATELLAR TENDON ELONGATION IN VIVO**

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1. Introduction This study examined the reproducibility of patellar tendon elongation measurements during isometric knee extension contractions (MVC) using brightness-mode ultrasonography (BMU). We hypothesized that the measurement of the patellar tendon elongation during only one maximal voluntary isometric knee extension contraction would not provide reliable results and that a wide number of trials are required to achieve acceptable reliability. 2. Methods Ten participants performed ten isometric knee extension contractions in two separate days (5 trials on each day). Using a modified knee brace, the ultrasound probe was firmly adjusted in the sagittal plane overlying the patellar tendon. The registered ultrasound images were analyzed by three different but equally trained observers. The reproducibility has been checked by the calculation within-day, between-day, overall and between-observer of the coefficient of multiple correlations (wCMC, bCMC, oCMC, boCMC) (Gronney et al., 1997). The Spearman-Brown prophecy formula at 50% and 100% of the MVC has been used to estimate the required trials to achieve the desired reliability. 3. Results The wCMC, bCMC and oCMC were in average  $0.82 \pm 0.07$ ,  $0.80 \pm 0.18$  and  $0.77 \pm 0.96$  respectively. The mean  $\pm$ SD values of the between-observer CMCs (boCMCs) were for the first day  $0.84 \pm 0.19$  and for the second day  $0.84 \pm 0.14$ . The Spearman-Brown prophecy formula showed that five to six trials are needed to achieve an excellent reliability of 0.95. 4. Discussion High reliability is a fundamental component for comparisons of patellar tendon stiffness values between different groups as well as for the monitoring of patellar tendon adaptation after exercise interventions. Our findings indicated a rather moderate reproducibility of patellar tendon elongation measurements. The present study demonstrates that the examination of the patellar tendon elongation during maximal voluntary knee extension contractions from only one trial did not ensure reliable results. Therefore, it is crucial to use 5 – 6 trials for the measurement of the patellar tendon elongation to achieve high reliability. Further, the results revealed an independency of the measurements from days and observers, which allows comparisons of reported values between different research groups. A basic experience of the observer by digitizing ultrasound images of the patellar tendon is enough to achieve acceptable results on tendon elongation. 5. References Gronney, E., Meglan, D., Johnson, M., Cahalan, T., & An, K. N. (1997). *Gait & Posture*, 6(2), 147-162.

## **RELATIONSHIP BETWEEN NERVE CONDUCTION VELOCITY AND SIZE OF ULNAR NERVE FASCICLES IN HUMANS**

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Introduction It has been reported in animal studies that nerve conduction velocity (NCV) increases with axonal diameter (Waxman, 1980). In human studies, changes in NCV with age (Norris et al., 1953) and differences of NCV between dominant and non-dominant arms (Hatta et al., 1995) have been observed by applying electrical stimulus to the ulnar nerve. These changes of NCV suggest plasticity of the axonal diameter of nerves. However, it is not clear how humans can increase the axonal diameter of nerves and thereby increase NCV. This is because little attention has been given to the direct measurement of the size of human nerves. Recent developments in ultrasonography have made it possible to scan human nerve fascicles directly. The purpose of this study was to measure directly the cross-sectional area of human ulnar nerve fascicles (CSA) and to examine the relationship between the NCV of the ulnar nerve and the CSA in humans. Methods 10 badminton players with bilaterally different arm size volunteered as subject. Electric stimuli were applied to both arms over the two separate points of the ulnar nerve. The action potential evoked in the muscles of the hypothenar eminence by applying electrical stimulus to the ulnar nerve and the latency of response (the time between stimulation and the onset of the action potential of the muscle) were measured. The NCVs of the nerves in both arm segments were calculated as the distances between the two stimulating electrodes divided by the differences in their latencies of response. CSAs were measured using a high-frequency ultrasound probe (frequency: 18 MHz; image resolution: 0.08 mm). Five CSAs were measured from a point 3 cm in a distal direction from the medial

epicondyle of the humerus to the point 3 cm in a proximal direction from the ulnar head at equal intervals. The five CSA images were analyzed and averaged. The forearm circumferences of both arms were measured using a measuring tape. Results/Discussion NCV, CSA and maximum forearm circumference (MFC) were significantly greater in the dominant limbs ( $53.8 \pm 4.33$  m/sec,  $6.2 \pm 0.9$  mm<sup>2</sup> and  $24.1 \pm 1.8$  cm, respectively) than in the non-dominant limbs ( $50.1 \pm 3.86$  m/sec,  $5.5 \pm 0.6$  mm<sup>2</sup> and  $22.4 \pm 1.9$  cm). These results agree with previous studies (Hatta et al., 1995). However, there was no significant relationship between NCV and CSA. CSA correlated positively ( $r=0.75$ ) with MFC. This result was not consistent with the results of previous animal studies (Waxman, 1980). The results of this study suggest that CSA may increase in proportion to forearm circumference but the difference of NCV cannot be attributed to the size of CSA. References Norris A H. et al. (1953). J Appl Physiol, 5, 589-593 Waxman S G. (1980). Muscle Nerve, 3, 141-191 Hatta A. et al. (1995). Adv Exec Sports Physiol, 2, 177-184

### MUSCLE-TENDON UNIT STIFFNESS DOES NOT INDEPENDENTLY INFLUENCE VOLUNTARY EXPLOSIVE STRENGTH

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**INTRODUCTION** Explosive strength, the ability to rapidly exert muscular force, is considered a key determinant of performance during fast and forceful muscle contractions. Muscle-tendon unit (MTU) stiffness may influence explosive strength [1], but its relationship with force production during explosive voluntary and involuntary contractions remains unclear. Any relationship of MTU stiffness with explosive strength may be because both are related to maximum strength (maximum voluntary force, MVF), rather than being independently related. **PURPOSE** To assess the relationship of MTU stiffness with voluntary and involuntary explosive strength of the knee extensors in absolute and relative (to MVF) terms. **METHODS** Following a familiarisation session 34 healthy untrained participants (17 males, 17 females; 19-28 yrs) performed a series of voluntary and involuntary [supra-maximal octets (8 pulses at 300Hz) electrically evoked via the femoral nerve] explosive isometric contractions. MVF was also assessed. Force was measured with a strain gauge perpendicular to the tibia at a knee joint angle of 85°. Force during the explosive contractions was measured at 50 ms intervals after force onset. Maximum rate of force development (MRFD) was measured as the peak slope over 5 ms. Force and MRFD were reported in absolute and relative terms (%MVF). Ultrasonic images of the VL were recorded at rest and during ramped contractions to assess MTU stiffness, which was expressed in absolute (N.mm) and relative (to MVF and resting tendon-aponeurosis length) terms. Stepwise multiple linear regressions assessed the relationship of MTU stiffness with force and MRFD. **RESULTS** Males had a greater MVF, absolute voluntary and involuntary force and MRFD; however, males and females exhibited equivalent relative voluntary and involuntary force and MRFD, and so their data were pooled. Bivariate correlations between absolute MTU stiffness and absolute voluntary ( $0.39 \leq R \leq 0.40$ ) and involuntary MRFD ( $0.47 \leq R \leq 0.71$ ) suggested that stiffness may influence explosive strength. However, regression analysis including MVF as an additional predictor variable showed absolute MTU stiffness did not contribute to the explained variance in absolute voluntary force at any time point, or MRFD. Similarly, relative voluntary force and MRFD were unrelated to relative MTU stiffness. However, MTU stiffness accounted for 4%, 8% and 11% of the variance in absolute involuntary force at 50 ms, absolute and relative involuntary MRFD, respectively. **CONCLUSION** Once maximum strength was considered, MTU stiffness had no independent relationship with voluntary explosive strength, and a weak association with involuntary explosive strength. **REFERENCES** [1] Bojsen-Moller et al. (2005) J Appl Phys, 99, 986-994

### THE INFLUENCE OF PLAYING SURFACE AND CLEAT DESIGN ON ACL-INJURY INCIDENCE: A PROSPECTIVE STUDY.

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**Introduction** Soccer is a very popular sport with a high injury incidence in men (10 – 35 injuries/1000 match exposure hours) and women (2– 24 injuries/1000 match exposure hours) (Hawkins et al., 1999) with the ankle (17,0 – 26,0%) and the knee (17,0 – 23,0%) being the most frequently injured and 20% of the knee injuries being ACL injuries (Dvorak & Junge, 2000). No consensus exists about the effect of the cleat design, a specific form and positioning of rubber studs, and the playing surface on the ACL-injury incidence. The aim of this study was thus to determine the incidence of ACL injuries in soccer and to investigate the influence of the playing surface and the cleat design on the ACL-injury incidence. **Methods** A 1 year prospective study design was used during the 2007 – 2008 soccer season. 25 female (n=277) and 19 male soccer teams (n=315) participated in the study. Lower limb injuries and mechanisms were monitored with a validated self-reporting questionnaire (Knaepen et al., 2007). Chi<sup>2</sup> and t-tests were performed to identify significant differences ( $p=0.05$ ) and correlations were analyzed with Kendall's Tau – b tests and ICC. **Results** We registered 344 lower limb injuries in 592 players. During the season 39,1% male soccer players got injured, compared to 37,9% females ( $p<0.05$ ). The amount of non-contact ACL injuries was markedly higher ( $p<0.05$ ) in female players (15,4%) compared to male players (9,8%). Eighty percent of all ACL-injuries occurred wearing shoes with the cleat design ( $p<0.05$ ). As for the playing surface, logical regression analysis showed that a soft and muddy surface was a significant predictor. **Discussion** Our study confirmed the higher ACL-injury risk for women and the non-contact injury mechanism. Earlier research showed that the cleat edge design increases the risk of an ACL-injury in American football (Lambson et al., 1996), but this was not confirmed in a more recent study in soccer (Gehring et al., 2007). A biomechanical study concluded that a higher shoe-surface interface is a possible risk factor for non-contact ACL-injuries (Drakos et al., 2010). This is reflected in our study, with the playing surface being a significant predictor for ACL-injuries, and the significant higher amount of ACL-injuries in players wearing the cleat design. **References** Drakos M, Hillstrom H, Voos J, Miller A. (2010). J Biomech Eng, 132, 110031-37. Dvorak J & Junge A. (2000). Am J Sports Med, 28, 35 – 95. Gehring D, Rott F, Stafelfeldt B, Gollhofer A. (2007). Int J Sports Med, 12, 1030-34. Hawkins R, Hulse, M, Wilkinson S, Hodson A. (2001). Br J Sports Med, 35, 43-47. Knaepen K, Cumps E, Zinzen E, Meeusen R. (2009). Ergonomics, 52, 461-473. Lambson R, Barnhill B, Higgins R. (1996). Am J Sports Med, 24, 155-159.

### MECHANICAL FACTORS OF ACHILLES TENDON RUPTURE IN KENDO

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**MECHANICAL FACTORS OF ACHILLES TENDON RUPTURE IN KENDO** Miyamoto, R.1, Ishige, Y.2, Taniguchi, Y.2, Ohoya, M.2 1: KAMEDA INSTITUTE OF SPORTS SCIENCES AND MEDICINE (Chiba, Japan), 2: International Budo University (Chiba, Japan) **Introduction** The Achilles tendon rupture often occurs in sports activities. In Kendo also, the Achilles tendon rupture is the most popular trauma, but the pattern of rupture is distinguishing characteristics. First, the injured leg is almost left side. (Nango, 2007) Second, the movement patterns which lead to rupture concentrate on the stepping forward movement just after backward movement and just after 180 degrees turn. (Matui et al,

1996) There are so many studies regarding the Achilles tendon rupture in Kendo. Most of those studies are dealing with prevention and its causes. But there are few studies which are examined from the mechanical point of view. So in this study we conducted the computer simulation of stepping forward movement in Kendo and quantitate the loads of Achilles tendon. Methods The research subjects were five male students who were the members of the University's kendo club. (age:  $19.5 \pm 1.0$  years, height:  $170.9 \pm 2.8$ cm, weight  $66.8 \pm 10.4$ kg) Each subject performed seven trials of stepping forward movements just after backwards which is typical motion in Kendo. 33 landmarks on the subject's body were captured through motion capture system (Eva-RT, Motion Analysis, USA) during those movements. At the same time the ground reaction force and EMG data were measured. All data were integrated into musculoskeletal model (nMotion muscular, NAC, JAPAN) in order to calculate the tension and length of the Achilles tendon. Results The average tension of the left side Achilles tendon at peak value was 2380N. The moment at which the left Achilles tendon force reach the maximum value corresponded with the instant of which the left leg struggle to stay on its feet at the latter part of stepping backward movement. Discussion Before it is considered that the most dangerous moment was just around the stepping forward movement. (Sato et al 2000.) However we speculated from our results that the moment of Achilles tendon rupture happened when the subject tried to stay on his left feet at the latter part of stepping backward movement. At this moment, the tension of Achilles tendon was two times larger than that of during stepping forward movement. Also the muscle activity of left gastrocnemius was active and Achilles tendon was elongated. This meant eccentric action of Achilles tendon. References Nanogo A, (2007). Japanese Society of Clinical Sports Medicine, 24(10), 1049-1055 Matui E, Yagi N, Yonezawa Y, Kobayashi H. (1996). Japanese Journal of Orthopedic Sports Medicine, 16(2), 7-4. Sato K, Yuzuki O. (2000). Kansai Clinical Sports Medicine and Science, 10, 51-53

## FUNCTIONAL OUTCOME AND ACTIVITY LEVEL AFTER TOTAL KNEE ARTHROPLASTY

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Introduction There is growing evidence that total knee arthroplasty (TKA) reduces pain and improves quality of life [2]. But in contrast to healthy people of the same age, deficiencies in function have been demonstrated [3]. The investigation of functional outcome and activity level makes a contribution to the understanding of the mechanisms of motor deficits before and after TKA. This is of importance for rehabilitation and prevention of further injuries due to falls. This study is currently in progress. Data of seven patients have been analyzed so far. Further results including a larger number of patients will be presented at the congress. Methods Seven patients with primary osteoarthritis (OA) and seven healthy age- and gender-matched controls participated. The OA group was tested one day before (pre) and at ten days (post1) and three months (post2) after TKA. The tests included (1) maximum voluntary contraction (MVC) of the leg muscles, (2) static postural control during bipedal stance under two conditions (open and closed eyes), (3) regional and whole body fat mass and lean mass (DEXA), (4) physical activity. Results Three month after surgery MVC was increased in the surgically treated and contralateral leg. In comparison with controls, patients' MVC of the operated leg was significantly lower before and after TKA. Area and velocity of the centre of pressure (COP) for each condition were significantly increased from pre- to post1-test in patients. Between post1- and post2-test patients' results differ in terms of postural control under the two conditions. COP parameters were significantly decreased with eyes open, whereas no differences were shown with closed eyes. In contrast to the controls, patients showed higher values of COP before and after TKA and a significantly lower physical activity level. Discussion The functional deficits and reduced activity level before and after surgery might be predominantly due to a destruction of articular tissues and pain. TKA led to an improvement of MVC, but muscle strength was not equivalent to that of people without OA. Disuse atrophy and failure of volitional activation probably induced by arthrogenic inhibition have been primarily suggested as causes of reduced muscle strength before and after TKA [3]. Patients still had profound impairment of balance under condition of visual deprivation three month after TKA. The high reliance on visual information suggests impaired sensory feedback from the lower limb and a shifting to a more visually dominated control strategy [4]. References 1. Levinger P, et al. (2010). Knee Surg Sports Traumatol Arthrosc, [Epub ahead of print] DOI: 10.1007/s00167-010-1325-8. 2. Meier W, et al. (2008). J Orthop Sports Phys Ther, 38, 246-56. 3. Mizner RL, et al. (2003). Phys Ther, 83, 359-65. 4. Tjon SS, et al. (2000). Arch Phys Med Rehabil, 81, 1489-93.

## EFFECTS OF EXERCISE THERAPY BASED ON REINFORCEMENT OF PROPRIOCEPTIVE SYSTEM ON THE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS AND BALANCE CONTROL

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Introduction Adolescent idiopathic scoliosis (AIS), a three-dimensional deformity of the spine, is the most common form of spinal deformities affecting girls aged 10-16 years. Due to the several sensory and motor impairments AIS patients exhibit a weak postural control and balance dysfunction (1). On the other hand, there are few studies investigating the effectiveness of exercise therapy based on reinforcement of proprioceptive system (RPS) in AIS treatment and control of balance (2). Therefore, the purpose of this study was twofold: the first one was to evaluate the ability of AIS patients to cope with sudden sensory deprivation and transform their sensory perception into appropriate motor commands, and the second one was to determine the effectiveness of a 6 month of exercise therapy based on RPS on scoliosis curve and balance control. Methods Twelve premenarchal AIS girls with a Cobb angle range of 10 to 20 degrees (average  $12.8 \pm 2.3$  degree) and fifteen healthy girls (C) participated in the experiment. Cobb angle and standing balance were measured before and after 6 months of exercise therapy based on RPS (90min/day, 3 days/week). Standing balance was measured on a Biodex force platform in different perturbed conditions (eyes closed and/or destabilizing surface). Analyses of variance (ANOVA) with repeated measures were used to analyze the data. Results Perturbation of visual information in both stable and destabilizing surface increased the body sway of scoliosis patients compared to control condition ( $p < 0.01$ ). Balance control of scoliosis patients was weaker than healthy subjects which improved significantly after 6 months of exercise treatment in all conditions ( $p < 0.05$ ). Exercise therapy based on RPS decreased Cobb angle significantly ( $p < 0.05$ ). Cobb angle decreased in 92.5% of patients by 3.5 degree on average. Discussion This research showed that AIS patients exhibit significant impairment in proprioceptive system, and compared to healthy subjects, they rely more on visual inputs rather than proprioceptive information to regulate balance. Exercise therapy based on RPS was effective in improving balance control, and reducing the magnitude of Cobb angle. In conclusion, exercise therapy based on RPS is recommended in the treatment of AIS to reduce the progression of spinal deformity and improve balance control in patients with minor spinal deformity. References 1. Simoneau M, Allard P, (2005). Exp Brain Res, 170: 576-582. 2. Negrini S, Antonini G, Carabalona R, (2003). Pediatr Rehabil, 6(3-4):227-35.

**THE INFLUENCE OF RANGE OF MOTION IN STRENGTH GAINS AND MUSCLE HYPERTROPHY OF ELBOW FLEXORS**

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Among the variables of strength training that have influence under strength gains and muscle hypertrophy, the range of motion in which the exercise is realized, seem have a important influence in adaptations. Therefore, of the purpose of present study, was compare the effect of ten weeks of strength training with Full (FROM) and partial (PROM) range of motion of elbow flexion in one maximal repetition (1RM) value and muscle thickness (MT), in three locals of elbow flexors distal (EF1), middle (EF2) and proximal (EF3). Forty male young subjects without training experience were divided in three groups: FROM (n=15; 21.7  $\pm$  3.7 years; 74.9  $\pm$  11.0Kg; 1.74  $\pm$  0.3cm), PROM (n=15; 21.7  $\pm$  3.3 years; 73  $\pm$  8.9Kg; 180  $\pm$  0.3cm), and control (n=10; 25.4  $\pm$  2.9years; 73  $\pm$  5.7kg; 179  $\pm$  0.9cm). The training was realized during ten weeks of bilateral mode utilizing a curling bar. The FROM group trained with range of 0° to 130° of elbow flexion (0° full elbow extension), and PROM group trained with range of 50° to 100° of elbow flexion (0° full elbow extension). The groups trained at week 1 and 2 with two sets with 20 repetitions, at week 3 and 4 with three sets of 15 repetitions, at week 5 and 6 with 3 sets of 12 repetitions, at 7 and 8 with 3 sets of 10 repetitions and 9 and 10 weeks with four sets of eight repetitions. The 1RM and muscle thickness of elbow flexors was assess at three locals, distal, middle and proximal (EF1, EF2 and EF3, respectively), were assessed pre, middle (week 5) and post training (10 week). Kruskal Wallis test and post hoc Dunnet C was utilized to analyze the changes in 1RM and MT among groups and two related sample to analyze within groups. The FROM and PROM showed significant increase (p<0.001) in the 1RM value after five weeks (16.2  $\pm$  9.7% and 8.3  $\pm$  4.5%, respectively) and ten weeks (25.7  $\pm$  9.6% and 16  $\pm$  6.7%, respectively), however the FROM group demonstrated significant increases (p<0.001) than PROM group after five and ten weeks. Both groups, FROM and PROM, showed significant increase (p<0.001) in the MT at all locals (EF1, EF2 and EF3), after five and ten weeks. However, the FROM group demonstrated significant increase (p< 0.001) than PROM group in all locals MT (EF1,EF2 and EF3) only after ten weeks. The results of present study demonstrated superiority of the training realized with full range of motion in gains of strength and muscle hypertrophy, moreover this results demonstrated the range of motion in which the exercise is realized have important influence in adaptations.

**Poster presentations****PP-BN04 Motor Learning 1****INTERSEGMENTAL DYNAMICS SURPASS AUGMENTED VISUAL FEEDBACK IN LEARNING COMPLEX RHYTHMIC MULTI-JOINT COORDINATION**

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In rhythmic movements, some patterns of coordination are intrinsically stable and require little or no practice to be performed (typically 0 and 180 degrees relative phase, RP), while other require substantial practice. The factors that influence learning of difficult coordination patterns depend on the context, such that there is no general agreement about the best approaches to facilitate learning. The present study compares three different methods to assist learning of a difficult 90 deg out of phase coordination between rhythmic flexion-extension (FE) and supination-pronation (SP) movements at the elbow: (i) practice with standard visual feedback (SVF), (ii) practice with augmented visual feedback (AVF), and (iii) practice with a favourable context of intersegmental dynamics in the form of interaction torques (IT), under SVF. Twelve subjects were randomly assigned to 1 of these 3 practice groups (SVF, AVF and IT). SVF consisted of one visual cursor per each of 2 axis of motion (one for FE and one for SP). AVF consisted of single visual cursor encapsulating both FE and SP movements (i.e., lissajou plot). Finally, IT was applied by a motorized device on SP axis as a function of FE movement in order to favour the intended 90 deg relationship. Performance was assessed for all three groups with eyes open (EO, SVF) and closed (EC) in pre- and post-learning tests. Averaged RP for all groups in post-test was approximately 45-55 deg. During learning with AVF, subjects were able to produce close to 80 deg RP, but in post-test (EO assessed with SVF), RP dropped and coordination stability decreased (p=0.04). On the other hand, other groups had similar RP during learning and post-test, probably because the same feedback (SVF) was maintained throughout. The IT group (with favourable dynamics) and AVF group (with visual help) had higher coordination stability than the SVF group during the second half of learning (p<0.01). In post-test, whereas coordination stability dropped in the AVF group, it remained high and similar to the last training trials, for the IT group. Consequently, AVF can assist in achieving the coordination task, but not to retain it once the visual help is removed (i.e. performance dropped with the SVF in the post-test). In marked contrast, coordination stability was not affected when the favourable context of intersegmental dynamics was removed in the post-test of the IT group. This suggests that IT provides a better approach to learn a 90 deg RP relationship under standard visual feedback.

**OCULO-MANUAL PURSUIT DURING TRANSIENT OCCLUSION OF EXTERNALLY GENERATED TARGET MOTION**

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LIVERPOOL JOHN MOORES

OCULO-MANUAL PURSUIT DURING TRANSIENT OCCLUSION OF EXTERNALLY GENERATED TARGET MOTION O'Donnell, D.I., Hansen, S.2, Bennett, S.1 1: LJMU (United Kingdom), 2: Nipissing University (Canada) INTRODUCTION When tracking an externally-generated moving target that is suddenly occluded, there is decay in smooth pursuit followed by an anticipatory recovery (Bennett and Barnes, 2003). Presenting trials in blocked order results in less decay and a predictive recovery, thus demonstrating volitional control. It has been suggested that smooth pursuit is also facilitated when the occluded target trajectory is internally generated (Gauthier and Hofferer, 1976). However, this was based on a comparison to an eye alone condition where participants were unable to exhibit any smooth pursuit. To better understand the contribution made by sensorimotor signals to the oculomotor system, the current study examined ocular and oculo-manual pursuit during the transient occlusion of externally-generated target motion. METHODS Participants tracked a target moving horizontally with velocity of 10, 15, 20deg/s. The target was initially visible for 600ms, then occluded for a 600, 800, 1000ms inter-stimulus interval (ISI), before reappearing for 400ms. Participants were instructed to pursue the target with the eyes alone (ocular) or eyes and hand (oculo-manual) during both the visible and occluded portions of the trajectory. During oculo-manual conditions, participants were tasked with keeping the moving target within a spherical hand cursor. RESULTS The decay of smooth pursuit during occlusion was attenuated during oculo-manual compared to ocular tracking (F(1,9)=5.64; p<0.05). At the moment of target reappearance, there was a

significant interaction between tracking condition and target velocity ( $F(2,18)=12.33$ ;  $p<0.05$ ). Oculo-manual tracking produced better scaling of smooth pursuit at the moment of reappearance for each level of target velocity ( $p<0.05$ ). This improvement in smooth pursuit during occlusion was reflected in a concomitant increase in smooth eye displacement ( $F(2,18)=7.30$ ;  $p<0.05$ ), and a reciprocal decrease in saccadic eye displacement ( $F(2,18)=10.40$ ;  $p<0.05$ ). **DISCUSSION** Using a paradigm in which target motion was externally generated, it was found that smooth pursuit during occlusion was facilitated by the contribution from sensorimotor signals available during oculo-manual pursuit (cf. Gauthier and Hofferer, 1976). Importantly, however, this facilitation was unable to fully offset the loss of input from visual feedback. As shown previously, hand and eye velocity showed elements of independence, which is consistent with smooth pursuit facilitation by adaptation of an internal gain mechanism (Lazzari, Vercher, Buizza, 1997). **REFERENCES** Bennett S, Barnes, GR. (2003). *Journal of Neurophysiology*, 90, 2504-2520. Gauthier GM, Hofferer, JM. (1976). *Experimental Brain Research*, 26, 121-139. Lazzari S, Vercher JL, Buizza A. (1997). *Biological Cybernetics*, 77, 257-266.

## STABILITY AND VARIATION IN MOTOR FUNCTION

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**STABILITY AND VARIATION IN MOTOR FUNCTION- A 6 YEAR LONGITUDINAL STUDY OF MOTOR FUNCTION IN NORWEGIAN CHILDREN.** Segberg, U., Hoigaard, R. Agder University College, Kristiansand, Norway **Introduction** There is an increasing concern about lower degree of physical activity among young children, especially related to physical fitness (Sallis et al., 2000) and psychological well-being (Biddle, S. and N. Mutrie, 2007). The data presented here are part of a larger longitudinal study that evaluates the relation between motor performance, self concept, social competency and contextual conditions. The data presented here highlights only motor function. The purpose is to monitor the stability and variation of motor function from grade 1 to 7. **Methods** At baseline, in grade 1, 96 children are tested with the German KTK – Körper Koordinationstest für Kinder. (Body Coordination Test for Children) (Kiphard & Schilling, 1974). In grade 7, at the final test, 77 children still are in the sample. **Results** There is a significant correlation between MQ in grade 1 and 7 ( $r(\text{pearson}) = 0.63$ ,  $p(< 0.001)$ ). The variance between the best and the weakest MQ increases from grade 1 to grade 7. The children are grouped in three levels (weak; average; strong) regarding to their MQ. The majority of the children 54 of 77 (~ 70%) stayed at the same level in grade 1 and 7. Among the children with weak motor performance ( $MQ < 80$ ) in grade 1, approx. 60% are still in the same group in grade 7. 68% of the children with best motor skills in grade 7 have been in the strong group at grade 1. A similar tendency has been observed for the average group (~70%). The strong group ( $MQ > 100$ ) contains more children in grade 7 than in grade 1. **Discussion** There is a great extent of stability in motor function from grade 1 to grade 7. The variance of motor function increases from grade 1 to grade 7. These findings support demands that motor-intervention programs have to start as early as possible, preferably before primary school. **References** Biddle, S. and N. Mutrie, (2007) *Psychology of Physical Activity: Determinants, Well-being and Interventions*, London, Routledge. Kiphard & Schilling, (1974) *Körper Koordinationstest für Kinder* Sallis J.F., J.J. Prochaska and W. C. Taylor (2000) *Med Science in Sports Exer*, 5, 963-975

## EFFECT OF EXERCISE-INDUCED FATIGUE ON POSTURAL CONTROL OF THE KNEE

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**Introduction:** Muscle fatigue is an inevitable part of high intensity exercise and is associated with reduced power output and work capacity of the skeletal muscle. Fatigue-induced impairments are believed to be a potential cause of increased injury rates during the latter stages of athletic competition particularly during sudden deceleration (Yu & Camner, 2007). **Methods:** Fatigue was induced using dynamic exercise which was performed on a bicycle ergometer. The Subject's maximal heart rate (HR) was calculated using the Carvenon equation. After the warm up the workload was increased until each subject reached 80 - 90% of their maximal heart rate and, thereafter, was kept constant until exhaustion. Surface electromyographic (EMG) signals were recorded from 10 healthy men from the knee extensor muscles (vastus medialis, rectus femoris, and vastus lateralis) and knee flexor muscles (the medial and lateral heads of the hamstring) of the right leg during full body perturbations at baseline and immediately following the high intensity exercise protocol. The platform was set to perform four perturbations: 8 cm forward slide, 8 cm backward slide, 10° posterior tilt, and 10° anterior tilt. Each perturbation was repeated eight times for a total of 32 perturbations. The 32 perturbations were randomized and occurred with random time intervals of 7 - 20 s, so that neither the type nor the time of the perturbation could be predicted by the subjects. Maximal voluntary knee extension force and conduction velocity of the vasti muscles were measured during sustained isometric knee extension contractions before and after the high intensity exercise to confirm the presence of fatigue. **Results:** The maximal voluntary contraction force decreased by 63% immediately after exercise ( $P<0.0001$ ) for knee extension ( $239\pm75.04$ ) and by 66% ( $P<0.0001$ ) for knee flexion ( $75\pm24.32$ ). Moreover muscle fiber conduction velocity recorded from the vasti muscles decreased post exercise compared with the pre exercise condition ( $P<0.05$ ). During the post exercise postural perturbations, the EMG average rectified value (ARV) was significantly lower than the pre-fatigue condition for both the knee extensor (baseline:  $19.73\pm25.48\mu V$ , post exercise:  $16.29\pm19.42\mu V$ ) and flexor (baseline:  $24.39\pm20.92\mu V$ , post exercise:  $13.88\pm11.06\mu V$ ) muscles (both  $P<0.05$ ). **Discussion:** fatigue has been demonstrated to have an adverse effect on neuromuscular control (M. P. Miles et. al, 1997). One way of quantifying an aspect of neuromuscular control is through measures of postural control. Muscle fatigue induces a reduction in the activation of both the quadriceps and hamstring muscles in response to rapid destabilizing perturbations potentially reducing the stability around the knee during such a destabilizing event. **References** Yu, B., & Garrett, W. E. (2007). Mechanisms of non-contact ACL injuries. *British Journal of Sports Medicine*, 41(suppl 1), i47. M.P. Miles, J.C. Ives and K.R. Vincent, Neuromuscular control following maximal eccentric exercise. *Eur J Appl Phys* 76 (1997), pp. 368-374

## COMPARISON OF LOVER LEG MUSCLE ACTIVATION DURING FREELY CHOSEN AND PREDEFINED STEP LENGTH

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**Introduction** When running with predetermined foot impact positions the co-activation of the lower leg muscles is higher with respect to free running due to accuracy demands (Luc et al., 2005). The aim of the study was compare the activation of some lower leg muscles during running with freely chosen step length and predefined step length, both of the same length. **Methods** Seven male (26 yrs; 178 cm; 76 kg) and two female (24 yrs; 169 cm; 62 kg) volunteers participated in this experiment. They ran six times 50 m on tarmac with rest 3 min between the runs. First three runs the subject ran in freely chosen velocity and step length (FSL). The velocity was measured in the last

30 m with photo cells. The next three runs the subject ran in freely chosen velocity but predefined step length (PSL). The step lengths were the same as in previous runs and were marked on the ground so that the subject had to step on the mark while running. Two trials (one of each condition) of similar running velocities were chosen and nine consecutive steps in the last 30 m were analyzed. EMG signals from m. soleus (SOL), m. gastrocnemius medialis (GM), m. tibialis anterior (TA) and m. peroneus (PER) of the right leg were recorded according to the SENIAM recommendations. Contact times (CT) were measured with accelerometer fixed on the heel of the shoe. The EMG signals were divided to pre-activation phase (-100 to 0 ms of pre-contact time), reflex mediated phase (30 to 120 ms of contact time) and entire contact phase (CT). Average EMG amplitude of these phases was analyzed. Descriptive statistics and paired-samples T-test were used to compare two running conditions. Results Freely chosen running velocities ranged from 3.75 to 5.45 m/s. There was no significant difference between mean velocities in each condition. The average contact times were 219 ms ( $\pm$  25 ms) and 216 ms ( $\pm$  25 ms) for FSL and PSL respectively and were not significantly different. We did not find any significant differences in EMG amplitudes between both conditions as well. Discussion We found no differences between FSL and PSL showing that accuracy of foot landing itself did not necessarily change the muscle activation pattern related to joint ankle stabilization. It seems there must be other influences related to accuracy to induce certain degree of variability into the running that provoke adaptation in ankle control during running. References Selen, LPJ, Beek PJ, van Dieën JH. (2005). Biological Cybernetics, 93, 373-381.

## INSIDE THE BRAIN OF EXPERT ICE HOCKEY PLAYERS: AN FMRI STUDY OF GAME INTELLIGENCE

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Introduction Success in sports is heavily dependent on the ability to anticipate actions in order to effectively react to situations that may occur during a game. A previous study showed that expert athletes pick up kinematic cues earlier than novices and therefore it was suggested that they have more time to make correct decisions (Aglioti et al., 2008). However, the underlying brain mechanism of such superior behavior is still not well understood. In this study, we examined expert superiority to anticipate outcome of game actions in ice hockey as well as the underlying neuronal mechanisms. Methods We used functional magnetic resonance imaging (fMRI) to measure regional blood flow while presenting videos of a hockey player shooting a puck towards a hockey goal. The videos (a total of 120) where stopped at different time frames with different amount of information provided, creating a paradigm with three different levels of difficulty to decide the fate of a shot. This allowed us to separate the performance between expert hockey players and novices. Results The results showed that expert hockey players were significantly more accurate compared to novices on deciding where the puck would go. The imaging results showed that when expert hockey players observed and anticipated the situation they recruited regions in the motor cortex. Further, when the difficulty increased they also recruited the superior temporal sulcus (STS), a region that previously been associated to social cognition. Novices, on the other hand, recruited visual regions when observing the situations. During the decision, hockey experts again used motor cortex, as well as hippocampus, to correctly anticipate the shot. In comparison, novices used frontal regions of the brain. Discussion These results suggest that the superior performance experts show can be explained by them using different brain structures both when observing game situations as well as when deciding upon the fate of the shots. Novices needed to visually search the situations for clues and then use cognitive resources to solve the task. Experts could instead recruit the motor representation and, thus, use their stored motor skills to know where the puck would go. We conclude that motor expertise and skill to analyze biological motions are necessary to effectively anticipate game actions. References: Aglioti M.S., Cesari P., Romani M. & Urgesi C. (2008). Action anticipation and motor resonance in elite basketball players. Nature Neuroscience. 11, 1109-1116.

## CONFIGURATION OF SPINAL PROJECTIONS OF THE LOWER LIMB MUSCLE MOTONEURONS IN HUMANS

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To research motoneuron nets, providing motion at the spinal level, there was made mapping of the lower limb skeletal muscle representation. We used the technique of registration of multisegmental monosynaptic responses (MMRs) (Courtine, S.J. Harkema, Ch.J Dy et al., 2007) which were evoked by percutaneous surface electric spinal cord stimulation at the lower thoracic and lumbosacral levels. These responses are equivalents of the H-reflex. The main idea was to map the spinal projection area defined by the number of points in the interspinal intervals at the T11-T12, T12-L1, L1-L2, L2-L3, L3-L4 levels. The percutaneous surface electric stimulation of these intervals led to registration of the reflex motor responses of the following bilateral limb muscles – m. biceps femoris, m. hamstrings, m. soleus, m. flexor digitorum brevis. The method of selection of the threshold stimulus, for each of the above mentioned points of surface projection of the spinal cord, was applied. The smallest threshold point is supposed always to correspond to the spinal cord level of the greatest density of motoneurons, that innervate the particular lower limb muscle. A group of healthy males (n=18) aged 17-22 was involved into the investigation. It was established that the stimulation of each indicated level was accompanied by registration of the responses of each studied muscle. Nevertheless, the test revealed that the optimal position, to get the responses from all the studied muscles, was T12-L1. It was also confirmed by the highest meanings of MMRs' maximal amplitudes received at that particular level stimulation in comparison with the meanings of MMRs' maximal amplitudes obtained at the stimulation of the other studied levels. Somatotopic mapping of muscle representations in the spinal cord allows to study spinal neural nets adaptation, to meet requirements of athletes' physical loading, and the nets modulation under the influence of pathology factors.

## EFFECT OF ACUTE EXERCISE ON PLASTICITY OF THE HUMAN MOTOR CORTEX

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EFFECT OF ACUTE EXERCISE ON PLASTICITY OF THE HUMAN MOTOR CORTEX Lavender, AP.1,2, Obata, H.2, Nakazawa, K.1. 1: The University of Tokyo (Tokyo, Japan), 2: National Rehabilitation Centre for Persons with Disabilities (Tokorozawa, Japan) Introduction A higher level of physical activity likely leads to improvements in psychomotor abilities (Plunzevic-Gligorska et al. 2010). Investigations have concluded that aerobic exercise can improve scores of cognitive tasks in healthy children (Reed et al. 2010) and older adults (Barella et al. 2010). These studies looked at effects of chronic exercise regimes on cognitive function only. In addition, enhanced neuroplasticity has been shown in highly active individuals compared with sedentary subjects (Cirillo et al. 2009). The effect of acute exercise on plasticity of the motor cortex has not yet been addressed. The present study, therefore, sort to investigate the effect of moderate aerobic exercise of the lower limbs on cortical excitability of a hand muscle (not involved in the exercise) using paired associative stimulation (PAS) which is

commonly used to induce neural plasticity in awake humans. Methods Right handed subjects aged 21 – 40 years attended the laboratory on three occasions separated by at least two days. An intermittent isometric finger abduction PAS protocol of the right first dorsal interosseous muscle (FDI) was conducted during each visit. A magnetic pulse at the hand area of left motor cortex elicited motor evoked potentials (MEP) of 1 mV in FDI preceded by an electrical stimulation of the ulnar nerve at the wrist with an interstimulus interval of 25 ms. PAS consisted of 180 stimulations at 0.2 Hz. MEP were measured before PAS and at five min intervals for 30 min after PAS. Each PAS session was preceded by either 30 min of stationary cycling at 60% age-predicted maximum heart rate ending 30 min or 120 min before or a control condition not preceded by exercise. Results MEP amplitude increased similarly between the control and 120 min conditions, peaking five min post exercise at  $161 \pm 42\%$  and  $152 \pm 36\%$  of the pre-test value respectively. However, MEP following PAS preceded 30 min by the exercise bout increased to  $249 \pm 59\%$  five min after exercise and remained elevated at  $233 \pm 54\%$  30 min later. Discussion These results suggest that moderate aerobic exercise 30 min before PAS modulates synaptic proteins in the motor area which may play a role in exercise-induced brain plasticity. The influence of exercise does not appear to last long as the modulation of MEP was similar for the control and 2 hrs conditions. References Barella LA, Etnier JL, Chang YK. (2010). *J Aging Phys Act*, 18, 87-98. Cirillo J, Lavender AP, Ridding MC, Semmler JG. (2009). *J Physiol*, 587, 5831-5842. Plunzevic-Gligorska J, Manchevska S, Bozhinovska L. (2010). *Med Arh* 64, 139-143. Reed JA, Einstein G, Hahn E, Hooker SP, Gross VP, Kravitz J. (2010). *J Phys Act Health* 7, 343-51.

## RELATIONSHIP BETWEEN MOTOR PERFORMANCE AND BODY MASS INDEX OF SCHOOL PUPILS IN ZURICH

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ETH ZURICH

Introduction The analysis of correlations between the motor performance and the health of children is an essential basis for the development of effective prevention approaches (Krombholz, 2006). Since in Switzerland reports on children's motor performance are missing (Müller et al., 2007), the Institute of Human Movement Sciences and Sport of the ETH Zurich annually assesses the motor performance of all first-grade pupils in the city of Zurich (start in 2005). The aims are to evaluate the long-term development of first-grade pupils and to link health parameters and motor performance. Methods During gym class, motor tests were performed with 14'521 first grade pupils (mean age  $7.1 \pm 0.4$  years, weight  $25.2 \pm 4.8$  kg and height  $124.2 \pm 5.5$  cm). The tests were chosen from existing test series (KTK, AST 6-11, Eurofit): Lateral Jump (LJ), 20m-Sprint (20m), Standing Long Jump (SLJ), Plate Tapping Test (PT) and Shuttle Run (SR). In addition, age, weight and height were assessed. Overweight and obesity were calculated according to Cole et al. (2007), with an age-adjusted scale. The significance level was set to 0.05. Results About 10 to 14 % of all subjects are overweight (obesity excluded) and 4 to 5 % of them are obese. No trends in body mass index (BMI) were detected in populations tested between 2005 and 2010. BMI poorly correlates with motor performance in first-grade pupils (0.13 LJ, 0.19 20m, 0.23 SLJ, 0.29 SR for boys and 0.13 LJ, 0.15 20m, 0.22 SLJ, 0.28 SR for girls; PT was not significant). However, the group with normal BMI performs significantly better than the overweight group and the overweight group perform significantly better than the obese group in almost all tasks (except for PT). In SR, the obese subjects performed significantly worse than the overweight ones (30 % less for boys, 22 % less for girls) and the ones within a normal weight range (49 % less for boys, 40% less for girls). Discussion Our results show the importance of a long-term assessment: the values of overweight and obese children are quite high but stable over the years. Only a long-term observation would be able to show whether the BMI of children changes. Significant differences in performance rate have been observed between normal weighted, overweight and obese children in specific tests: even if BMI has poor correlation with motor performance due to the large subject variance, the normal weighted group performs better than overweight and obese children. References Cole TJ, Bellizzi MC, Flegal KM, Dietz WH (2000). *BMJ*. 320(7244): p. 1240-1243 Krombholz, H (2006). *Percept Mot Skills*. 102(2): p. 477-84. Müller R, Krebs A, Wittensöldner C, Murer K (2007). *Schweizerische Zeitschrift für Sportmedizin und Sporttraumatologie*. 55(4): p. 121-125

## REFLEX-FUNCTIONAL EXERCISE FOR THE FIRST YEAR INFANTS

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REFLEX-FUNCTIONAL EXERCISE FOR THE FIRST YEAR INFANTS A. SHKLYARENKO, T. KOVALENKO, L. PASHKOVA Volgograd State University Slavenskiy-on-Kuban Pedagogical State Institute, Russia Introduction. It is well known that the first year of a child has its crucial effect on his future life in many respects. It is exactly in this period that many infant body systems should get their correct development. Study methods and management. We performed and tested for seven years a reflex-functional complex of exercise with the use of physical culture devices for newborns and first year children. This training helps to achieve high performance in infants' development and rehabilitation. Research results and their discussion. The physical exercise was treated as an integral movement activation and not as separate muscle group training. Massage in combination with physical exercise proved their effectiveness. When estimating the physical exercise we presume that its mechanism of action is based on the motor-viscerogenic reflex. The motor activity had its major influence. The reflex-functional training that we offer is aimed at this link of regulation by reference of different afferent systems. The movement force, its proper value and direction were used. Furthermore, we sought out the most appropriate biologically approved methods of mobilization of growing organism adaptive, protective and compensatory properties. It is well-known that when doing physical exercise arousal summation in nerve centers accrues. It must be emphasized that the exercise establishes with babies not only physical but also psycho-emotional contact. When doing the reflex-functional complex of exercise the following regulations and rules were observed: - establish a contact with a baby; - start a massage or gymnastics with simple exercises and manipulations: gradually complicate and introduce new elements; - avoid strong grasps, pushes or any compression of infant's tissue and joints; - all the procedures and movements must be executed carefully, accurately and professionally; - do not use any massage cream or baby talk. Conclusion: Analyzing and comprehending all the factual material we can presume that the therapeutic reflex-functional complex of exercise with the use of physical culture devices contributes to the optimal development of all body systems of newborns and first year children due to the adaptive and functional modifications such as urgent adaptation to one-time loads and long-term adaption to systematic loads.

## THE DIFFERENCES IN MOTOR PERFORMANCE ABILITIES AND BODY MASS INDEX OF EGYPTIAN AND GERMAN CHILDREN

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**Introduction:** The growth process and development are ongoing according to the rhythm that is established by genetic inheritance and environmental factors. In addition the stages of motor development are the same for all children worldwide, but the developmental rate is influenced due to the special characteristics of the environmental conditions in which every child is growing. Therefore, the aim of this study was to identify the differences in motor performance abilities and BMI of Egyptian and German children. **Methods:** The participants are (n= 348) children aged from 6-8 years old in public primary schools in both Egypt (n=210) and Germany (n=132). The sample for the study has been selected randomly. The motor performance abilities have been assessed, and body mass index has been calculated using DMT 6-18 years old (Bös, 2009). **Results:** The results show that the level of motor abilities of German children is generally better compared to the Egyptian children. The differences between groups are significant ( $p=.000$ ). The general level of motor abilities of German children was average and BMI was normal ( $M=17.20$ ,  $SD=2.6$ ). However, for Egyptian children the level of motor abilities was below average and BMI was also normal ( $M=16.07$ ,  $SD=3.0$ ). The best motor ability was demonstrated in balance as well for Egyptian and German children. On the other hand the worst of Egyptian children was demonstrated in endurance ability and demonstrated by German children in power ability. **Discussion:** Although the BMI has the same level of Egyptian and German children, there are significant differences in the level of motor abilities between the groups. That shows the BMI has less influence on motor abilities in this age stage. The social-culture factors which are better in Germany compared to Egypt play a vital role in the level of motor abilities. The influential factors from the environment for instance living conditions, use of sport equipment or suitable places for motor activities are more influential factors (Daniel, 2007). In addition it's an indication of long-term commitment of the German children compared to the Egyptian children in physical education, sports, and motor activity (Booth, 1997). These make them physically better and they are healthier children (Bös, 2009). **References:** Booth, M., Macaskill, P., Phongsavan, P., Okeley, T., Patterson, J., Wright, J., Bauman, A., & Baur, L. (1997). NSW Schools Fitness and Physical Activity Survey. Sydney. Bös, K. (2009): Deutscher Motorik Test (DMT 6-18), Deutsche Vereinigung Für Sportwissenschaft, ad-hoc-Ausschuss, 33- 40. Bös, K, Pratschko, M. (2009): Das Gross Kinder-Bewegungsbuch mit Kinder- Fitness. Daniel, W., (2007): Motorische Leistungsfähigkeiten vor Grundschulkindern, Untersuchung der Einflussfaktoren.

## Poster presentations

### PP-SH06 Physical Education 1

## INVESTIGATION OF EMOTIONAL INTELLIGENCE LEVELS ON PHYSICAL EDUCATION AND SPORTS TEACHING STUDENTS

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**Introduction:** At the present days, it is lay emphasis on important to exert effectively of emotional intelligence to establish relations with friends and acquaintances either business life or private life of persons. As regard as emotional intelligence height in persons who supplied self-identity and prove the needs, notice consuming and efficient, have command over one's temper establish relations with friends and acquaintances (Taskin, 2008). Therefore, the aim of this study was to investigate the emotional intelligence levels of Physical Education and Sports Teaching students at Anadolu University according to their gender, their class levels, their type of high school graduated fields and their sport branches. **Methods:** 107 students were formed the research universe. Data were collected by means of "The Emotional Intelligence Questionnaire" which is originally developed by Bar-On (1997) and later shortened and reorganised by Acar (2001) in Turkey. In the data analysis, "arithmethic mean and standart deviation" for numerical comparisons were used. In order to determine the differences among attitudes, t-test was used for two-way comparisons for independent groups and ANOVA was used in order to compare variables of groups more than two. In the statistical analysis, 0.05 was accepted as the significance level. **Results and Discussion:** As a result of this study there is no significant difference between their genders for personel skills, interpersonal skills, compatibility and general emotional state. On the other hand there is significant difference between their genders for overcome stress ( $p<0.05$ ). The result of this study is supported with literature (Acar, 2001). There is no significant difference between their class levels for compatibility and overcome stress. On the other hand there is significant difference between their class levels for personel skills, interpersonal skills and general emotional state ( $p<0.05$ ). The same results were founded by Mayer (2001). There is no significant difference between their type of high school graduated fields for personel skills, compatibility, overcome stress and general emotional state. On the other hand there is significant difference between classrooms for interpersonal skills ( $p<0.05$ ). The result of this study is supported with literature (Bender, 2006). **References:** Taskin, A. K. (2008). Beden eğitimi öğrencilerinde duygusal zeka düzeylerinin bazı degiskenlere göre incelenmesi. Yüksek lisans Tezi, Selçuk Üniversitesi, Sağlık Bilimleri Enstitüsü, Beden Eğitimi ve Spor Anabilim Dalı, Konya. Acar, F.T. (2001) Duygusal zeka yeteneklerinin göreve yönelik ve insana yönelik liderlik davranışları ile ilişkisi: Banka şube müdürleri üzerine bir alan araştırması. Doktora tezi, İstanbul Üniversitesi, Sosyal Bilimler Enstitüsü, İstanbul. Mayer, J. (2001). "Emotional intelligence and giftedness". Roeper review, 23 (3), 131-137. Bender, M. T. (2006). Resim-is Eğitimi Öğrencilerinde Duygusal Zeka ve Yaratıcılık İlişkileri, Doktora Tezi, D.E.Ü. Eğitim Bilimleri Enstitüsü, İzmir.

## PROSPECTIVE ASSOCIATIONS BETWEEN CARDIOPULMONARY FITNESS AND ACADEMIC PERFORMANCE IN PRIMARY SCHOOL CHILDREN

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**Purpose:** This study was designed to examine the relationships between cardiopulmonary fitness and academic performance among primary school children at the beginning of the six-grade and follow-up to the end of the six-grade. **Methods:** A total of 810 children from three primary schools in Taiwan participated in this study. Data including gender, mother's and father's educational levels, family structure, numbers of siblings, intelligence quotient, cardiopulmonary fitness, and body composition were collected at the beginning of the six-grade as the baseline data. Cardiopulmonary fitness was assessed by a 1600(boys)/800(girls)-meter run and was grouped into three levels: 'good', 'normal', and 'bad' according to the national fitness norm. Body composition was obtained through measured height and



weight and converted to body mass index. Three groups were categorized as 'underweight', 'normal weight', and 'overweight/obese' based on the age- and gender- specific cut-off points of the national definition of obesity. Academic performance was the mean scores of Language, Mathematics, Science and Social Studies, extracted from the school records and converted into T-scores. The ANOVA analysis was performed to examine differences in academic performance at the end of the six-grade between fitness groups. A multivariate linear regression for predicting academic performance at the end of the six-grade was undertaken adjusted for potential confounding factors at baseline. Results: Children in the good fitness group had greater academic performance at the end of the six-grade compared with those in the bad fitness group after the ANOVA analysis ( $p = .013$ ). In the multivariate model, gender, father's educational level, family structure, intelligence quotient, and baseline academic performance were significant predictors and accounted for 45.3% of the variance in academic performance at the end of the six-grade. Cardiopulmonary fitness showed no significant association with academic performance at the end of the six-grade after multivariate adjustments. Discussions: Previous research has provided a positive relationship between fitness and academic achievement (Castelli, et al., 2007; Chomitz et al., 2009). However, this study does not support the positive link between cardiopulmonary fitness and academic performance in multivariate analysis after one-academic-year follow-up. Further studies are necessary to investigate the longitudinal influence of fitness on academic achievement. References: Castelli, D. M., Hillman, C. H., & Buck, S. M., et al. (2007). *J Sport Exerc Psychol*, 29, 239-252. Chomitz, V. R., Slining, M. M., & McGowan, R. J., et al. (2009). *J Sch Health*, 79(1), 30-37.

### **CAN TURNITIN™ OPERATE AS A FORMATIVE FEEDBACK MECHANISM TO IMPROVE WRITING DEVELOPMENT FOR SPORT AND EXERCISE SCIENCE STUDENTS?**

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**Introduction** The development of early drafts is a significant skill in enhancing writing practice. Some students may submit first or draft writing for assessment (Bean, 2001). The use of plagiarism detection software (Turnitin™) may offer opportunities to support writing development via the submission of early drafts (Davis, 2007) and formative feedback (Heinrich et al., 2005). The aim of this study was to evaluate the use of Turnitin™ to provide formative feedback via early submission and re-drafting, for a group of Sport and Exercise Science students (BSc Level 4). **Methods** Two groups of Sport and Exercise Science students ( $n=48$ ;  $n=63$ ) completed laboratory reports in two sequential years and gave written informed consent. The study was approved by the local ethics committee. Data was collected from academic results and an attitudinal web based questionnaire (using a 5-point Likert-type scale) designed to explore perceptions and experiences of the introduction of Turnitin™. An independent sample t-test was used to compare differences of the academic grades using SPSS (v.16). Results There were no significant differences in grades between cohorts ( $47.27 \pm 12.26\%$ - $46.54 \pm 13.38\%$ ) ( $t = .29$ ,  $df = 109$ ,  $p = 0.77$ ). Questionnaire Scale respondent data was 74% of  $n=63$ . Taking responses of 4 or more in the Likert scale (1-5 ascending) as an indication of overall agreement with a particular statement, the results show that Turnitin™ was perceived as a very effective way of submitting and correcting assignments by the majority of students (76.9% of respondents,  $4.2 \pm .4$ ). Majority of students (70%) reported the main purpose of Turnitin™ was to detect plagiarism. **Discussion** The suitability of Turnitin™ as a tool to promote writing development did not affect grades significantly. The perceptions of students indicate that Turnitin™ is an effective way of submitting and correcting assignments. The majority of students perceived Turnitin™ to be practical as a means of monitoring the originality of their work, although they shared a lack of understanding about the implications of the originality report. A significant aspect emerging from the questionnaire was that students identified the main purpose of the use of the software was plagiarism detection. It is useful to be mindful of the tensions that may emerge when attempting to make use of the dominant discourse of academic malpractice for the purposes of writing development. There were indications that the use of Turnitin™ acted as a deterrent to plagiarise rather than as support to develop writing for assessment for the majority of students. References Bean J. (2001). San Francisco: Jossey-Bass. Davis M. (2007). *Brookes e-Journal of Learning and Teaching*, 2, (2). Heinrich E, Milne H, Moore M. (2009). *Educational Tech. & Soc*, 12 (4) 176-192.

### **PHYSICAL EDUCATION, PHYSICAL ACTIVITY AND ACADEMIC PERFORMANCE**

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**Introduction:** There is an ongoing debate among educators about the status of Physical Education (PE) in the curriculum, particularly in relation to more vocationally-oriented learning areas. **Objective:** The present study examined the relationship between physical activity (PA) and academic performance of Portuguese high school students, according to gender. **Methods:** A total of 245 boys (age  $17.7 \pm 1.0$ ) and 386 girls (age  $17.4 \pm 0.9$ ) from the 12th grade of three secondary schools participated in the study. Data was collected using a questionnaire about leisure time activities, PA participation (informal and formal), attitudes toward school and PE, and academic performance. Pearson's correlations were applied to identify the relationships between the number of weekly sessions of PA participation and the final mark obtained in 11th grade, in Mathematics, Language (Portuguese) and PE. In the Portuguese context, classifications range between 0 (minimum) to 20 (maximum). The lower reference for success is 10 values. Significance level was  $p < 0.05$ . **Results:** On average, boys presented lower academic performance than girls in Mathematics ( $12.6 \pm 3.2$  vs  $13.5 \pm 3.3$ ) and Language ( $12.3 \pm 2.2$  vs  $13.7 \pm 2.4$ ), but not in PE ( $16.9 \pm 2.2$  vs  $15.5 \pm 2$ ). Regarding PA, boys have reported to participate in more sessions per week than girls ( $4.9 \pm 3$  vs  $3.8 \pm 2.5$ ). In both genders significant and moderate correlations were established between Mathematics and Language ( $r = 0.518$  boys,  $r = 0.614$ ). There was also significant but low association between the scores obtained in PE and Mathematics ( $r = 0.355$  boys,  $r = 0.314$ ) and within PE and Language ( $r = 0.275$  boys;  $r = 0.382$ ). Moreover, significant but little correlations were observed between PA participation and PE marks ( $r = 0.223$  boys;  $r = 0.193$ ). Finally, it is worth noticing that there were no significant correlations between PA participation and both Mathematics and Language final marks. These results suggest that the practice of physical activity and the time allocated to PE do not adversely affect academic performance. **Conclusion:** Adding time to "academic" or "curricular" subjects by taking it from PE programs does not increase marks and might be detrimental to health (Trudeau & Shephard, 2008). In accordance to this investigation, this study highlights the fundamental role that schools and PE can assume in the promotion of active and healthy lifestyles. References: Trudeau, F. & Shephard, R. (2008). Physical education, school physical activity, school sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity*, 5 (10).

## THE IMPACT OF A HYBRID SPORT EDUCATION-INVASION GAMES COMPETENCE MODEL SOCCER UNIT ON OFFENSIVE DECISION MAKING AND SKILL EXECUTION ACCORDING TO PLAYERS' GENDER

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FADEUP

THE IMPACT OF A HYBRID SPORT EDUCATION-INVASION GAMES COMPETENCE MODEL SOCCER UNIT ON OFFENSIVE DECISION MAKING AND SKILL EXECUTION ACCORDING TO PLAYERS' GENDER Santos, D., Farias, C., Araújo, R., Mesquita, I. Centre of Research, Education, Innovation and Intervention in Sport, CIFI2D, FADEUP, Porto, Portugal Introduction The coalition of SE and IGCM takes into account the personal and social needs of students and the specificity of tactics on invasion games. Therefore, the purpose of this study was to examine the impact of the application of a hybrid SE-IGCM soccer unit on students' improvements in offensive decision making (DM) and skill execution (SE). Method A class of fifth-grade (17 girls and 9 boys) from a Portuguese elementary school participated in a 22-lesson soccer unit, which was designed following a hybrid SE-IGCM. One Pre-test (PTT) and two post-tests (PTT1, PTT2) measured the offensive decision making and skill execution obtained using the instrument developed by Blomqvist et al.(2005). Results From pre-test to post-tests 1 and 2 all students improved in holding the ball (DM) and dribbling (SE). From PTT to PTT2, girls improved in movements to a position to receive a pass (DM) and in passing (SE). At PTT boys have outperformed girls in passing (DM and SE), in holding the ball (DM), and in receiving the ball (SE). At both post-tests girls leveled scores with boys in passing (DM and SE); conversely, boys have overcome girls in holding the ball (DM), in dribbling (SE), and in shooting (SE). Discussion The impact of the program could be explained by the quality and quantity of students' opportunity of response that were envisaged by the learning tasks structure (Musch et al.,2005) which often gave students, time and space to decide and execute properly. Additionally, the tasks' structure (IGCM), encouraged the transferability of the skills to the game, allowing students to improve skills without losing the focus on game-problems solving (Tallir et al., 2007). The performance improvements were extended to both DM and SE suggesting that both are important and can determine the students' performance improvements in sports (Blomqvist et al., 2005). References Blomqvist, M., Vääntinen, T. & Luhtanen, P.(2005). Assessment of secondary school students' decision-making and game—play ability in soccer. *Physical education and Sport Pedagogy*, Vol. 10, n.º 2, 107-119. Musch, E., Mertens, B., Timmers, E., Mertens, T., Graça, A., Taborsky, F., Remy, C., De Clercq D., Multaet, M. & Vonderlynnck, V. (2002). An innovative didactical invasion games model to teach basketball and handball, presented on cd. Paper presented at the 7th Annual Congress of the European College of Sport Science, Athens, Greece. Tallir, I. B., Musch, E., Valcke, M. and Lenoir, M.(2007) 'Do Alternative Instructional Approaches Result in Different Game Performance Learning Outcomes? Authentic Assessment in Varying Game Conditions', *International Journal of Sport Psychology*, 38: 263-282.

## CAN JOB SATISFACTION EXPLAIN WHY A PHYSICAL EDUCATION TEACHER MORE THAN OTHER TEACHERS WANTS TO LEAVE THEIR PROFESSION

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Can job satisfaction explain why a physical education teacher more than other teachers wants to leave their profession? INTRODUCTION: Does Norwegian physical education teachers have a low score on job satisfaction, and do they experience their job situation so heavy loaded that they appraise to quit teaching the subject? Several studies have shown that job satisfaction is one important factor to avoid exhaustion and is essential to prevent job turnover. (Travers and Cooper 1996) Lack of status of the subject has also been claimed as a problem among physical education teachers. (Næss 1996, Armour and Jones 1998, Kougioumtzis 2006) Armour and Jones (1998) claims that the role of teacher education must be clearer. METHODS: 520 physical education teachers answered a validated questionnaire consisting of 150 questions concerning their job as a physical education teacher. Regression-analysis and path analysis were undertaken to check what independent variables had an significant impact on the two dependent variables "job satisfaction" and "probability of continuing teaching the subject" RESULTS : The independent variables that had the highest impact on "job satisfaction" ( $R^2 = 357 \text{ sig } ,01$ ) were education, how many lessons physical education they teach during a week, their physical fitness status, if they thought it was fun to teach the subject, the lack of problems with their pupils, lack of experience of physical and psychological stress in teaching and the feeling of competence as a physical education teacher. The independent variables that had the highest impact on "probability of continuing teaching the subject" ( $R^2=407 \text{ sig } ,01$ ) was: education, their experience of age and physical fitness, age, their thought of the importance of having a sport background, and lack of experience of physical and psychological stress in teaching the subject. Discussion: The teachers who studied physical education for one or more year, taught between 4 to 12 hours a week, training 3 or more times pr. week were the once who reported the highest teaching satisfaction and the probability of continue teaching the subject This indicates the importance of the choice of future physical education teachers characteristics/ criteria. REFERENCES Armour,K.,M. and Jones, R.(1998) *Physical Education Teachers' Lives and Careers*, PE Sport an educational status New York Routledge Kougioumtzis, K : (2006) *Lärarkulturer och professionskoder. En komparativ studie av idrottslärare i Sverige och Grekland*. Göteborgs Universitet Næss, F., D.: (1998) *Tales of Norwegian Physical education teachers: A life history analysis*. The Norwegian University of Sport and Physical education, Oslo Travers, Ch., & Cooper, C.: ( 1996) *Teachers Under Pressure, Stress in the Teaching Profession* Routledge

## REFLECTIVE PRACTICE AND PHYSICAL EDUCATION: A SYSTEMATIC REVIEW OF THE LITERATURE SINCE 1995

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REFLECTIVE PRACTICE AND PHYSICAL EDUCATION: A SYSTEMATIC REVIEW OF THE LITERATURE SINCE 1995 Standal, Ø.F. 1 & Moe, V.F. 2 1: NSSS (Oslo, Norway), 2: SFUC (Sogndal, Norway) Introduction The ability to reflect over one's practice is considered an important part of PE teacher education and PE teacher's work. In a review on this topic, Tsangaridou & Siedentop (1995) claimed that questions regarding the use and effectiveness of programs to enhance reflectiveness were unanswered. They also expressed hope that a future review would "assess the value of reflection from a firm evidentiary base" (p. 233). The purpose of this study was to review the literature published on reflective practice and physical education from 1995 to 2010. Method A systematic review of literature was conducted. The databases ERIC, ISI Web of Science and SportDiscus were searched for the combination of key words "physical education" AND "reflective practice", "reflective practitioner" or "reflective teaching". Inclusion criterions were: a) Journal article or book chapter; b) Physical education or education of physical education teachers as contexts; c) Available in English; d) Published 1995-2010. Results The articles included can be divided in conceptual and empirical articles. About 25% of the articles are conceptual, broadly arguing for why reflective practice is necessary, and how it can be promoted among PE teachers and PE students. In the empirical articles, the methodological quality varied

considerably, and a further division can be made between empirical work which is practice-based and low in methodological rigor, and empirical work with scientific quality. The majority of the articles belong to the latter group. For the most part, the empirical articles presented qualitative data. The review shows that the concepts reflection and reflective practice are used in very different ways by the different authors. Also, a concept like 'critical reflection' is used in various and sometimes contradictory ways. Discussion Compared to the study by Tsangaridou & Siedentop, it appears that the literature on reflective practice in physical education has increased. Yet, it is far from safe to say that we now have a "firm evidentiary base" to assess the value of reflection. By drawing on Wackerhausen's (2008) "structural anatomy of reflection", this review raises question about what the object of reflection is, and it draws attention to the knowledge base and concepts with which reflection takes place. In addition, it shows the various interests and motivations from which reflection takes place. Though educating unreflective practitioners is a bad option, this review points to a need to consider more closely the concept of reflection as well as its place and purpose in the education of PE students. References Tsangaridou, N. & Siedentop, D. (1995). *Quest*, 47, 212-237. Wackerhausen, S. (2008). RUMI, Institut for filosofi og idehistorie, Aarhus

## THE DEVELOPMENT OF PROFESSIONAL IDENTITY AMONG PRESERVICE TEACHERS. THE MEANING OF THE BOARD DIARY

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Introduction Professional Identity (PI) has served as an important construct in research on teachers and teaching[1]. Considering that the construction of the PI happens in the context of school[2], and the importance of professional training in that construction, the aim of this study was to capture the daily life of the pre-service teachers and the meanings they attribute to their experiences. Methods The participants were 11 pre-service teachers of Physical Education (PE), from 4 practicum's groups of academic year 2010-2011 (Faculty of Sport, University of Porto). They were invited in the beginning of the practicum to develop a board diary[3], with the events, experiences, thoughts and feelings regarding the practicum process. In the middle of the first semester, all the students participated in a focus group [4], conducted by 2 facilitators. The issues discussed were: which and what kind of situations were registered and why; what was the meaning given to these situations. The focus group was filmed and audio recorded with previous agreement of all participants. The confidentiality and anonymity was granted. The video and audio records were analyzed using NVivo 9. A thematic analysis was developed with the following themes: Type of registration; Situations most valued; Meaning of the previous situations. Results and conclusion Regarding the type of registration, the data shows that the pre-services teachers register class-room situations; feelings; anguishes; and issues related with the group of PE. The situations most valued involve the social interactions with their pupil and other teachers. Finally, the meanings attributed to the situations varies according to the school community and the pupil' level. The difficulty of still being a student and simultaneous the need to be a teacher was the feeling most observed within all the participants. FCT/PTDC/DES/115922/2009 References 1. Marcon D, Nascimento J, Graça A (2007) Construction of pedagogical competences in the practicum as a curricular module of physical education teacher education. *Brazilian Journal of Physical Education and Sport*, 21(1): 11-25. 2. Jurasaitė-Harbisson E. (2005) Reconstruction Teacher's Professional Identity in a Research Discourse: A Professional Development opportunity in an informal setting. *Trames*, 9(2): 159-176. 3. Attard A; Armour K, Learning to become a learning professional: reflections on one year of teaching. *European Journal of Teacher Education*, 2005. 28(2): 195-207. 4. Stewart D, Shamdasani P (1998) Focus group research. Exploration and discovery. In: L. Bickman, D. Rog (eds) *Handbook of applied social research methods*. Sage Publications, London: 505-526.

## MODERN PROBLEMS OF PHYSICAL EDUCATION OF YOUTH IN RUSSIA.

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MODERN PROBLEMS OF PHYSICAL EDUCATION OF YOUTH IN RUSSIA. Likhachev O.1, Alpatskya E.1, Fomin S.2, Fomin A. 1. 1: Smolensk State Academy of Physical Culture, Sports and Tourism (Smolensk, Russia); 2: Russian State University of Physical Culture, Sports and Tourism (Moscow, Russia). Introduction. Transition to new social economical conditions in modern Russia led to the decrease of efficiency of the youth physical education. It has been the result of authoritative pedagogics that was carried out in the Soviet Union in condition of slow, but yet going on democratization of the country. New, not authoritative methods of physical education haven't been completely worked out yet. Methods During this investigation we inquired 1211 students of age of 18-22 from different higher educational establishments of the European of the part Russia: Smolensk, Orel, Kaluga. The questionnaire included 47 close and open type questions (items). The aim of investigation was to find out conditions under which we can involve students to different kinds of sport games. Discussion. The conducted questioning has shown that overwhelming majority of students (girls) (90,6%) realize (at least at the verbal kevel) the necessity of going in for recreative physical culture, but only 33% actually do it. The research has made it possible to reveal the expressed feature in choosing of a kind of recreative physical culture, which has been shown at the comparison of women, going in for an individual event-aerobics, and women going in for a team event- volleyball, basketball and others. Students (future businesswomen), whose main task is self – improvement: weight, reduction, appearance improvement, aspiration to improve health, etc., prevail in aerobics trainings. They consider that their future business career, family, life will depend on their good, physical condition, modern elegant appearance. Girl, going in for sport games, prefer to receive the emotional discharge from trainings, to change conditions, to expand contacts with other girls of the same age. The going gives them pleasure and they are fond of it. Result. This investigation showed that modern students don't clearly realize that important fact that a certain level of physical fitness should be constantly kept, that various diseases and abnormal conditions in elderly people are natural consequences of their ignorant treatment of their health in youth. It's the result of their irresponsible attitude to keeping fit in maturity.

## PHYSICAL EDUCATION ON VIRTUAL COMMUNITIES

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PHYSICAL EDUCATION ON VIRTUAL COMMUNITIES Origuela, M.A.1, Lopes da Silva, C.1 1: UNIMEP (Piracicaba , Brazil) Introduction Virtual communities on internet are a current phenomenon. They are sources of research and access to social discourses. The objective is to analyze discourses in two virtual communities: "I love Physical Education" and "I hate Physical Education" on Orkut website. The emergence of these communities constitutes an element for reflection about the signifiers assigned to Physical Education classes at school and the tradition of these classes in Brazil. Methods Literature search is performed based on classical and contemporary authors and

field research based on principles of ethnography, featuring a discussion eminently qualitative. Results The participants of the community "I hate Physical Education" use the virtual space for debates and complaints in Physical Education classes at school. It was realized that in "I love Physical Education" communities, the users use the space mainly for advertisements. Discussion New phenomena, such as the Internet virtual communities "I love Physical Education" and "I hate Physical Education" in the Orkut social network site, are elements for reflection in this direction and to debate problems related to school lessons on Physical Education. In our culture, it is common to hear people recalling with joy their lessons of Physical Education and, also, to hear people who relate to these lessons with much regret or anger. This fact can be associated to the experiences that students had in their Physical Education classes on school and the activities performed in leisure moments. This work contributes to review the concepts and values by students and professionals working in the area of Physical Education and Leisure. References Daolio, J. (1996). Educação Física Escolar: em busca da pluralidade. Rev. Paul. Educ. Fis. São Paulo, supl.2, p.40-42. Dumazedier, J. (1979) Sociologia empírica do lazer. São Paulo: Perspectiva. Gozto, V.M.(2003) O processo de comunicação: teoria e prática social. São Paulo: Fian,s.d.In: Schwartz, G.M. O conteúdo virtual do lazer: contemporizando Dumazedier. Licere,Belo Horizonte,v.6,n.2,p.23-31.

## MIDDLE SCHOOL PUPILS ON THE PURPOSE AND EVALUATION OF PHYSICAL EDUCATION

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Introduction The review of literature provides evidence that physical educators rely on subjective measurements to evaluate student learning. Research also shows that physical education teachers are concerned with behavior rather than with how much students learn. Our aim was to examine 10-14 years-old pupils' views and experiences on 1) the aim of PE lessons, 2) the importance of PE lessons, 3) tendencies in PE lesson evaluation and the extent to which they are accepted, 4) their perceptions on their mark. Methods The sample consisted of 1218 pupils between 10 and 14 years of age (67% return rate). All filled out an open-ended questionnaire. Distribution of gender, age and PE teachers' gender were equal. In the analysis categories were coded and grouped in themes according to their characteristic features, and then non-parametric statistics were used. Results 36.5% of middle school pupils consider the purpose of PE as the improvement of physical condition. According to 35.3%, PE lessons provide physical exercise that cannot be done elsewhere, 20.5% considered that the aim of PE is to promote health and a healthy lifestyle. Most pupils believe that regular PE lesson is of high importance (90.8%). Those students who had three or more PE lessons a week mentioned less frequently exercise as PE's main purpose and more frequently healthy lifestyle ( $p < 0.0001$ ). Pupils of female PE teachers indicated more frequently that PE is an important subject than those of male PE teachers ( $p < 0.0001$ ). PE teachers formally assess and evaluate the techniques and tactics of sports, the development of physical condition and coordination (45.3%) and „everything we do at PE lessons“ (35.3%). 84.3% of students accepted and approved the present form of grading and evaluation system ( $p < 0.0001$ ). 83.6% has a 4 or a better mark in PE (5 being the best and 1 being the worst) ( $M = 4.338 \pm 0.7025$ ). 93.5% of the pupils accept their own PE mark ( $p < 0.0001$ ). The 7th and 8th grade pupils didn't agree with the purpose of evaluation, 5th grades students have a better PE mark than all other students ( $p = .012$ ,  $p = .004$ ). Boys believe that performance and achievement are assessed/evaluated in the PE lessons ( $p = .036$ ) and boys also had significantly better marks than girls ( $p = .012$ ). Those pupils who had a female PE teacher mentioned more frequently that they were evaluated on the basis of their own advancement than the pupils of male PE teachers ( $p < 0.001$ ). Pupils who have more PE lessons a week have better marks ( $p < 0.0001$ ). Those not doing regular extracurricular sports tend to disagree with the form of evaluation ( $p = .015$ ). The marks of those who did sports were also significantly better than of those not doing sports ( $p < 0.0001$ ). Conclusions Results show that it is worth consulting the pupils in order to improve the quality of the physical education class. The current form of evaluation of PE as a subject area seems to be appropriate. According to our expectations, the results can be very well used well in the dispute regarding the question of assessment and evaluation in physical education.

## PHYSICAL EDUCATION CAN INFLUENCE THE LIFESTYLES OF GIRLS?

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Introduction The nature of personal experiences in Physical Education (PE), can influence the choices of lifestyles as adults (1), but also as future teachers and educators. Note that PE quality programs help to maintain positive perceptions of students (2). It is therefore important to know and to characterize the perception that future educators and teachers have about the influence of experiences in physical education (3), for a more active lifestyle and healthy. Methods A questionnaire was applied to 277 students girls from 1st year of Bachelor in Basic Education from the University of Aveiro over 4 academic years (2007/2008 to 2010/2011), using a scale of perception (level 1 - not at all ... 7 - enough) and explanation of the reasons. Data were analyzed using descriptive statistics and content analysis. Results 60.6% of respondents identified themselves with a perception of the influence of PE between level 4 and 5. The scale value was less than 1 (2.2%), followed by 2 (3.3%) and 7 (3.3%). Level 4 is the most expressive in all of four years' study. Only in 2010/2011 the level that is no longer the 4 to be the 5. Level 3 grows smoothly over the years (from 11.1% to 20%). The category specific effects of PE was the most significant and emerge as the main justification ('The PE has prepared me and encouraged me to enjoy sport', 'because I developed a taste for sport which until then had not', 'because I realized the importance of physical activity', 'He taught me many games and have developed some capacity. It made me gain appreciation for various sports' or 'because I learned different sports'). Discussion The PE seems to have a strong influence on the lifestyles of the students, indicating a neutral trend or not strongly marked. Despite the results the reasons given as justification to focus significantly on the positive aspects associated with the specific effects of PE. These results should make us reflect on the training offered at the EP, especially for girls. (1) TRUDEAU, F., LAURENCELLE, L. & SHEPHARD, R. (2004) Tracking of physical activity from childhood to adulthood. Medicine & Science in Sports & Exercise. 36, 11: 1937 - 1943. (2) TRUDEAU, F. & SHEPHARD, R. (2005). Contribution of school programmes to physical activity levels and attitudes in children and adults. Sports Medicine, 35, 2: 89 - 105. (3) NEVES, R. (2007). A construção curricular da educação física no 1º ciclo do ensino básico - conhecimento e percepções dos professores. Tese de Doutoramento apresentada ao Departamento de Didáctica e Tecnologia Educativa - Universidade de Aveiro (policopiada).

## Poster presentations

### PP-SH07 Sociology of Physical Activity

#### CHILDREN PHYSICAL ACTIVITY PARTICIPATION AND THE PERCEPTION OF THEIR PARENTS' WEEKLY PHYSICAL ACTIVITY

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Introduction: Identifying psychological influences affecting children's behaviour about physical activity (PA) is important to understand individual differences in children's activity participation. Objective: This study sought to examine the relationship of children PA behaviours and the perception they have of their parents' weekly participation in PA. Methods: A total of 251 boys (age  $10.7 \pm 0.7$ ) and 164 girls ( $10.5 \pm 0.7$ ), age ranged between 10 and 12 years old, participated in the study. The informed consent was obtained from each participant and their parents. Data was collected using a questionnaire used on international research project on children's lifestyles. A two-way ANOVA was used to determine main effects and interactions of children's perceptions of their parents' PA participation on children PA participation. Significance level was  $p < 0.05$ . Results: On average boys spent  $4.2 \pm 2.8$  hours in PA a week and girls  $3.1 \pm 2.3$ . Boys and girls with both active parents were more involved with PA ( $4.21 \pm 3.1$ ) than those whose parents were inactive ( $3.4 \pm 2.1$ ). In both genders the most active children had the perception that their fathers practiced weekly PA. ANOVA revealed no significant interaction for children's perception of their father and mother PA participation (boys,  $p = 0.92$ ; girls,  $p = 0.95$ ). For girls, non significant differences were observed neither for the perception regarding fathers' PA participation ( $p = 0.18$ ), nor for the perceptions towards their mothers ( $p = 0.24$ ). However, a significant difference was found between boys who perceived that fathers were active and those who said their father were inactive ( $F(1,239) = 4.96$ ,  $p = 0.03$ ). Conclusion: Children's participation in PA is not significantly related to their perception of parental involvement, with the exception of boys who perceived their fathers as actives. However, despite not having found significant differences, we could observe a tendency that points to a relation between the perceptions that parents are active with the amount of PA practiced by children.

#### TOURISM IN THE PERSPECTIVE OF SACRUM

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Tourism in the Perspective of Sacrum Prof. Dr. Jerzy Kosiewicz Josef Pilsudski University of Physical Education in Warsaw Regardless from the fact if free time is considered from a religious or a non-religious viewpoint, it is possible to proclaim that there are two kinds of possible relations between tourism and sacrum: 1. Concerning wandering, which can have, firstly, strictly religious (that is: pilgrimage) character and, secondly, non-religious, cultural character connected with studying religion. 2. Connected with reception of nature during outdoor tourist wandering. Those experiences can have threefold qualities: parareligious, nonreligious and religious ones. That type of sacral experiences of spontaneous qualities appear solely because of direct influences of nature and not under the influence of man's works and religious objects which have been appointed by him and which are approved by a given community. A proper example in that respect is constituted by Tatra and sea travels of Mariusz Zaruski – a Polish seafarer and mountaineer from the turn of the 19th and the 20th century. In his considerations on tourism he refers to the simplest solutions characteristic for general assumptions of Hellenistic philosophy of nature. It concerns, among other things, Pythagorean harmony and Heraclitean mind of the world as well as hylozoism or animism of Ionic philosophers of nature, which obviously stem from superficial empirical cognitions, perceptions and observations of nature; from the simplest (from the present viewpoint) explanations of inductive and intuitive character.

#### THE ROLE OF SOCIAL SUPPORT IN 17-18 YEARS OLD IN TIRANA.

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UNIVERSITY OF SPORT OF TIRANA

Shehu, A.1, Spahiu, M.1, Qeleshi, A.1 1: UNIVERSITY OF SPORT OF TIRANA Introduction: Social Support has been recognized for a long time in the behavioral science as an important adjunct to therapy(1). Social support can come from a variety of sources (friends family, teacher) and the goal is to identify and nurture relationships that can provide this type of support (2). How is the situation in our selected group? Objectives: To see how much do they take part in life, as a member, as a part of the group, as a part a society, specially for their delicate ages in our long and delicate transitions Subjects: Proximately 194 boys and girls 17-18 years old are selected as a part of our study, from famous High Schools ("Partizani" – "Arben Broci") in the center of Capital .. Methodology: SSS(The social Support Scale)questionnaire assessment the Social Support has been applied. (Poul M.Insel and Walton T .Roth 1988). Results: Rating Total score female male total High Support 70 or more ---- 0 % 0 % 0 % Moderate Support 40-69 --- 48 % 50 % 49 % Low Support less than 40 --- 52 % 50 % 51 % Discussion: The situation from questionnaire speak clear that it is no good for the half of students .Data show that 51 % in total are at Low Support which suggest that they lack the minimum support structure to counter the negative effects of stress. In our information study we tried to be honest, true and simple as a postulate in science said . References- 1.Poul M.Insel and Walton T .Roth. Core Concepts in Health. Fifth Edition . 2: 36-38. 1998 2. 1- Charles B.Corbis, Ruth Lindsey, Greg Welk. Concepts of Physical Fitness ,2000;19: 368-370.

## Poster presentations

### PP-SH08 Personality, Motivation, Coherence

#### SPORTS ACTIVITIES AND SENSE OF COHERENCE AMONG COLLEGE STUDENTS

ENDO, S., KANO, H., OISHI, K.

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Introduction Increased depressive symptoms and anxiety as well as a loss of confidence and decreased self-esteem have been noted among young adults in Japan. In this background, more attention has been paid to salutogenesis and Sense of Coherence (SOC) which

was theorized by Antonovsky (1979, 1987). Salutogenesis is the theory that examines why people can stay healthy and which focuses on maintenance and promotion of health. SOC refers to a perception and sense of one's experiences in the world in which he or she is living is coherent, consistent, reasonable, and comprehensible. It is known that if people have strong SOC, they can mobilize General Resistance Resources (GRRs) and cope with stresses successfully. Former studies suggest the possibility of increasing one's SOC through the acquisition of positive psychological states and various psychological skills brought about by sports activities. The purpose of this study was to compare the level of SOC in athletes to that of non-athletes among college students. Methods Subjects were 732 college students (315 males, 417 females; mean age:  $19.4 \pm 1.4$  years). SOC was measured by using the Japanese version of SOC-13. This questionnaire reveals the degrees of SOC and the three elements of SOC (sense of comprehensibility, sense of manageability, and sense of meaningfulness). Additionally, sports activities among the subjects were surveyed in terms of their affiliated athletic organizations, sporting events, and frequency of play. Results Subjects were categorized into three groups, i.e., athlete, semi-athlete, and non-athlete groups. The Kruskal Wallis test showed significant differences in the SOC and sense of meaning scores among the three groups ( $\chi^2=12.35$ ,  $11.80$   $p<0.01$ ). Additionally, the Steel-Dwass test for multiple comparisons showed significant differences between the athlete and non-athlete groups ( $t=3.22$ ,  $3.24$ ,  $p<0.01$ ), and the semi-athlete and the non-athlete groups ( $t=2.50$ ,  $2.41$ ,  $p<0.05$ ). Discussion Our results showed the consistent and strong relationships between sports activities and SOC. Additionally, these results suggested that the successive sports activities elevated SOC, and the athlete and semi-athlete have more desirable mental attitude than the non-athletes. References Antonovsky A. (1979). *Health, Stress and Coping. New perspective on Mental and Physical Well-being*, Jossey-Bass, San Francisco. Antonovsky A. (1987). *Unravelling the Mystery of Health. How People Manage Stress and Stay Well*, Jossey-Bass, San Francisco.

## A RESEARCH ON THE ANXIETY AND AGGRESSION LEVEL OF TEAM AND INDIVIDUAL SPORTSMEN

YILDIZ, M.

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A RESEARCH ON THE ANXIETY AND AGGRESSION LEVEL OF TEAM AND INDIVIDUAL SPORTSMEN Yıldız, M.1, Şahan, H. 2, Tekin, M. 3, Güllü, M.4, Devecioğlu, S.5 1 Karaman, Turkey, 2 Karaman, Turkey, 3 Karaman, Turkey, 4 Malatya, Turkey, 5 Elazığ, Turkey Introduction Aggression is a crucial problem for us with which we come across at all stages of the social life, in street, in school, within family and sports environment. And depending on this issue, factors affecting aggression must be considered. Level of anxiety of is considered as the most recognizable one among these factors. For this reason, investigation for the anxiety and aggression level of sportsmen doing individual and team exercises is aimed in this study. Method The groups included in this study are consisted of 82 team sportsmen and 65 individual sportsmen and totally 147 sportsmen actively in physical training and sports academy from Karamanoğlu Mehmetbey University, Selçuk University, Gazi University and Akdeniz University. To reach the aim of the research; State-trait Anxiety Inventory developed by C. Spielberger (1970) and Aggression Inventory developed by Kiper (1984) are used. In the solution and the interpretation of the data; Kolmogorov-Smirnov test and t test are used and significance is determined as  $P<0.05$ . Results It is found that level of continuous anxiety is higher in team sportsmen than individual ones ( $P<0.05$ ). Level of destructive aggression, recklessness and aggression in general of team sportsmen is higher than individual ones ( $P<0.05$ ). Level of passive aggression in individual sportsmen is found higher ( $P<0.05$ ). Discussion As the result of this study; it is found that level of continuous anxiety is higher in team sportsmen than individual ones (Adam et al 2009). The findings in this study were parallel with the current study. Level of destructive aggression, recklessness and aggression in general of team sportsmen is higher than individual ones. It is thought that there may be some aggressive behaviour depending on the qualities of the sportsman, trainer's tactics, and sports fan and media pressure. Level of passive aggression in individual sportsmen is found higher. Many reasons, such as individual sportsmen's taking decisions on their own, the intensity of their social or psychological problems, not achieving their expectations from sport and how are they affected from this failure, their tendency towards these kind of behaviours, partially. References Adam RN, Remco P, Andrew RL (2010). Coping Self-Efficacy, Pre-Competitive Anxiety, And Subjective Performance Among Athletes. *European Journal Of Sport Science*, March 2010; 10(2): 97-102 Kiper, İ(1984). *Several Species of Aggression on Economic, Social and Academic Variables Relationship Unpublished Master Thesis*, Ankara University Institute of Social Sciences, Ankara Spielberger C.D (1974). *Anxiety As Emotional State*, Hn, C.D Spielberger C.D. *Anxiety Currents Trend In Theory On Research Academic Press New York* P:23-43 1970

## SPORTS ACTIVITIES AND THE BIG FIVE PERSONALITY FACTORS

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Introduction Many researchers have studied personality of athletes. In many cases, those studies reported that the athletes were more extroverted, and less depressive and/or anxious than non-athletes (de Moor et al., 2006). Additionally, longitudinal studies have shown that the sports activities enhance extroversion of the subjects. Therefore, it is suggested that the sports activities and personality are closely connected. However, there are few reports in which the relationships between the sports activities and the Big Five personality factors (extroversion, neuroticism, agreeableness, conscientiousness, and openness) are studied. The purpose of this study was to clarify these relationships. Methods The subjects were 732 college students (315 males, 417 females; mean age:  $19.4 \pm 1.4$  years). We asked them about their daily sports activities and examined their personalities by questionnaire based on the Big Five personality factors (Nettle, 2007). They were divided into three groups (athlete, semi-athlete and non-athlete groups). Then, Kruskal-Wallis test was used to examine the differences of the personality factors in those three groups. Results The Kruskal Wallis test showed significant differences in the neuroticism ( $z=18.38$ ,  $p<0.001$ ), the conscientiousness ( $z=9.85$ ,  $p<0.01$ ), and the openness scores ( $z=6.61$ ,  $p<0.05$ ) among the three groups. Additionally, the Steel-Dwass test for multiple comparisons showed significant differences between the non-athlete group and the athlete or the semi-athlete groups in those personality factors. Discussion From the above results, it was suggested that the sports activities were related to the parts of the Big Five personality. Former studies have shown that the athletes are more extroverted than that in the non-athletes. However, this study did not support them. References de Moor, M. H. M., Beem, A. L., Stubbe, J. H., Boomsma, D. I., and De Geus, E. J. C. (2006). Regular exercise, anxiety, depression and personality: A population-based study. *Preventive Medicine*, 42:273-279. Nettle D. (2007). *Personality: What makes you the way you are*: Oxford Univ. Press.

## THE HUNGARIAN ADAPTATION OF PERCEIVED MOTIVATIONAL CLIMATE IN SPORT QUESTIONNAIRE-2

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**Introduction** Sport scientific researchers are interested in the influencing factors of success in sport for a long time. The physiological, physiological, biomechanical etc. aspects of achievement are well known, however it does not give a complex view on all important factors. For participation in sport and for high achievement the personality of sportsmen seems to be also very important factor, that is why we think it is worth to measure and find out all the contexts in that field. The purpose of the present study was two-fold. Firstly, enlarge the Hungarian resources of Social Sciences in the domain of sport furthermore add a new questionnaire in Hungarian sport science research which can be able to compare international differences between athletes. Secondly, determine the validity and reliability of the Hungarian version of Perceived Motivational Climate in Sport Questionnaire (H-PMCSQ-2). Large number of literature can be found about the motivations and aims of athletes. The PMCSQ-2 questionnaire is widely used in sport, convenient to measure the motivational orientation, motivational climate (Task-Involving, Ego-Involving), and achievement goals. **Methodology** The adaptation of the questionnaire was achieved through a long process. First of all it was tested with a smaller sample (N=150) of athletes /Study 1/. Taking the conclusions of that measurement the questionnaire was corrected and tested with a bigger sample (N=917, mean age 16.32±1.21 years) as well /Study 2/. In Study 2. elementary and high school students were selected. 464 of the students (50,6 %) were actually pursuing sports, 352 of them (38,4 %) were previously pursuing sports and 101 students (11%) were never pursuing any sports. Analyzing the results we were looking for significant differences between the measured three (3) groups. **Results** Study 1. The Cronbach-alfa value of the whole questionnaire was 0,8, in the case of Task-involving scale 0,85 and Ego-involving scale 0,82. All cases showed strong correlation between higher-order scales and subscales, as well as between the items of subscales. Both the Task and Ego-involving subscales showed correlation with the higher-order scales. Study 2. ANOVA showed no significant differences based upon the type of sport. For gender analyses ANOVA was used, and significant differences were found. Analyses showed significant differences in the case of effort/improvement (Task) and punishment for mistakes (Ego) subscales. Further analyses showed significant differences in both Task- and Ego-involving subscales based upon team or individual sports. One subscale, the effort/improvement did not show differences in this case. **Conclusion** Based upon the statistical analyses made for proving the validity and reliability of the questionnaire, we can conclude that the Hungarian version can be widely used in Social Sciences for measuring motivational climate as well as Task- and Ego-orientation.

## SPECIALIZATION IN YOUTH BASKETBALL: THE ROLE OF SPECIFIC MOTIVATION

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**Introduction** The specialization years are seen as a decisive moment to lift the skill level, athletic readiness and commitment (Gonçalves et al., 2009). Selection and orientation of talent has been strongly dependent of biological and motor variables. The purpose of this study is to describe the achievement and motivation variables that can explain the belonging to an elite competitive level of young basketball players. **Methods** Eighty-two basketball players under 16 years fulfilled the WOFO (Spence & Helmreich, 1983), and an adapted version of the DPMQ (De Bruin, Rikers & Schmidt, 2007). Forty players were engaged in high performance centres and forty-two played in national level clubs. The WOFO assesses three dimensions of achievement: work, mastery and competitiveness. The DPMQ assesses two dimensions of deliberate practice: will to compete and will to excel. A random forest analysis between elite and national level players was performed (Breiman et al., 1984). **Results** The measurements rank Will to Excel, Winning, Mastery, Competitiveness, and Work in decreasing order of importance, consistent with the results of a single decision tree. In both types of analysis, the competition-related variables play the main role to discriminate the athletes by level. The task orientations, like Mastery or Work discriminate the players in a much lower percentage. **Discussion** The results confirm previous studies (Gonçalves et al., 2009) that did not find a significant effect of achievement variables (work, mastery) on specialization. These findings suggest that a self orientation to excellence may play a crucial role in persistence in practice in order to achieve higher standards in competition. The will to excel can be considered as a condition to engage in more specialized practice. The inclusion of measures of specific motivation in the specialization process for elite performers is useful and relevant. However, the studies with team sports are scarce and must be a topic in future researches. The assessment of the path to expertise only through motor variables or through the accumulated hours of deliberate practice is limited. The use of a more comprehensive model is needed. **References** Breiman, L., Friedman, J. H., Olshen, R. A. & Stone, C. J. (1984). Classification and Regression Trees (1st edition). Chapman and Hall/CRC. De Bruin, A., Rikers, R., & Schmidt, H. (2007). The influence of achievement motivation and chess-specific motivation on deliberate practice. *J Sport & Exercise Psychology*, 29, 561-583. Gonçalves, C.E., Figueiredo, A., & Coelho e Silva, M. (2009). Multidimensional analysis of dropout in youth basketball: 2-year follow-up among portuguese initiates. In Toivo Jurimae, Neil Armstrong, Jaak Jurimae (Eds). *Children an Exercise XXIV* (pp. 190-195). London, Routledge. Spence, J.T., & Helmreich, R.L. (1983). Achievement-related motives and behaviours. In J.T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 10-74), San Francisco, CA, W.H. Freeman and Company.

## PHYSICALLY ACTIVE TEENAGERS MORE PRONOUNCED EGO- AND TASK-ORIENTED THAN SEDENTARY PEERS

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**Introduction** Successes and failures can be explained by a variety of causes – attributions, which affect not only expectations of success or failure but also emotional reactions (Biddle et al, 2001). Performance goal can be either performance-oriented with focus on comparing themselves with others, or task-oriented where the focus is to improve in comparison with themselves. In some situations, you can be both ego-oriented and task-oriented, but most tend to be either ego-oriented or task-oriented (Weinberg & Gould, 2010). **Methods** A questionnaire including questions about ways of living, self-reported physical activity (PA), membership in sport clubs, attribution style, attitudes towards school physical education (PE) and to PA in general. The sample was 659 teenagers, 15-16 years old, in comprehensive schools in Sweden. Goal orientation was investigated by the TEOSQ form (Duda & Whitehead, 1998). The chi squared test and the Student's t-test were used in the statistical analyses. **Results** The teenagers who reported high levels of PA had higher scores in ego-orientation than their sedentary peers (20.5 vs 18.1; p=0.001) and in task-orientation (29.4 vs 26.8; p<0.000). Teenagers who were members in sport clubs had higher scores than non-members in ego- (19.0 vs 17.6; p=0.004) and in task-orientation (28.7 vs 25.0; p<0.000). Students with positive attitudes towards PE had higher scores in both ego- (19.3 vs 17.7; p<0.000) and in task-orientation (28.3 vs 26.2; p<0.000) than students with less positive attitudes. **Discussion** Students who were physically active in leisure time seemed to be more pronounced in both ego-and task-orientation than their more sedentary peers. Being ego-oriented, when combined with high task-

orientation, has been shown to be associated with high motivation (Wang & Biddle, 2001). Ego-orientations interact with perceptions of competence and task-orientation is connected with self-improvement and effort (Weinberg & Gould, 2010). The sedentary teenagers were more gathered "in the middle", not high in ego-, nor in task-orientation. Students with the combination low-task low-ego are difficult to motivate in the PE situation. Those students are not task-oriented enough to put any effort to do PA, and they are not ego-oriented enough to compete and to care about the self-perceived competence. References Biddle, SHJ, Hanrahan, SJ, & Sellars, CN. (2001). Attribution: Past, Present, and Future. In R. Singer, H. Hausenblas, & C. Janelle (Eds.). *Handbook of Sport Psychology*. (2nd ed., Pp. 447-471). New York: Wiley. Duda JL, Whitehead, J. (1998). Measurement of goal perspectives in the physical domain. In JL Duda (Ed) *Advances in sport and exercise psychology measurement*. Morgantown, WV: Fitness Information Technology. Wang, CKJ, Biddle, SJH. (2001). Young people's motivational profiles in physical activity: a cluster analysis. *Journal of Sport and Exercise Psychology*, 23, 1-22. Weinberg, RS, & Gould, D. (2010). *Foundations of Sport and Exercise Psychology* (5th ed). Champaign, IL: Human Kinetics.

## MOTIVATIONAL FACTORS AND SPORT PARTICIPATION IN EARLY ADOLESCENTS

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**Introduction** Several studies have shown that individuals invest their psychological energies in actions that promote a positive state of consciousness (Csikszentmihalyi & Csikszentmihalyi, 1988). Everyone searches, selects, and replicates all the activities that support the increase of good practices, during their life. According to cultural beliefs and daily commitments, the activities that produce positive emotions became good practises. This research aims to explore motivation and involvement in sport or physical activities of pre-adolescents in the district of Enna (Sicily, Italy) and to study the relationships between Physical Self and sport or physical activities. **Methods** The present study involved 190 students attending the 8th grade of middle school in the district of Enna. The instruments used were the following: - the Sport and School Questionnaire by Pignato & Nicolosi (2011, in press); - the Italian translation of Physical activity Motivation Questionnaire by Sirard & coll. (2006); - the Italian version of Physical Self-Description Questionnaire by Scarpa & coll. (2010). **Results** Our study identified motivational factors, such as competition, social, fitness, and skills, associated with sports program participation and attrition in middle school students. **Discussion** Since the 80's the study of motivation has affected the field of sport psychology. Some studies have shown the benefits of the practice of physical activity: it improves the perceived well-being and the degree of life satisfaction (O'Connor & coll., 2000; O'Neal & coll., 2000). Overall, our data suggest that the habits of the preadolescents involved in this study can be successfully classified into healthy and wrong habits finally providing a valuable tool to improve sport programming in the district area. **References** Csikszentmihalyi M. & Csikszentmihalyi I. (Eds.) (1988). *Optimal experience: Psychological studies of flow in consciousness*. Cambridge University Press, New York. O'Connor P.J., Raglin J.S., & Martinsen E.W. (2000) Physical activity, anxiety and anxiety disorders. *International Journal of Sport Psychology*, 31, 136-155. O'Neal A., Dunn A.L., & Martinsen E.W. (2000) Depression and exercise. *International Journal of Sport Psychology*, 31, 110-135. Scarpa S., Gobbi E., Paggiaro A., & Carraro A. (2010) Un contributo alla validazione italiana del Physical Self-Description Questionnaire. *Giornale Italiano di Psicologia dello Sport*, 8, 25-31. Sirard J.R., Pfeiffer K.A., & Russell R.P. (2006) Motivational factors associated with sport program participation in middle school students. *Journal of Adolescent Health*, 38, 696-703. Santiello M., Dallago L., & Mirandola M. (2003) L'attività fisica e il benessere tra i preadolescenti. *Psicologia della Salute*, 3, 121-133.

## INDIVIDUAL FEATURES IN EXTREME SPORTS

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**Introduction** Risk behaviors are defined as daring conduct that may endanger physical, psychological and social well-being in the short and long term. These behaviors include the practice of extreme sports, different disciplines that share research of the physical limits and risk taking. The scientific literature has highlighted as psychological determinants of extreme practice the personality trait sensation seeking (Boyd & Kim, 2007; Asci et al, 2007) and the emotions' regulation system (Gray, 1999). This study investigated risk perceptions, emotions' regulation and some personality traits in a sample of adolescents and young adults engaged in various extreme sports. **Methods** The total sample consists of 102 young people (71 males; 31 females) aged from 16 to 28 years ( $M=22.23$ ,  $SD=3.31$ ): 49 practicing extreme sports and 53 belonging to a control group. Participants completed following tests: Sensation Seeking Scale, Positive and Negative Affect Schedule, Behavioral Activation Scale/Behavioral Inhibition Scale (BAS/BAS), Physical Risk Assessment Inventory, Flow State Scale. To evaluate the differences between the groups we conducted a multivariate analysis of variance (MANOVA) using the group's membership and gender as independent variables, and the average scores of scales as dependent variables. **Results** The group of extreme sports has a greater orientation toward the BAS, with significantly higher values in all its subscales. It also reported the highest scores in positive affect, challenge balance skills and thrill and adventure seeking. There were also significant differences by gender: males have higher scores on clear goals, unambiguous feedback and thrill and adventure seeking; females showed a BIS score similar to BAS score and significantly greater than males. **Conclusions** Young people who practice extreme sports have a greater impulsivity (as evidenced by BAS scores), positive affects linked to dangerous experiences and a greater propensity for thrill and adventure. Women seem to represent a more healthy model to live the extreme sports adventure, since they show a greater balance between the behavioral activation systems (BAS/BAS). **References** Asci, F. H., Demirhan, G., Dinc, S.C., (2007). Psychological profile of Turkish rock climbers: An examination of climbing experience and route difficulty. *Perceptual and Motor Skills*, 104 (3, Pt 1), 892-900. Boyd, M.P., Kim, M., (2007). Goal Orientation and Sensation Seeking in Relation to Optimal Mood States Among Skateboarders. *Journal of Sport Behavior*, 30(1), 21-35. Gray, J.A. (1999). Cognition, emotion, conscious experience and the brain. In T. Dalgleish & M.J. Power (Eds.), *Handbook of cognition and emotion*. Chichester, England: John Wiley & Sons Ltd, 83-102.

## IS IT BETTER SELF-MOTIVATION OR COACHING ADVICE IN ORDER TO ACHIEVE A GOAL DURING THE SHOUTOUT PROCEDURE?

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**IS IT BETTER SELF-MOTIVATION OR COACHING ADVICE IN ORDER TO ACHIEVE A GOAL DURING THE SHOUTOUT PROCEDURE?** Papamargaritis Th., Zachoulou D. Department of Aquatic Sports, Faculty of Physical Education and Sport Science, University of Athens Greece **Introduction** An action that helps to shape the outcome in a water polo match is penalty. Actually it is a very difficult situation. Penalties are charged to the defending player when he is making a hard foul in the defensive zone of 5m, facing to the terminal. The execution of



penalty takes place in a distance about 5m from the terminal without the mediation of a defensive player except from the goalkeeper. The shoot happens after the referee's command. Case-Purpose The purpose of this study is to determine whether the shooter player, selects only the angle to shoot without being affected by an agent or if he chooses an angle after the coaching directive. The coaching directive always mentioned about the angle that a player has to shoot in order to achieve a goal. We will try to understand if self-motivation or the adherence to coach instructions is more effective, by counting the reaching rates goal on both cases. Method For the purpose of research, took part three of the top teams in the age division from 17 to 20 years in Greece. Each team was consisted of 15 athletes. After a stage of 20 minutes warm each player was asked to perform 10 penalty shoots. Coach, was back of the terminal observing goalkeeper's movements and position using a beam of light, he was directing the shooter player about the angle he has to shoot. Angle's suggestion was instantaneous before referee's whistle. Then we measured the percentage of the athlete's self-reactive and the percentage of those who followed the coach's direction. After all we count down the percentage of the successful penalties. Results According to final results we conclude that 24% of the total efforts of players are acting contrary to coach's suggestion. To be more specific, the percentage of goals that achieved, when athletes self-motivated was 58, 1% of the total. The remaining 76% indicated to the angle that coach chooses as the best choice in order to achieve a goal. About the 79, 8% of those attempts resulted in goals. Conclusions We are observing that the largest executions players follow the command even that is right or wrong. This shows that coaching direction even more in underage water polo player provides a form of security to the players. Between those two cases, coach's suggestion and self-motivation, the difference in rates that resulted in goals was 21, 7%. According to this difference we conclude that the shooters must follow coaching instructions because research's results showed that better results achieved on those ages.

## Poster presentations

### PP-SH09 Coaches, Officials and Supporters

#### POINTS OF VIEW: PROFESSIONAL PLAYERS' AND MANAGERS' PERCEPTIONS OF VENUE IN FOOTBALL

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Points of View: Professional Players' and Managers' Perceptions of Venue in Football Anderson, M.A, Wolfson, S. & Neave, N. (Northumbria University, UK) Introduction An abundance of studies are in existence exploring the home advantage phenomenon from a quantitative perspective, most of them highlighting factors such as crowd support, referee bias, familiarity, travel, rule factors and more recently a hormonal response as determinants of why teams perform better at home than they do away (See Courneya & Carron, 1992; Pollard & Pollard 2005 for review). However, despite this plethora of research little is known about the belief systems which operate from key personnel regarding the home advantage phenomenon. The aim of the study was to explore the beliefs of professional football managers and players in ascertaining their perceptions of why teams perform consistently better at home than away. Methods An opportunity sample consisting of three male professional football players and six male professional football managers participated in a semi-structured interview designed to ascertain their beliefs and perceptions of the home advantage. Results Thematic analysis arising from the interviews revealed support for previously identified factors comprising the home advantage including familiarity, travel, crowd and referee factors. There were also two newly identified higher order factors, experience and control which were deemed to impact upon these original factors. An extension of Pollard and Pollard's (2005) conceptualisation of the home advantage is also proposed. Discussion The present study provides an insight into the key beliefs held by football managers and players providing a unique insight into the home advantage phenomenon. The present study supports the findings of quantitative research in the area (travel, referee bias, familiarity, physiological response) whilst additionally uncovering some of the more prominent belief systems which underpin these well-known factors. The findings also provide suggestions for further research with a view to extending knowledge in the area. References Courneya, K. S. & Carron, A. V. (1992). The home advantage in sport competitions: a literature review. *Journal of Sport & Exercise Psychology*, 14, pp. 18-27. Pollard, R. & Pollard, G. (2005). Home advantage in soccer: a review of its existence and causes. *International Journal of Soccer and Science*, 3, 1, pp 28-44.

#### JOB STRESS AND BURNOUT IN ELITE SOCCER COACHES

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Introduction Elite coaches work in a constantly challenging environment. Strain and exhaustion associated with the coaching role has drawn interest, not the least because of the significant number of persons leaving the coaching ranks every year (Raedeke, 2004). The purpose of this study was to see whether job stress in a group of elite soccer coaches is related to differences in emotional exhaustion. Method The participants consisted of 47 elite soccer coaches from the two highest male leagues and the highest female league in Sweden. The coaches individually completed two instruments: Maslach Burnout Inventory Educators Survey (Maslach et al., 1996) as modified for coaches (Kelley, 1994), and the Job Stress Survey (JSS; Spielberger & Vagg, 1999). Three JSS-scales were used: JS-S measuring the perceived severity of 30 items on a 1-9-scale in relation to a reference item with a constant of 5. Secondly, JS-F measuring the frequency of occurrence of the 30 items during the last six months, from 0 to more than 9. Thirdly, JS-X, which is an overall index of perceived stress formed by multiplying the Severity-items with the matching Frequency-items. Results No difference between coaches with high versus moderate or low emotional exhaustion scores was found for the Severity-scale. However, for the Frequency-scale, there was a significantly ( $P = .03$ ) greater mean score observed for the group with high EE ( $M = 3.9$ ,  $SD = 1.6$ ) than for the group with low or moderate EE ( $M = 2.7$ ,  $SD = 1.5$ ). For the JS-X scale, a significant difference ( $P = .04$ ) was also found; the group with high EE displayed a higher overall perceived stress ( $M = 20.0$ ,  $SD = 9.8$ ) than the group with moderate or low EE ( $M = 13.2$ ,  $SD = 8.0$ ). Discussion Our findings indicate that the group of coaches scoring high on emotional exhaustion did not perceive the job stress demands (JS-S) as more stressful than the group with moderate or low scores on EE. However, the significant differences in both the frequency (JS-F) and the index (JS-X) scales show that the groups differ in areas linked to the actual work situation. The group scoring high on EE perceive that they have to deal with stressors linked to job stress to a higher degree than the moderate or low scoring EE-group. The former are either overexposed to these kinds of job stress demands, or they have lower thresholds for how they perceive the stress as measured by the JSS-items. References Kelley, B. (1994). *Research Quarterly for Exercise and Sport*, 65, 48-58. Maslach, C., Jackson, S. & Leiter, M. (1996). *Consulting Psycholo-*

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### **IS COACHING EVALUATION ASSOCIATED WITH COLLECTIVE EFFICACY ON UNIVERSITY BASEBALL ATHLETES? - DEVELOPMENT OF COACHING EVALUATION SCALE AND COLLECTIVE EFFICACY SCALE FOR BASEBALL ATHLETES-**

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Introduction Baseball is the one of the most popular sports in school club activities from elementary to college level in Japan. Prior studies reported that baseball coaching in Japanese schools includes not only instruction of baseball skills and strategies but also social norms, ethics and human relationships. The purpose of this study was to develop Coaching Evaluation Scale for Baseball Manager and Coach (CESBMC) and Collective Efficacy Scale for Baseball Athletic Teams (CESBAT) and to examine the relationship between factors of CESBMC and CESBAT. Methods The subjects of 89 baseball athletes (mean age=19.08, SD=0.83, mean baseball experience=11.33, SD=1.96) in official university baseball team were asked to answer a questionnaire that was composed of socio-demographic questions, 48 coaching evaluation question items developed from our preliminary survey in 2009 and collective efficacy question items edited from Collective Efficacy Scale for Soccer Teams by Kuniyoshi and Shimizu (2009). Exploratory factor analyses and reliability analyses were conducted to develop CESBMC and CESBAT. In order to examine the relationships between CESBMC and CESBAT, multiple regression analyses were conducted. Results The results of exploratory factor analyses identified that CESBMC has 8-factor model with 40 items: "Coaching Policy," "Coaching Attitude," "Skill Instruction," "Original Personality," "Team Leadership," "Team Observation," "Communication Skill," "Counseling Abilities," and CESBAT has 7-factor model with 35 items: "Efficacy for Practice," "Efficacy for Performance," "Efficacy for Social Support," "Efficacy for Goal Achievement," "Efficacy for Cooperation," "Efficacy for Emotional Expression," "Efficacy for Loyalty." Reliability analyses confirmed that each scale had satisfactory Cronbach's alpha coefficient reliabilities from 0.877 to 0.952. The results of multiple regression analyses showed that the sub-scales of CESBMC were significantly positively associated with the sub-scales of CESBAT. Discussion Each of the factors of CESBMC and CESBAT showed statistically satisfied Cronbach's alpha reliabilities. The results of multiple regression analyses indicated that the subjects with higher CESBMC scores were likely to have higher CESBAT scores. Future research using larger sample sizes and longitudinal design is needed to examine effective psychological coaching intervention methods for baseball managers and coaches. References Daijiri Kuniyoshi, Yasuo Shimizu (2009) Development of Coaching Evaluation Scale and Collective Efficacy Scale for Soccer Athletes. *Kyusyu Journal of Sport Psychology*. 21:38-39.

### **THE INFLUENCE OF CROWD NOISE ON JUDGING SPORT**

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THE INFLUENCE OF CROWD NOISE ON JUDGING SPORT Myers, TD 1, Balmer, NJ 2 1: NUC (Birmingham, UK), 2: UCL (London) Introduction Home advantage has been established in a number of sports. Research has found home advantage to be particularly prominent in subjectively judged sports (Balmer, Nevill & Williams, 2001). One plausible agent postulated for the effect on subjective decisions, is crowd noise (e.g. Unkelbach & Memmert, 2010). Crowd noise might influence officials via a number of mechanisms including normative and informational conformity. A major limitation of studies conducted in this area is the use of recorded rather than live crowd noise. In the absence of participants' expectations of a vocal crowd's real response, the possibility of considering normative conformity is reduced considerably. As such, the aim of this study was to examine the influence of the noise from a real crowd on home advantage in judging Muay Thai bouts. Method 17 qualified Muay Thai judges participated, judging 30 Muay Thai bouts in one of two conditions: a crowd noise condition and in no crowd noise condition. The crowd noise condition involved judges experiencing the natural crowd noise, and the no noise condition involved judges wearing noise cancelling headphones and listening to a track of white noise. Each bout was judged by four participants; two in each condition. Multilevel modelling was used to analyse the data using MLwiN. The difference between home and away scores over five rounds was modelled as a normal response variable. This type of data structure can be described as cross-classified and modelled using Markov Chain Monte Carlo methods within MLwiN. Results Crowd noise had a significant impact on judging ( $\chi^2 = 5.17$ ,  $p = 0.023$ ). Using points in favour of the home side as an outcome measure, results showed that exposing judges to crowd noise resulted in a difference of 0.53 points in favour of the home competitor. Discussion The results suggest that crowd noise can result in judges awarding inflated scores to contestants receiving the greater crowd support. The results support previous findings in this area (Nevill, et al., 2002; Unkelbach & Memmert, 2010) but in a more ecologically valid setting. The findings suggest judges may have conformed to the views of the majority, who vocally supported the home favourite. However, the white noise used in the no crowd noise condition may have been a confounding factor. Although the results can be explained by social conformity factors, it is possible that they could have been the result of other factors (visual perceptual errors; the incorrect application of a noise heuristic and or cue salience). It is possible that a combination of all these factors may be responsible for the results found. References Balmer NJ, Nevill AM, Williams A. (2001). *J Sports Sci*, 19, 120-139 Nevill AM, Balmer NJ, Williams M. (2002). *Psychol Sport Exerc*, 3, 261-272 Unkelbach C, Memmert D.(2010). *J. Sport Exerc. Psychol.* 32, 4, 483-498

### **MOTIVES FOR BEING A REFEREE IN FOOTBALL**

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MOTIVES FOR BEING A REFEREE IN FOOTBALL (SOCCER) Johansen, B.T., Bjørnstad, J.O. University of Agder, Norway Introduction The study of motivational issues among referees and officials in sport is limited, but nonetheless important in order to provide information about what factors stimulate for becoming and for being a referee in football (Helsen & Bultynck, 2009). One may ask: "Who's the man in black?" And, for what reasons do they choose to be a referee in football? The aim of this study is to investigate different motives for being a referee or refereeing among Norwegian qualified football referees. Methods 44 part-time referees from Agder region in southern part of Norway participated. Totally it was 3 female referees and 41 males mean age of 38.3 (SD = 13). The referees were in a questionnaire asked to report randomly three main reasons or motives for why they become a referee. The data were analyzed using a well specified phenomenological procedure for qualitative research (Marton, 1995). Results were obtained by bracketing, intuiting, and describing the different motives or reasons for being a referee reported and organized into categories of description. The different categories of description that emerged were studied and regrouped by two colleagues. Results 107 (81 %) of a total of 132 different motives or reasons for

being a referee reported were bracket and grouped, and three main categories emerged; fitness motives, 31 % (e.g., physical activity, being in good shape, body appearance), passion motives, 25 % (e.g., simply love football, enjoyment, excitement), social motives, 25 % (e.g., meeting with people, staying in football, competition situation, member of the team). Among the 25 remaining statements (19 %) there were only seven economic related motives reported, seven motives were related to leadership, and seven motives were related to decision making. Discussion The findings reveal that Norwegian part-time referees have a solid practical and educational background, and based on the motives reported, and their modest income from officiating, the money seems not to be an important motivational factor. Moreover, one may claim that Norwegian part-time referees in some extend are motivated by just being part of the football family and playing a vital part of the game, and based on research in this field, there is little or no reason for suggesting that this is not the case for football referees in other parts of the world. One could say that Norwegian part-time referees officiating involvement is more or less pure enthusiastic and it seems that the referees are motivated through satisfaction through physical activity, being a part of the football family, and they love doing it! References Helsen W, Bultynck JB. (2009). *J Sports Sci*, 22, 179-189. Marton F. (1995). *Nord Ped*, 15, 165-180.

## DEALING WITH PAIN: THE COACH'S SUBJECTIVE SENSE OF THE ATHLETE'S PAIN IN HIGH PERFORMANCE TRAINING

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Introduction In our researches into subjectivity and sport, particularly on Iron Man athletes, pain has been shown as part of daily training and competition. This has been a subjective sense indicator in the relationship coach/athlete that is connected to multiple symbolic and emotional processes that characterizes that social environment. Although Iron Man demands high levels of intense physical exertion, pain can be related to psychological issues, with repercussions for the athletes and coach communication and therefore for the sport performance. This study aims to analyze the coach's subjective sense about the athlete's pain. Method The study emphasizes the constructive-interpretative and dialogical character of the knowledge (González Rey's, 2005). Participants: a 15 years old female triathlon athlete, two Iron Man athletes -48 and 36 years old-, and a 39 years old female coach. For the accomplishment of this study the instruments used were: conversational dynamics, term used to emphasize the procedural and open character of the relationships with the participant; complement of sentences, which allowed acquiring information about the production of sense of the individual; and a field diary. Results The analysis of the subjective sense indicators supported by instruments, took us to the construction of the following subjective senses nuclei: i) the influence of the former athlete's subjectivity on hers athlete's subjective sense; ii) the influence of the pain in the production on the athlete and coach's subjective sense. Discussion The meaning of pain for the athlete and for the coach is not the same for each of them. The individual subjective sense of the athletes pain is not related to it, but to how the coach interpretes it. Athletes compare their pain, triggering an unconscious process of competition between them, disputing for the coach's attention and her bond. By touching with care the bruises, the coach conveys her support or not and her feelings related to it. It is important to mention that she is aware of the group's dispute for her attention, and she interpretes this dispute as a recognition of her technical competence. She also does not establish a dialog with the athletes as a group she only does it individually not building a sympathetic feeling among the athletes as a group. The coach and team's subjective configuration is developed on production of the symbolic processes based in competition. The competition between all athletes on individual's subjective sense only decreases when one of the members' achievements stands out in a way that others recognize this result as worthy of special attention of the coach, although they may also experience feelings of jealousy. References González Rey, F. (2005). *Subjetividade, Complexidade e Pesquisa em Psicologia*. São Paulo: Thomson.

## THE BRAZILIAN MEN'S ARTISTIC GYMNASTICS JUDGES' EDUCATION DURING THE 2005-2008 OLYMPIC CYCLE

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Introduction Although there are rules which brought reliability and objectivity to AG scoring system, the performance of an athlete is evaluated according to the judge's individual perception (STE-MARIE, 1996). In order to minimize the inherent subjectivity in the AG evaluation, the judges need a proper education program along with a constant updating and experience in competitions (BORRMANN, 1980). This abstract aims to discuss the Brazilian men's artistic gymnastic judges' education during the 2005-2008 Olympic Cycle. Methods We conducted semi-structured interviews with nine AG experts who work directly with the high level of Brazilian MAG. For data treatment we used the Content Analysis (BARDIN, 2008). Results In recent years, with better organization of AG in Brazil, we notice an expressive improvement in the quality of the judges, especially among those with the national and international brevets. The experts said that the better format of the regional and national courses and the implementation of a more rigorous assessment to obtain the brevets helped to improve the Brazilian judges qualification. However, this qualitative improvement was not reflected quantitatively in the country. There was a lack of judges with national brevet during the 2005-2008 Olympic cycle due the realization of only one national course. The study also found out that many states didn't organize regional courses which contribute, significantly, to the development problems of MAG in Brazil. The experts also reported that the scarcity of incentive and the insignificant financial support contributed to the lower number of judges in MAG. Conclusion There was a qualitative improvement in Brazilian MAG judges' education but, unfortunately, this not reflected quantitatively due to the few number of courses realized in the national and regional levels. The lack of recognition and support to the judges' carrier are the main aspects that contribute to the reduced number of judges in action in Brazil. We would like to emphasize the importance of the judge education because before acting as a judge, he is an educator who through his actions provides directions to the coaches and athletes supporting the development of AG. References BARDIN, L. (2008) *Análise de conteúdo*. 19ª ed. Lisboa: Edições 70. BORRMANN, G.(1980) *Ginástica de aparelhos*. Lisboa: Estampa. STE-MARIE, D. M. (1996) International bias in gymnastics judging: conscious or unconscious influences? *Perceptual and Motor Skills*, 83:3, 963-975.

## COMPETENCES OF FLEMISH BASKETBALL COACHES

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Introduction The European Qualification Framework (EQF) is the basis for many countries of the world to set up a National Framework. It consists of competences of all jobs, classified in numbered levels (OECD, 2005). This study aims to determine the competences of basketball coaches and create a framework in which the coaches work, to improve the quality of coaches and coaching programs. Once the educational programs comply completely with the EQF norms, coaches can be recognized internationally (Scatoli, 2009). Method The Delphi Method was used to personally interview Flemish qualified basketball experts (in different rounds) to ensure that all coaching

views/opinions were enclosed and that the results are borne by everyone. After two personal contacts, the experts had a meeting to discuss the specific core tasks with their associated knowledge, skills and attitudes and try to reach a consensus (Dalkey, 1969). Then, in the final round, the competences were composed (using COMET, 2003) and confirmed by all experts. Results A strict framework was built, combining the coach levels versus the target the coach is trained for. The basketball coach EQF 5 and 6 has five main tasks, including following refresher courses and self-assessment, training, recruit and coordinate, coaching and supporting/guiding. There were seven competences formed, namely: to communicate, to give feedback, to provide individual coaching, to act as a responsible teacher and pedagogical practitioner, to plan, to work in a team and to act with a purposeful vision. Due to the fact that coaches work in level-dependent contexts, the contents of the competences differ. The experts decided unanimously that a higher level (EQF 7) should be established, based on the existing FIBA concept. Discussion and conclusion The results have been synthesised into competency cards for basketball coaches 5 and 6 and refer to the EQF. To be able to make international comparisons it is necessary that other countries incorporate their teaching/coaching programs into the EQF. References Comet, the competency modelling toolkit, Open Universiteit Nederland, Onderwijstechnologisch Expertisecentrum, 2003, [http://www.open.uu.nl/ast/comet\\_eindversie/index.htm](http://www.open.uu.nl/ast/comet_eindversie/index.htm). Dalkey, N.C. (1969). The Delphi Method: an experimental study of group opinion. Prepared for US Air Force Project Rand. The Rand Corporation, Santa Monica, California.79 p. OESO (OECD), The definition and selection of key competencies, 27th of may 2005, <http://www.oecd.org/edu/statistics/deseco>. Scatoli, C., The European qualifications framework for lifelong learning, presentation on the international seminar: National Qualifications Frameworks in an international perspective, Brussels (November 2009).

## REPRESENTATION OF COMPETENCE IN COACHES: A STUDY WITH ELITE COACHES OF FOOTBALL AND GYMNASTICS.

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Introduction Despite multiple efforts for clarification around the concept of competence, several areas of contamination still persist, resulting not only in an indiscriminate use of the word competence in common sense, but also in the not so cautious, or even arbitrary use, which is made on the scientific discourse (Parente, 2003; Weinert, 1999). According to Sandberg (2000), to describe competence requires not just their attributes but as a starting point of the workers conceptions. Through this study we tried to capture the coaches' understanding of competence according to the sport they coach (football and gymnastics). Methods Eight elite coaches were interviewed (4 from football and 4 from Gymnastics). The procedures of content analysis were used to data analyze with the support of Nvivo7. The generality of the categories were defined a priori based on the professional competence model (Cheetham & Chivers, 1998) and some of them were defined a posteriori. Results In general the results show that the nuclear component of competence most valued by the coaches were the knowledge/cognitive and the least the values/ethical. The functional component and the personal/behavioural were found in the middle. In relation to the competence representation of the football coaches the categories more valued were the knowledge/cognitive and the personal/behavioural competence. Whereas, for the gymnastics coaches the others factors (e.g. personality, heteroperception of competence, results and context) were the most relevant components in their representation of competence. Discussion The notions coaches held of competence are different in relation to the kind of sport, nevertheless the two groups give more importance to the knowledge component of competence. Therefore, in the study of competence it is fundamental include the actors voice, because the context are distinguished and the needs are also different. Like Sandberg (2000) say there is an intimate relationship between the work, the worker and the context. References Cheetham, G., & Chivers, G. (1998). The reflective (and competent) practitioner: a model of professional competence which seeks to harmonise the reflective practitioner and competence-based approaches. *Journal of European Industrial Training*, 22(7), 267-276. Parente, C. (2003). *Construção social das competências profissionais: dois estudos de caso em empresas multinacionais do sector metalomecânico*. Porto: Cristina Parente. Dissertação de Doutoramento apresentada à Faculdade de Letras da Universidade do Porto. Sandberg, J. (2000). Understanding Human Competence at Work: an Interpretative Approach. *Academy of Management Journal*, 43(1), 9-25. Weinert, F. E. (1999). Definition and Selection of Competencies. Concepts of Competence. Munich: Max Planck Institute for Psychological Research

## ROLE AND IMPORTANCE OF FOOTBALL REFEREES IN WRITTEN AND VISUAL MEDIA

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Role and Importance of Football Referees in Written and Visual Media Cuhacıoğlu, A.E., Gündüz ,N., Abstract Introduction The professions like football, which draw interest worldwide as well as Turkey, have widespread media coverage and are influenced by media. Therefore, it is indispensable that written and visual media influences football referees. Hence, the appropriate use of media for the improvement of football and its resulting positive effects on football are of great importance. This survey study aimed to detect the role and importance of football referees in the written and visual media. Methods Qualitative techniques were used in data collection process. Study sampling was composed of 100 media employees. Study questionnaire was administered to visual media employees during the visits paid to the national 11 television channels and to written media employees during the visits paid to Turkish Sports Writers' Association and to the 6 national newspapers. Among the study sampling, 12 participants voluntarily answered the interview questions. Questionnaire items were developed on the basis of the studies and resources on this issue as well as expert opinions. Validity and reliability of the questionnaire was tested on 20 participants and, Alpha reliability coefficient of the questionnaire was calculated to be .87. Study questionnaire is composed of 3 parts. First part includes items on personal information of the participants; the second part includes a 12-item Likert-type questionnaire about the role and importance of referees in the written and visual media; and the third part presents 7 interview questions. Arithmetic means and percentage and frequency distribution of the study data were calculated by using SPSS package programme. Moreover, the study data were subjected to t-test and variance analysis. Results According to study results, news on football referees is closely monitored by the written and visual media employees. These people think that football referees have a good media image and that referees are paid required attention by the media. In addition, written and visual media employees believe that criticisms and performance evaluations targeted at referees should be more tolerant. Discussion Although it is stated that those working in written and visual media should not be influenced by the news regarding referees published/broadcasted following an event (Goral, 2003), it was found that there exists a group being influenced by the news published. The research results showed that it is not required to be a former referee or football player in order to be a football critic but rather media should follow ethical principles (Uzun, 2004). References 1- Goral,M., (2003),Spor Basın Ahlakı, Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, Sayı:8, s:1-2 2- Uzun, R., (2004), "Türkiye de Spor Basınının Etik Anlayışı" Gazi Üniversitesi İletişim Kuram ve Araştırma Dergisi, Sayı:19, s: 17-19

## WORKING WITH BRAZILIANS: SUPPORTING A FOOTBALL TEAM FROM CONCEPTS DERIVED FROM A COMPLEX-CONSTRUCTIVIST PARADIGM

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Buchanan, N.I, Ollis, S.I 1: University of the West of Scotland (Hamilton, Scotland) Introduction: There is considerable desire to understand how we develop, instruct and generate peak performance in various sporting domains. This work reports on a complex-constructivist paradigm of applied multi-disciplinary support – to organisation, team and individuals. The model had already been adopted on the creation of a suitable talent development environment and peak performance capability with the Scottish small-bore shooting team (Ollis & Sproule, 2007). However, could it be replicated in an alternative sporting domain? The aim of this report was to analyse the benefits of a complex constructivist notion of expertise in the support of a football team....not merely Brazilians, but the more infamous Blue Brazil. Methods: The report looks at the complex-constructivist worldview of applied support through a case study which shifted from applied to action research to ethnographic design over a prolonged period of three years. The final phase of the work, within which the work resides as research, focuses on an ethnography of how the club, coaching staff and players functioned. Results: Like the previous research study on small-bore shooting, the findings suggested the ability to adapt and regulate to a challenging, complex and real-world event such as playing football professionally is dynamic, iterative and multi-faceted. Thus, the focus on enhancing adaptive capability across the full 'complex-ecological' model of what is a football club, and its synergetic properties were recorded. The ability to evolve the club, develop talent, coach and peak perform were identified as a trans-disciplinary model which accepted the running of a football club and real world coaching as messy, uncertain and paradoxical. Those who were offering applied support and the primary researcher were fortunate enough to partake in a football club which had a 'dream' three seasons and performing beyond itself. Discussion: The applied report and subsequent ethnography suggest that there is scope to understand the development of talent, the development of a team, and the development of a club from more non-linear and complexity science based design of learning, coaching and development. The work suggests that the trans-disciplinary nature of the sporting institution may serve for the ability to peak perform more than the addition of contributions alone. Thus talent development, sports management, coaching and the peak performance may be served better through more systemic and trans-disciplinary concepts and tools. The model served as the platform for the primary authors PhD investigating the principle of 'deliberate experience'. References: Ollis S, Sproule J. (2007). Constructivist coaching and expertise development as action research. *International Journal of Sport Science and Coaching*, 2(1), 1-14.

## HEURISTIC REASONING AND SPORT OBSERVERS: ON THE INFLUENCE OF EXAMPLE-AVAILABILITY ON AD-HOC FREQUENCY JUDGMENTS

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Introduction A corpus of social cognitive research has documented that when performing everyday reasoning tasks 'on-the-fly', individuals rarely (if ever) attempt a comprehensive examination of all relevant resources from social memory. Instead, metacognitive strategies – judgemental heuristics – are employed to expedite these tasks. The most robustly demonstrated 'heuristic' is the availability heuristic (Tversky and Kahneman 1973; 1974). This heuristic, describes the manner in which estimations of frequency or probability tend to be induced from the information most cognitively salient to an individual, i.e. task-relevant examples that can be easily recalled have a disproportionately high frequency/probability estimation. Incorporating 'fame availability' (Mekelvie 1997) the empirical focus of the study was on the 'snap judgements' made by observers of sport images. Methods Subjects (n=141) were shown a variety (50) of images of football, tennis, golf, netball, running athletes in action from the public domain. Images were grouped and divided into celebrity (high profile professional athletes in football, tennis, golf) and non-celebrity (low profile recreation athletes participating in netball and running). In a time-pressured environment, participants estimated the frequency of images observed for each sport. The scores of the five sports, consisting the two groups were averaged to provide a single participant value for celebrity and non-celebrity sports. Results Normality of data was checked using Kolmogorov-Smirnoff and subsequently confirmed. A paired t-test was used to examine for difference between the two groups. Frequency scores for celebrity sports ( $12.0 \pm 3.3$  times) were significantly more ( $t(136) = 7.394$ ,  $P = 0.001$ ) than non-celebrity sports ( $9.9 \pm 3.3$  times). Discussion Results of this initial study indicated the influence of the availability heuristic on the frequency estimations of the sport spectators. Heuristics are an adaptive tool (Gigerenzer, 2006) which have the potential to produce effective on-the-spot judgements. However these results suggests that significant distortions of frequency may arise through the influence of heuristics at this peripheral site of sport involvement. Given the contextual ambiguity influencing those centrally involved in sport (coaching, refereeing, scouting) and the importance of decision-making under time constraints, further research on the influence of heuristics in the decision making of practitioners is recommended. References McKelvie, S. (1997), The Availability Heuristic: Effects of Fame and Gender on the Estimated Frequency of Male and Female Names. *The Journal of Social Psychology*, 137, 63-78 Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5, 207-232. Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185, 1124-1131. Gigerenzer, G. (2006). Bounded and rational. In R. J. Stainton (Ed.), *Contemporary debates in cognitive science* (pp. 115-133). Oxford: Blackwell.

## Poster presentations

### PP-SH10 Sports Psychology 1

## AN ETHNOGRAPHIC STUDY OF PSYCHOSOCIAL DYNAMICS IN ELITE SPORT

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UWE HARTUPURY

Elite sport is firmly established as a business enterprise with personnel now operating within sport organisations that are similar in structure to commerce organisations. This evolution of the sports industry has imposed numerous demands on the key stakeholders responsible for performance and as such the requirement for effective organisational processes is imperative for developing both team and individual flourishing. Research emanating from the management literature would suggest that many key determinants for success stem from environmental dynamics and how effectively organisations operate. Conversely, sport psychology and organisational psychol-

ogy literature indicates that ineffective sport organisations compromise athletic performance. However, despite these lines of inquiry, progress has been slow in attempting to establish the specific dynamics that determine organisational effectiveness within sport, particularly from the psychosocial perspective. Therefore, the purpose of this study was to identify psychosocial dynamics of effectiveness within an elite rugby union team, playing in the English Premier League. Following procedures used by Faulkner and Sparkes (1999), ethnographic methods were employed to establish the common themes that impact on effectiveness. Findings indicated psychosocial dimensions of effectiveness associated with: communication and relationships, atmosphere and culture (open environment conducive to relationship building); socio-emotional skills (emotional and social intelligence); social norms and behaviour expectations; and goal orientation (shared vision of being achievement-orientated). Results suggest that interpersonal dynamics contribute to organisational flourishing in such a way that has the potential to impact on both team and individual performance. As such, practitioners must be aware that personnel, the internal processes that they share in, and their socio-emotional skills are imperative to developing and sustaining environments where high performance can be achieved. This investigation has highlighted the importance of understanding how sports organisations are able to flourish, paving the way for further enquiry. Faulkner, G. & Sparkes, A. (1999). Exercise as therapy for schizophrenia: An ethnographic study. *Journal of Sport and Exercise Psychology*, 21, 52-69.

### COGNITIVE APPRAISAL JUDGMENTS AS DETERMINANTS OF THE PRECOMPETITIVE EMOTIONAL RESPONSE

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COGNITIVE APPRAISAL JUDGMENTS AS DETERMINANTS OF THE PRECOMPETITIVE EMOTIONAL RESPONSE Wolf, S.1,2, Eys, M.2, Kleinert, J.1 1:GSU (Cologne, Germany), 2:WLU (Waterloo, Canada) Introduction One critical aspect of successful sports performance is the athlete's precompetitive emotional state (Prapavessis and Grove, 1991). According to cognitive-motivational-relational theory (Izard, 2010), each discrete emotion is elicited by a unique pattern of cognitive appraisal. However, with respect to precompetitive emotions, the specific appraisals that distinguish each emotional state have yet to be established. Hence, the aim of the present study was to uncover differences in cognitive appraisal between athletes experiencing anxiety compared to those experiencing positive anticipation prior to a competition. Methods A sample of 353 Canadian university and college athletes (46% female, M=20.28 yrs.) from the sports of basketball, ice hockey, and volleyball completed the Directional Modification (DM; Jones and Swain, 1992) of the Competitive State Anxiety Inventory-2 (Martens et al., 1990) approximately 80 minutes prior to a regular in-season game. Athletes with somatic/cognitive DM values  $\leq M-1SD$  were defined as anxious, whereas athletes with values  $\geq M+1SD$  were defined as experiencing anticipation. Precompetitive appraisal was assessed by 7 items targeting goal-relevance, goal-congruency, blame/credit, coping potential, and future expectations. Results Two MANOVA revealed differences between anxious athletes as compared to those experiencing anticipation regarding their overall cognitive appraisal: somatic,  $F(7,89)=3.06$ ,  $p=.006$ ,  $\eta^2=.19$ ; cognitive,  $F(7,87)=1.80$ ,  $p=.097$ ,  $\eta^2=.13$ . For somatic symptoms, anxious athletes associated the upcoming competition with significantly less desirability ( $\eta^2=.09$ ), responsibility ( $\eta^2=.05$ ), coping resources ( $\eta^2=.08$ ), and success-expectations ( $\eta^2=.07$ ). For cognitive symptoms, anxious athletes reported significantly less desirability ( $\eta^2=.05$ ), control ( $\eta^2=.05$ ), and success-expectations ( $\eta^2=.06$ ). We found no differences regarding goal-relevance. Discussion Consistent with theoretical assumptions and previous findings (Uphill and Jones, 2007), cognitive appraisal emerged as an important factor discriminating between the similar yet distinct precompetitive emotional states of anxiety and anticipation. Specifically, perceptions of the situation's general favorability and estimated options/prospects of coping appeared to play an important role and provide potential targets for applied interventions. Further investigations are needed, however, to generalize these findings to other types of sports or performance levels. References Prapavessis, H, Grove JR (1991). *Sport Psychol*, 5, 223-234. Izard CE (2010). *Emot Rev*, 2, 363-370. Jones G, Swain A (1992). *Percept Motor Skill*, 74, 467-472. Uphill MA, Jones MV (2007). *Res Q Exercise Sport*, 78, 79-89. Martens R, Vealey RS, Burton, D (1990). *Competitive Anxiety in Sport*, 117-173. Human Kinetics, Champaign IL.

### AFFECT AND PERFORMANCE IN A BADMINTON TOURNAMENT: AN ANALYSIS OF CHANGES WITHIN AND BETWEEN MATCHES.

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UNIVERSITY OF WORCESTER

Introduction Positive affect has been shown to be related to performance in climbing (Sanchez et al., 2010) and wrestling (Treasure et al., 1996) however both studies utilise only pre-performance affect. Affect fluctuated within a golf tournament (Gaudreau et al., 2002) although retrospective methods of assessing affect during the tournament were used. The aim of the current research was to utilise within activity methods to analyse affect and performance both between and within matches during a badminton tournament. Methods Sixteen male and female county badminton players aged  $25 \pm 7.44$  yrs participated in a competitive mixed doubles round robin tournament comprising 2 groups of 4. Each pair played in 3 group matches and 1 further match to determine their final ranking within the 8 pairs. Players completed the PANAS (Watson et al., 1988) to measure positive affect (PA) and negative affect (NA) 5 minutes before and after each match. Between match games players rated their PA and NA on the Worcester Affect Scale ranging from 1 'not at all' to 10 'very much' (Rhoden & West, in press). Games and match scores were recorded throughout. Results Fluctuations in PA and NA were observed throughout the tournament. Players within the top 4 final ranked pairs maintained moderate to high levels of PA across matches (range 6 to 9). Positive affect for players within the bottom 4 final ranked pairs decreased significantly from the beginning to the end of the tournament (Pre match 1 PA median=28; post match 4 PA median=14;  $z=-2.39$ ,  $p=0.017$ ). Despite similar levels of PA and NA pre-tournament, final PA scores were significantly different between the top 4 (PA median=30) and bottom 4 ranked pairs (PA median=14;  $z=-2.83$ ,  $p=0.005$ ). Discussion A unique feature of this research was the within match assessment of affect and performance. PA and NA fluctuated over the course of the badminton tournament thus extending the findings of Sanchez et al. (2010) and Gaudreau et al. (2002) and stresses the importance of affect-performance research. More successful players; ranked higher in the tournament overall, exhibited higher levels of PA characterised by feelings of confidence, determination and alertness (Watson, 2000) which corresponded to better mixed doubles performance and are discussed within the context of goal expectation and achievement. References Gaudreau, P., Blondin, J.P. Lapierre, A.M. (2002). *Psych of Sp and Ex*, 3(2), 125-150 Rhoden, C.L. & West, J. (in press) *Sport Science Review* Sanchez, X., Boscher, M.S.J., Llewellyn, D.J. (2010). *Scandinavian J of Med & Sci in Sport*, 20, 356-363 Treasure, D.C., Monson, J. & Lox, C.L. (1996). *The Sp Psychologist*, 10, 73-83 Watson, D. (2000). *Mood and Temperament*, New York: The Guilford Press. Watson, D., Clark, L.A. & Tellegen, A. (1988). *J of Personality and Social Psychology*, 54, 1063-1070.

## COMPRASSION OF COMMUNICATION SKILLS LEVEL OF TEAM AND INDIVIDUAL SPORTS ELITE ATHLETES

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COMPRASSION OF COMMUNICATION SKILLS LEVEL OF TEAM AND INDIVIDUAL SPORTS ELITE ATHLETES Ozdemir Sahin, F. N.1, Gezer E.D.1, Aslan C.S.1 1: Ankara University PES (Ankara, Turkey) Introduction Communication can be defined as transactional process that involves an exchange of ideas, information, feeling, attitudes beliefs and impression (Sen, 2008). Good and effective communication leads personal effectiveness, help to network with other people, create better interpersonal relations, and increase listening abilities and influence motivation to enhanced performance. Communications skills (CS) are one of the important components of sports for success especially in team sports. Therefore the purpose of this study is to compare CS of individual athletes (IA) and team sport players (TSP). Methods 131 elite athletes (80 TSP, 51 IA ) participate in this study as voluntary. Communication Skills Evaluation Scale (CSES) and its validity (.86) and reliability (.78) was established by Korkut in 1996 was used in this study. This scale consists of 25 item and 5 point Likert scale. Obtained data were analyzed by SPSS (ver. 16). Mann-Whitney U was used to compare groups and  $\alpha$  was set as 0,05. Results Mean age of IA is  $21,16 \pm 6,55$  and TSP is  $26,96 \pm 3,74$  years. CS score of team sports group indicated that  $101.58 \pm 9.08$  and individual athletes group was  $98,82 \pm 11,90$ . There is no statistically significant differences between TSP and IA ( $p=0,198$ ;  $p>0,05$ ). Discussion In this study, each group scored high in CSES. Although many studies indicated differences between athletes and non-athletes CS, there are limited studies about differences between athletes themselves. Tepekoylu et al (2009) and Yilmaz & Cimen (2008) found there were no significant differences between athletes at the point of CS. When evaluating athletes in themselves in this study also there is no significant difference between TSP and IA's communication skills. In conclusion; when being athlete improves CS, it may claim that being a TSP or IA not effect on CS level. References Korkut F. (1996). Developing Communication Skills Inventory: Its Validity and Reliability. *Psikolojik Danışma ve Rehberlik Dergisi*, 2(7), 18-23. Sen L (2008) Communication Skills, 4-6. Prentice-Hall of India Private Limited, New Delhi. Tepekoylu O, Soyuturk M, Camliyer H. (2009). Examining the Levels of Perception of Communication Skills in Physical Education and Sports College (Pesc) Students in Terms of Pre-Determined Variables. *SPORMETRE Physical Edu. & Sports Sciences J.* 7(3), 115-124 Yilmaz I, Cimen, Z. (2008) The Communication Skill Level of Physical Education and Sports Teacher Candidates. *Atatürk Journal of Physical Education and Sports Sciences (ATABESBD)*, 10(3),

## AN INVESTIGATION INTO THE EMOTIONAL INTELLIGENCE AND MOOD STATES IN UNIVERSITY STUDENTS

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Introduction Evidence shows that measures of self-report emotional intelligence and mood states are important predictors of performance in a range of contexts including academic and sports settings (Lane et al., 2010). Despite encouraging evidence on the utility of using emotional intelligence to assess athletes, we argue that replication of findings to demonstrate the consistency of relationships could provide a solid footing for developing intervention designed to improved performance via enhancing emotional intelligence. The present study investigated the relationship between mood and emotional intelligence in relation to successful and unsuccessful academic and sports performance among university students attending sports-related degree courses, a design that replicates the one followed by Lane et al. Methods Sports students ( $n=134$ , mean age=20.0 years,  $s=2.3$ ; male=85, female=49) completed the 32-item Brunel Mood Scales (BRUMS, Terry et al., 1999) based on retrospective accounts of mood in relation to successful and unsuccessful academic and sports performance. Emotional Intelligence (EI) was measured by using the 10-item Brief Emotional Intelligence Scale (BEIS, Davies et al., 2010). Results A  $2 \times 2$  (EI x performance) repeated measures MANOVA was conducted to test for differences in mood states before successful and unsuccessful sports and academic performance. The two-way interaction was significant (Pillai's Trace= .254,  $F_{1,600}=2.442$ ,  $p=.003$ ). Univariate tests showed significant differences: High EI was associated with low anger ( $F=6.455$ ,  $p=.012$ ), depression ( $F=4.305$ ,  $p=.04$ ), fatigue ( $F=5.405$ ,  $p=.011$ ) and confusion ( $F=4.707$ ,  $p=.032$ ) before successful sport performance; low EI was associated with less fatigue before poor academic performance ( $F=6.145$ ,  $p=.014$ ). Conclusions Our study lends support to the notion that students with high level of emotional intelligence report higher scores of pre-competition mood in both sport and exam situations. We suggest future work should investigate the effects of intervention strategies to design to enhance emotional intelligence on pre-competition mood and performance. References Davies, K., Lane, A. M., & Devonport, T. (2010). Validity and reliability of a Brief Emotional Intelligence Scale: The BEIS-10. *Journal of Individual Differences*, 31(4), 198-208. Lane, A. M., Devonport, T. J., Soos, I., Karsai, I., Eva Leibinger, E. and Hamar, P. (2010). Emotional intelligence and emotions associated with optimal and dysfunctional athletic performance. *Journal of Sports Science and Medicine*, 9, 388-392. Terry, P. C., Lane, A. M., Lane, H. J., Keohane, L. (1999). Development and Validation of a Mood Measure for Adolescents: POMS-A. *Journal of Sport Sciences*, 17, 861-872.

## PSYCHOMETRIC ISSUES IN ORGANIZATIONAL STRESSOR RESEARCH: A REVIEW AND IMPLICATIONS FOR SPORT PSYCHOLOGY

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Sport performers seeking to attain peak performances must ensure that they are in an optimum physical and psychological state when they compete. This is a challenging task since the organizational and social environment surrounding athletes imposes numerous demands on them, many of which can potentially elicit a number of undesirable consequences for them and disrupt their preparations for competition (Gould, Guinan, Greenleaf, Mudbery, & Peterson, 1999). It is, therefore, imperative that psychologists better understand the demands that athletes encounter via their exploration and assessment. However, although researchers have identified a wide range of organizational stressors experienced by performers (see, for a review, Arnold & Fletcher, 2011), they have yet to develop a measure or indicator to assess these demands. In contrast, scholars working in other sub disciplines of psychology have designed instruments that measure organizational-related stressors in different contexts (see, for a review, Rick, Briner, Daniels, Perryman, & Guppy, 2001). The development and use of these measures have the potential to inform the advancement of stress research in sport. Therefore, the purpose of this paper is to review psychometric issues in organizational stressor research and to discuss the implications for sport psychology. The review is divided into four main areas: conceptual and theoretical issues (e.g., defining organizational stress-related concepts, underpinning measures with a theory, and differentiating between the separate components of the overall stress process), item development issues (e.g., distinguishing between different types of stressors, selecting the number of items to develop, and establishing the generality versus specificity of the wording), measurement and scoring issues (e.g., measuring stressors subjectively or objectively, adopting a triangulation strategy, measuring dimensions over demand, and choosing the most appropriate response format and scor-

ing method), and analytical and statistical issues (e.g., sample selection, factor analysis, and measuring and controlling for confounding variables). References Arnold, R. S., & Fletcher, D. (2011). A Research Synthesis and Taxonomic Classification of the Organizational Stressors Encountered by Sport Performers. Manuscript in preparation. Gould, D., Guinan, D., Greenleaf, C., Mudbery, R., & Peterson, K. (1999). Factors affecting Olympic performance: Perceptions of athletes and coaches from more and less successful teams. *The Sport Psychologist*, 13(4), 371-394. Rick, J., Briner, R. B., Daniels, K., Perryman, S., & Guppy, A. (2001). A critical review of psychosocial hazard measures. Brighton, England: Institute for Employment Studies.

### **CHEATING IN FOOTBALL; TEAM CULTURE, PLAYER BEHAVIOUR OR A QUESTION OF CIRCUMSTANCE?**

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CHEATING IN FOOTBALL; TEAM CULTURE, PLAYER BEHAVIOUR OR QUESTION OF CIRCUMSTANCE? Stride, C.B. 1, Patterson, M. 1, Thomas, F.E. 2 1: Inst. Work Psych., University of Sheffield; 2:University of Cambridge Introduction Cashmore (2000) describes cheating as "to act fraudulently, to deceive, swindle, or flout rules designed to maintain conditions of fairness". We examined cheating, categorised in a sporting scenario by Loland (2005), in the context of association football, extending his typology by grouping 17 offences into 4 types: Simulation, Classic Cheating, Professional Fouls and Calculated Dissent. We investigated whether and why the incidence of these types differed between players, teams and matches. Hypotheses We hypothesised that variation in cheating would exist between players, teams and matches. Between player variation would exist due to differences in both mental and physical drivers, such as moral functioning, motivation, ability, experience and playing role. Between match variation would be due to differences in importance, closeness, and law enforcement. Between team variation would be due to varying ability, expectation, styles of play, 'team climate', and national culture (e.g. dimensions of Individualism, Masculinity, Power-distance, Uncertainty Avoidance; Hofstede, 2003). Method We collected data from the 2010 Football World Cup (WC2010). Two coders watched every match, recording each cheating incident they identified. Data was also collected for players (e.g. experience, position), teams (ability, manager's background, Hofstede cultural dimension scores), and matches (importance, result, referee). For each type of cheating, multilevel generalised linear models were used to partition variation in the number of cheating events by player, team, and match, and test the effects of player, team and match variables in explaining this variation. Results 412 cheating incidents were recorded, primarily Professional Fouls (275) and Simulation (83). For Professional Fouls, variation was found between matches and between players. This was predicted by playing position (defenders commit more), experience (players with more caps commit less) and importance of match. For Simulation, variation was found between players and between teams. This was predicted by playing position (forwards commit more) and cultural dimensions (countries with high Power Distance and Uncertainty Avoidance commit more), the latter mirroring Franke & Nadler's (2008) findings within organisations. References Cashmore, E. (2000) Sports culture: An A to Z guide. London: Routledge Franke, G R. & Nadler, S.S. (2008) Culture, economic development and national ethical attitudes. *Journal of Business Research*, 61, 3,254-264 Hofstede, G. (2003) Culture's Consequences, Comparing Values, Behaviors, Institutions, and Organizations Across Nations Beverly Hills, CA, Sage Publications Loland, S. (2005) The varieties of cheating - comments on ethical analyses in sport. *Sport in Society*; 8: 11-26

### **SPORT CAREER TRANSITION: SOME ASPECTS OF THE DIFFICULTIES FACED BY A FORMER ATHLETE IN EMBRACING A NEW ROLE AS A COACH**

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PONTIFÍCIA UNIVERSIDADE CATÓLICA DE CAMPINAS

Dobránszky, I. 1; Ruete, H. Gonzalez Rey, F. 2 1PUC-Campinas (Campinas, Brazil); 2Universidade de Brasília Introduction Although sport organizations and sport managers in Brazil do not usually pay attention to this subject, to sport psychologists it has been otherwise, mainly because a significant part of these former athletes become coaches or school teachers. One of the major problems caused by a poorly planned career transition is the change of the role from athlete to coach (Lavallee, Wylleman, 2000; Stambulova, Stephan, Jäphag, 2007). The main goal of this study is to analyze the subjective sense of the female former athlete on the athletes' subjectivity. Method Eight international and national tri-athletes and a female coach participated in the study. The coach ended her career as a tri-athlete two years before this research, and during it she already worked as triathlon coach to increase her earnings. The method qualitative is based on epistemological studies developed by the psychologist Gonzalez Rey (1997), and emphasizes the constructive-interpretative and dialogical character of the knowledge. The instruments used were: conversational dynamics, term used to emphasize the procedural and open character of the relationships with the participant; complement of sentences, which allowed acquiring information about the production of sense of the individual; and a field diary. Results Our analysis, took us to the construction of the following subjective senses nuclei: i) the influence of the former athlete's subjectivity on her athlete's subjective sense; ii) the difficulty in the moving from the athlete's subjectivity sense to the coach's subjectivity sense. Discussion In Brazil, most athletes cannot dedicate themselves exclusively to their sports career as long as they usually have to work as coach or in another activity to support themselves. Usually they cannot achieve their maximum potential consequently they face frustration or other problems during their sport career transition having difficulties embracing the new role as a coach. The way that athlete faces the difficulties in his sporting life, depends on the subjective's sense that sport has for him and not of his physical, tactical and technique. There are different difficulty levels, which are singular and pass through processes of individual and group subjectivity, and is subject to change according to the production process of subjective senses. References González Rey, F. (1997). Epistemología Cualitativa y Subjetividad. São Paulo: Educ. Lavallee, D, Wylleman, P. (2000). Career Transitions in Sport: International Perspectives. Morgatown. Fitness Information Technology. Stambulova, N, Stephan, Y., Jäphag, U. (2007). Athletic retirement: A cross-national comparison of elite French and Swedish athletes. In: *Psychology of Sport and Exercise*. Elsevier: Vol. 8, 101-118

### **RELATIONSHIP BETWEEN IMPLICIT ABILITY BELIEFS, PERCEIVED COMPETENCE AND AMOTIVATION: A STUDY BY VALLERAND'S HIERARCHICAL MODEL**

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RELATIONSHIP BETWEEN IMPLICIT ABILITY BELIEFS, PERCEIVED COMPETENCE AND AMOTIVATION: A STUDY BY VALLERAND'S HIERARCHICAL MODEL Juan-Recio, C., López, A., Moreno, JA. Sports Research Centre, Miguel Hernandez University of Elche, Alicante, Spain. Introduction Using self-determination theory (Deci and Ryan, 1985, 2000) and the hierarchical model of intrinsic and extrinsic motivation (Vallerand, 2001), the aim of this study was to test a theoretical model, relating ability beliefs with perceived competence and each of the dimensions



of amotivation. Since the Amotivation Inventory-Physical Education had not been validated to the Spanish context, psychometric properties were analyzed too. Methods Five hundred and two adolescent students in physical education (252 men and 250 women; mean age:  $14.78 \pm 1.72$  years) volunteered to take part in this study. Instruments -Conceptions of the Nature of Athletics Ability Questionnaire-2. A Spanish version (González-Cutre et al. 2007) of the Conceptions of the Nature of Ability Athletics Questionnaire-2 created by Biddle et al. (2003) was used. -The competence factor of Psychological Needs Satisfaction Scale by Wilson et al. (2006). -Amotivation Inventory-Physical Education (AI-PE). It was adapted and translated from Shen et al. (2010). Results Psychometric properties of AI-PE were analyzed using confirmatory factor analysis, supporting that the reasons why students are not motivated in physical education can be grouped into four dimensions: ability beliefs, characteristics of the task, task value and effort beliefs, showing appropriate validity and reliability. The results of structural equation model indicated that the incremental ability belief in sports positively predicted perceived competence ( $B = .30$ ) and this, in turn, negatively predicted the amotivation ( $B = -.63$ ), explaining the 40% of its variance. Discussion This model can help teachers and trainers to understand better the nature of amotivation and thus facilitate the development of motivational strategies to prevent the abandonment of physical activity in adolescents. These should be aimed to develop incremental ability beliefs, and to promote the perceived competence of students in physical education classes. References Biddle, SJH, Wang, CKJ, Chatzisarantis, NLD, & Spray, CM. (2003). *J Sports Sci*, 21, 973-989. Deci, EL. & Ryan, RM. (1985). *J Res Pers*, 19, 109-134. Deci, EL. & Ryan, RM. (2000). *Psychol Inq*, 11, 227-268 González-Cutre, D, Martínez Galindo, C, Alonso, N, Cervelló, E, Conte, L, y Moreno, JA. (2007). In J. Castellano y O. Usabiaga (Eds.), *Investigación en la Actividad Física y el Deporte II* (pp. 407-417). Vitoria: Universidad del País Vasco. Shen, B, Wingert, RK, Li, W, Sun, H. & Rukavina, PB. (2010). *J Teach Phys Educ*, 29(1), 72-84. Vallerand, RJ. & Rousseau, FL. (2001). In RN. Singer, HA. Hausenblas y CM. Janelle (Eds), *Handbook of Sport Psychology* (2<sup>nd</sup> Ed), (pp. 389-416). New York: John Wiley & Sons. Wilson, PM, Rogers, WT, Rodgers, WM, & Wild, TC. (2006). *J Sport Exerc Psychol*, 28, 231-251.

## Poster presentations

### PP-SH11 Computer Application in Sports

#### ONLINE MODELLING OF THE CYCLIST'S HEART RATE RESPONSE TO POWER OUTPUT.

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**INTRODUCTION:** Controlling the exercise intensity is important during cycling training to avoid overtraining. Power output can be used as the most direct indicator of exercise intensity (Jeukendrup et al., 1998). Nonetheless, heart rate is more often used as an indicator for exercise intensity and to calculate heart rate zones for the training. These heart rate zones are based on tests on a population level, so they neglect the fact that cyclists are complex, individual, time varying and dynamic systems (CITD-systems) (Quanten et al., 2006). This means that, among other things, the heart rate response to a certain training intensity will vary in time for an individual cyclist. Furthermore, it is likely that the heart rate response could give information about the real-time physical status of the cyclist. The aim of this research is to make a step forward in the development of more individual training sessions for cyclists by making use of engineering, monitoring and control theory. More specifically, the objective is to investigate if we can model the individual heart rate response to power output in real-time. **METHODS:** Three professional male road cyclists and one professional male triathlete ( $24 \pm 4$  years;  $72.3 \pm 4.3$  kg;  $184.0 \pm 4.3$  cm) participated in this study. Ninety-six datasets were collected at random from the participants training and race sessions over the last three years. Those datasets were collected on the road as well as on the track. Two different compact, dynamic and data-based model structures were used to model and simulate the individual heart rate response to power output. The first model structure was the ARX model structure and the second one was the OE model structure (Ljung, 1987). These model structures were calculated recursively and in real-time to model the changing heart rate response to power output. **RESULTS:** The average RT2 between the measured and simulated heart rates with the ARX and OE model structures were 0.86 (std = 0.15) and 0.89 (std = 0.13) respectively. The time constants of the models varied between 2 and 100 seconds. These time constants were consistent with time constants found in literature (in average  $42 \pm 11$  sec). **CONCLUSIONS:** Compact dynamic model structures make it possible to model the cyclist's individual heart rate response to power output in real-time during the training. The acquired information can later be used to adapt and optimise the training for that specific cyclist. **REFERENCES:** Jeukendrup, A.E. & Van Diemen, A. (1998). Heart Rate Monitoring During Training and Competition in Cyclists. *Journal of Sports Sciences*, 16, 91-99. Ljung, L. (1987). *System identification. Theory for the user*. New Jersey: Prentice Hall. Quanten, S., De Valck, E., Mairesse, O., Cluydts, R. & Berckmans, D. (2006). Individual and time-varying model between sleep and thermoregulation. *Journal of Sleep Research*, 15, 243-244.

#### A FLEXIBLE AND EASY-TO-USE WIRELESS SENSOR NETWORK FOR ONLINE MONITORING OF PHYSIOLOGICAL AND BIOMECHANICAL DATA OF MULTIPLE ATHLETES EXEMPLARILY APPLIED IN INDOOR SPINNING

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UNIVERSITY OF KAISERSLAUTERN

**Introduction:** Online monitoring and feedback of objective performance data has been widely proven to substantially enhance the quality of training. Especially for individual sports such as cycling or running highly specialized commercial systems are available. Only few systems support team sports (e.g. LPM, Abatec Electronic AG). To fill this gap, a flexible, compact and easy-to-use wireless sensor network platform named AmiCA has been developed interdisciplinary and customized for online monitoring of physiological and biomechanical parameters of multiple athletes (Wille et al., 2010). It supports the integration of various types of sensors and therefore can easily be adapted to the varying requirements of different types of team sports or group training. A first prototypical application was realized in Spinning. **Methods:** A wireless sensor network (WSN) was established supporting up to 20 wireless nodes mounted on a Spinning bike with integrated sensors for heart rate and cadence measurement. A central gateway node connected to a PC collected data from each node three times per second. Raw data were stored, preprocessed and resultant heart rate and cadence values were presented online on an external display. A baud rate of 38.4kbaud ensured a highly reliable communication between the nodes up to 280m line-of-sight, which is quite sufficient for indoor training. **Results and discussion:** The flexible design of the AmiCA platform and the software framework enabled a development within only two weeks. The WSN was tested during a 12 week Spinning experiment consisting of three training units a week (45 minutes each). Heart rate and cadence data of up to 17 participants were collected and monitored simultaneously during 15 training units. During the whole experiment data communication were highly reliable. Trainers were able to use the nodes

without previous knowledge. As soon as two nodes were activated the WSN worked autonomously. Later activated nodes were automatically reintegrated into the network. The measurement results exceeded our expectations, a clearly improvement of the athletics was traceable. Outlook: The WSN platform allows an easily integration of additional sensors for pedal forces, e.g., and can therefore expanded for different settings such as group training in cycling. At a higher baud rate sensor data of more than 20 participants could be monitored simultaneously. References: Wille, S., Wehn, N., Martinovic, I., Kunz, S., and Goehner, P. (in press). 7th International ICST Conference on Mobile and Ubiquitous Systems 2010. LNICST. Springer  
([http://ems.eit.uni-kl.de/uploads/tx\\_uniklwehn/AmICA\\_A\\_flexible\\_compact\\_easy-to-program\\_and\\_low-power\\_WSN\\_platform.pdf](http://ems.eit.uni-kl.de/uploads/tx_uniklwehn/AmICA_A_flexible_compact_easy-to-program_and_low-power_WSN_platform.pdf))

## THE CONCURRENT VALIDATION OF THE FACTOR STRUCTURE OF WOMEN'S HEPTATHLON

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**Introduction** The women's heptathlon is an Olympic event, which consists of seven events and conducted over two days of competition. The order of events day 1, 100m hurdles, high jump, shot put and 200m; and day 2, long jump, javelin and 800m. Heazlewood (2008) indicated the factor structure of the heptathlon, using IAAF 2006 data was a three factor model, where 110m hurdles, 200m, high jump and long jump loaded with factor 1, shot put and javelin loaded with factor 2 and 800m on factor 3. The aim of the research was to evaluate if the factor structure in the 2006 data would be replicated with 2010 IAAF heptathlon data. If the interrelationships between the seven events are relatively invariant over time, the factor structure should be replicated across different athletic seasons. As well, the information has implications for heptathlon training based on the factor structure. **Methods** The data consisted of 2010 IAAF ranked heptathletes (n=173) based on points scored in the heptathlon and performances in the seven events to the closest 0.01s for track and 0.01m for field events. Different factor methods of maximum likelihood, principle axis factoring and principle component analysis were applied using PASW Statistics 18 software (SPSS Inc., 2007). The result that generated the most interpretable and parsimonious factor solution was selected to represent the factor structure of the 2010 data and then compared to the factor structure of the 2006 data. **Results** The most interpretable factor structure using 2010 data was principle component analysis, using varimax rotation with Kaiser normalization and an orthogonal structure. This analysis generated a four factor model, which explained a significant 73.1% of the total explained variance. The model based on the 2010 data was simple, interpretable and parsimonious. In this model 100m hurdles (loading = .818) and 200m (loading=.793) loaded with factor 1, high jump (loading = .876) and long jump (loading = .711) with factor 2, shot put (loading = .750) and javelin (loading = .818) with factor 3, and 800m (loading = .940) with factor 4. No factor complexity was displayed as occurred with the 2006 data. **Discussion** The 2006 and 2010 data indicated different factor structure for each competitive season and therefore factor variance over time. This may reflect different training approaches or different ability athletes in terms of the seven event interrelationships between the 2006 and 2010 athletic seasons. However, the four factor model for the 2010 data to an extent simplifies approaches to heptathlon training. As the sprint, jump, throw and endurance events did load simply across the four factors, then training units can be based on these factors as they represent underpinning motor fitness factors, such as strength (throws), speed (100m hurdles, 200m), power (high jump, long jump) and endurance (800m). References Heazlewood, I. (2008). Volume I: Computer Science in Sport, 283-288. SPSS. Inc. (2007). PASW® Statistics 18 Core System User's Guide. SPSS, Chicago.

## MOTOGP TREND ANALYSIS. A DECADE OF THE MOTORCYCLING WORLD CHAMPIONSHIP.

D'ARTIBALE, E.1,2, DI SPENSA, L.2, DI CAGNO, A.2, CALCAGNO, G.2

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**Introduction** Road racing motorcycling is competed in the oldest motorsports championship in the world, established by the FIM (Fédération Internationale de Motocyclisme) in 1949. Research and developments in engineering, mechanics, electronic systems and aerodynamics, make motorcycles faster and more competitive. The aim of this study was to examine race results of the top class of the FIM Road Racing World Championship Grand Prix from 2000 to 2009. **Methods** Data were obtained by official results of a total of 167 races held in the FIM Road Racing World Championship from 2000 to 2009. Official documents were posted from the race direction ([www.motogp.com](http://www.motogp.com)), and recorded in a purpose-built file on Epidata Software. Year, track, race duration, mean speed winner, gap, starting and finishing riders, race conditions, air and ground temperatures and crashes were the items selected for the analysis. Both descriptive and statistical analysis were applied. **Results** A total of 135 races satisfied the inclusion criteria and were analyzed. The average value of the mean speeds of the winners was 156.2±7 Km/h in 2000, 162.4±8 Km/h in 2005, and 160.7 ±7 Km/h in the 2009 season, determining a positive linear regression trend line (coefficient R<sup>2</sup>=0.65). The linear regression trend line of starting riders was negative (coefficient R<sup>2</sup>=0.44). No correlations between race temperatures (air and ground), mean speed winner and crashes were found. **Discussion** Race results from the top class of the FIM Road Racing World Championship Grand Prix from 2000 to 2009 showed that technology and developments made motorcycles faster and improved performance. Since road-race motorcycling imposes a high load on the riders, appropriate training programs for those athletes could be essential for road-race motorbike performances. Road racing motorcycling performance has a tendency to improve, although strict rules could limit the evolution of motorbikes, whereas, appropriate training for riders could represent a new frontier for performances evolution. References D'Artibale E., Tessitore A., Capranica L. (2008). Lippi G., Salvagno G.L., Franchini M., Guidi G.C. (2007). D'Artibale E., Tessitore A., Tiberi M., Capranica L. (2006)

## A PILOT TEST ON THE PERCEPTION OF E-LEARNING IN THE UNIVERSITY OF SPORTS OF TIRANA

LILE, A., KAÇURRI, A.

UNIVERSITY OF SPORTS OF TIRANA

**Introduction** Teaching and learning methodologies in Higher Education Institutions of Albania are nowadays experiencing important changes. In this concern, University of Sports of Tirana (UST) has already realized the need for Learning Management System (LMS) implementation, based on students' and teachers' demands. E-Learning platforms enables educational institutions to improve the learning and teaching experience (Nichols 2003). **Methods** Participants in this study were 46 sports physical education students enrolled in 'Informatics and Statistics' course in Spring semester 2010 at UST. In this course Moodle (Moodle, 2010) Learning Management System (LMS) was used as a supportive tool. In order to evaluate the Moodle LMS, a pilot test was conducted using OLES (On-Line Learning Environment Survey), a web-based instrument that contains 54 items arranged in nine scales (Pearson & Trinidad 2004). **Results** Means of scores ranged from 1.60 to 3.41 for 'actual' and 3.21 to 4.72 for 'preferred'. Analyses of Variance (ANOVA) revealed significant differences for Computer Usage (CU), Personal Relevance (PR), Equity (EQ) and Asynchronicity (AS) scales in 95% confidence. The result revealed a large F

Ratio for CU, TS, SIC, PR, SA, EQ, EN, AS and a small one for AL. Discussion Results showed that students' actual e-learning environment was not satisfactory in Computer Usage, Personal Relevance, Equity and Asynchronicity scales. Measuring students' attitude towards e-learning was very valuable to get relevant findings since UST is planning to adopt an e-learning system (Bertea, 2009 ; Anarkia, 2004). The support on the items of these scales should be improved to increase the student perception. Findings of such a pilot study may still be useful to higher education institutions that are planning to implement e-learning platforms. References Anaraki, F., (2004). Developing an Effective and Efficient eLearning Platform, *International Journal of The Computer, the Internet and Management*, 12 (2), 57-63. Bertea P. (2009). Measuring students' attitude towards e-Learning. A case study. The 5th International Scientific Conference, Bucharest, Romania. Moodle e-Learning System. Retrieved May 2010 from <http://moodle.org>. Nichols, M. (2003). A theory for eLearning. *Educational Technology Society*, 6(2), 1-10. Pearson J. & Trinidad S. (2005). OLES: an instrument for refining the design of E-learning environments. *Journal of Computer Assisted Learning* 21, pp 396-404.

## **APPLYING DATA MINING TECHNIQUES IN E-LEARNING: CASE STUDY OF INFORMATICS AND STATISTICS COURSE AT THE UNIVERSITY OF SPORTS OF TIRANA**

LILE, A., KAÇURRI, A.

*UNIVERSITY OF SPORTS OF TIRANA*

**Introduction** The educational process in University of Sports of Tirana (UST) is currently facing several issues such as identifying students needs, predicting the quality of learning experiences etc. Educational Data Mining (EDM) has become an emerging research field used to extract knowledge and discover patterns from e-learning systems (Baker, 2010). The aim of this study is to describe a step by step process (Romero, & Garcia, 2007) of applying data mining techniques to e-Learning data, in order to discover interesting patterns. Methods Participants in this study were 29 sports physical education students enrolled in 'Informatics and Statistics' course in Spring semester 2010 at UST. In this course Moodle (Moodle, 2011) Learning Management System (LMS) was used as a supportive tool. In order to discover knowledge and discover interesting patterns from the Moodle LMS, several data mining techniques Attribute Weighting by Information Gain, Clustering ( K-Means) and Classification(Tree Induction) were applied (Romero, Ventura, & Garcia 2007). Rapid Miner (v5.0) data mining tool was used to extract knowledge from logs data, by mining summarized tables from moodle database. Results Weighting by Information Gain revealed Resource View as the most dominant activity. KMEANS (k=2) generated two groups of students based on their interactions in Moodle: Cluster 0 characterized by active students in moodle, with high assignment score number, which participated to the online quiz etc; and Cluster 1 characterized by inactive and moderately active students with a low number of actions in the logs. A set of IF-THEN-ELSE rules was generated from the decision tree operator classifying three main categories of students: 1) students with a low assignments score classified as FAIL; students with medium assignments score classified as FAIL or PASS depending on their quiz score, and students with a high assignments score classified as FAIL, PASS or EXCELLENT depending on number of hints in the system. Discussion The experimental results have shown that the data mining model presented in this study was able to obtain comprehensible and actionable feedback from the LMS data describing students' learning behavior patterns. This educational data mining work allowed identifying and locating information about e-Learning processes that need improvements. To further extend this research, more extensive experiments should be conducted by using larger data sets. References Baker , M.,(2010). Data Mining for Education. In McGaw, B., Peterson, P., Baker, E. (Eds.) *International Encyclopedia of Education* (3rd edition), vol. 7, pp. 112-118. Oxford, UK: Elsevier. Moodle e-Learning System. Retrieved January 2011 from <http://moodle.org>. Romero, C., Ventura, S., García, E. (2007). Data Mining in Course Management Systems: MOODLE Case Study and Tutorial. *Computers and Education* , 51,368-384. Romero, C., Ventura, S. (2007). Educational Data Mining: a Survey from 1995 to 2005. *Expert Systems with Applications* , 33(1), 135-146.

## **ALTITUDE ADAPTATION AND TEAM SUCCESS DURING THE FIFA WORLD CUP 2010**

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**Introduction** During the FIFA World Cup 2010 matches were played from sea level up to an altitude of 1,700 m. Performance at altitude can be impaired without appropriate acclimatisation (Levine et al., 2008). Thus, the present descriptive analysis aimed at comparing the success of teams living at different altitudes during the World Cup. Methods Altitude of team hotels and stadiums was obtained from Google Earth. Team accommodation as well as match locations were assigned to 3 different categories: sea level (SL, <500 m, N=7), low altitude (LA, 500-1,500 m, N=16), and medium altitude (MA, >1,500 m, N=9). Match results and FIFA world ranking positions were obtained from [www.fifa.com](http://www.fifa.com). Information regarding the preparation period and arrival of the teams at their base camps were collected from mass media. Results Median world ranking position was similar in all altitude categories (19-22, p=0.78). All but one SL team were eliminated after the preliminary round. In addition, all quarterfinalists lived at an altitude above 1,100 m. Teams arrived at their base camps on average 7 days prior to the first match with no difference between categories (p=0.54). When playing against teams of lower altitude category winning and losing percentage was 44% [95%CI: 26-62%] and 22% [8-36%], respectively. Winning percentage of LA (40% [24-56%]) and MA teams (39% [28-50%]) was more than twice that of SL teams (18% [2-34%]). LA and MA had a better ratio of scored vs. received goals compared to SL (MA: 1.2 vs. 1.0 goals/match, LA: 1.3 vs. 1.1, SL: 0.7 vs. 1.3). MA teams showed the best relationship of scored vs. received goals (1.7 vs. 1.2 goals/match) when matches were played in Johannesburg (1,700 m) and scored most goals during the second half of the match. Discussion It is well established that teams living at altitude have an advantage compared to SL teams when competing at altitude. These effects might be caused by physiological and/or physical mechanisms (Levine et al., 2008). Impairments in maximal aerobic capacity and match play performance might be already present at altitudes above 500 m. Timely acclimatisation can counteract these altitude-associated physiological deteriorations. In addition, the considerably lower air density at altitude (17% lower in Johannesburg compared to SL) may have an impact on ball flight and sprint performance. In conclusion, the choice of accommodation during the World Cup might have influenced team success. When competitions take place at altitudes relevantly above sea level, it should be taken into account that altitude adaptation may have an advantage compared to living at sea level. Reference Levine BD, Stray-Gundersen J, Mehta RD. (2008) *Scand J Med Sci Sports*, 18 (Suppl 1), 76-84.

### PILOT STUDY TO DETERMINATE THERMAL ASYMMETRIES IN JUDOKAS

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**Introduction** As a part of a new researching line about establishing a specific thermal profile for high performance athletes of each specialty, we have analyzed the irradiated heat variation in judokas. Infrared thermography is a fast and non-invasive technique to control muscular thermal balance. The aim of creating a thermal profile for each sport is based on controlling the thermal singularities, which could influence the thermographic interpretation (Ring et al., 2002). **Methods** We have developed a pilot study with 2 right-handed high performance judokas from the Spanish National League, with an average age of  $21,75 \pm 0,65$  years, weight of  $78,5 \pm 10,5$  kg, and height of  $187,5 \pm 4,5$  cm, and a minimal training frequency of 4 times per week. Our aim was to start with a small sample to set the main points for further researches about thermal profile for Judo athletes. Athletes were monitored for 5 months, since October until February, with a number of 10 thermographic assessments along this period. Images were taken following the patterns set by Gómez Carmona et al. (2010) patented protocol. All images were taken in the same isolated room and conditions: 10 minutes of acclimation; a temperature average of  $18,04^\circ\text{C}$  and a humidity of 43,75%. The assessments took place before the training session and the frequency was at least once per month. A T335 FLIR Thermographic camera was used to take the images, which were analyzed through TernoTracker 1.0.0.4 software. We used the average temperatures of each body areas in order to obtain thermal differences between bilateral body areas. **Results** After analyzing all thermal images through the software, bilateral significant differences ( $p < 0,05$ ) were only found on dorsal exterior forearm, with an upper 0.4-degree difference in favor of the dominant hand. **Discussion** The thermal results obtained are into the normal distribution established by Nomura Cabrera et al. (2008). In terms of the significant differences founded, they could be due to the asymmetry in the dominant forearm diameter in judokas -7% bigger- (Krawczyk, 1998), or the influence of the repetitive rotational movements characteristic from judo practice (Zakynthinaki, 2010). Furthermore, the 0.4-degree difference would not be considered as injury risk (Gómez Carmona et al., 2010) but a thermal singularity in judokas because of their practice. **References** Gómez Carmona, P. M. (2010). Spain Patent No. P201031080. Oficina Española de Patentes y Marcas: UPM. Krawczyk, B. (1998). Lateral asymmetry in upper and lower limb measurements in selected groups of male athletes. *Biology of sport*, 15(1), 33-38. Nomura Cabrera, I. (2008). Thermography techniques. In M. H. M. Lee & J. M. Cohen (Eds.), *Rehabilitation medicine and thermography* (pp. 25-32). Wilsonville, OR: Impress Publications. Ring, E. (2000). The Technique of Infra red Imaging in Medicine. *Thermology International*, 10(1), 7-14. Zakynthinaki, M. S. (2010). Rotated balance in humans due to repetitive rotational movement. *Chaos*, 20(1), 013118.

### VARIABILITY AND PREDICTABILITY OF FINALS TIMES OF ELITE ROWERS

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**Introduction** Little is known about the competitive performance characteristics of elite rowers. We report here analyses of performance times for finalists at world cups, world championships and Olympics from 1999 to 2009. **Methods** A linear mixed model of finals times for single and crewed boats provided estimates of within-boat variability and between-boat differences as coefficients of variation. The model included terms to account for differences or changes in performance between calendar years, venues and the various levels of finals (A, B, C...). **Results** Differences in the effects of environmental conditions, estimated as variability in mean race time between finals, were very large to extremely large (2.3-4.0%), with possibly greater variability for singles compared with quads and eights. Within-boat race-to-race variability was 0.6-1.5% (90% confidence limits  $\times/\div 1.09-1.21$ ); singles were almost certainly more variable ( $>1.10\times$ ) than quads and eights, males were likely more variable than females, and variability in A finals of singles was very likely less than that in other finals. Smallest worthwhile enhancements in performance, given by  $0.3\times$  within-boat variability, ranged from  $\sim 0.3-0.4\%$  for the singles down to  $\sim 0.2\%$  for the eights. Between-boat differences in a given final ranged from small to large (0.5-2.0%), with differences for females likely more than those for males. Predictability of performance, expressed as within-year intraclass correlation coefficients, was moderate to very high (0.33-0.83), with females very likely to be more predictable than males. **Discussion** The environmental variability is of such a magnitude that B, C or even D finals could end up faster than A finals at a given venue, which is not uncommon. Overall, the variability of performance is similar to that in comparable endurance sports performed against water or air resistance but higher than that for elite middle distance track runners. We believe the additional variability for rowers compared with runners arises predominantly from environmental conditions; for example, a tailwind could benefit some rowers more than others, and a side wind could benefit rowers in lanes in which there is a wind shadow. The lesser variability for females is probably a consequence of more consistent motivation. Bigger differences in performance time between females, due presumably to less competitive depth, contributes to the higher predictability of competitive performance in females. The crewed boats show less variability than singles, probably because of less effect of the environment and some averaging of the variability of the individual crewmembers. The findings of this study will help inform investigations of factors affecting elite competitive rowing performance.

## Poster presentations

### PP-PM01 Sports Nutrition: Supplements 1

#### EFFECTS OF SHORT-TERM BETA-HYDROXY-BETA-METHYLBUTYRATE SUPPLEMENTATION ON MARKERS OF MUSCLE DAMAGE, SORENESS AND MUSCLE FUNCTION AFTER PROLONGED INTERMITTENT HIGH-INTENSITY SHUTTLE RUNNING

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**Introduction** Most sports at the highest levels and annual training patterns demand high physiological, psychological, technical and tactical qualities from athletes. There is a need for an optimal turnover of those substances with high catabolic rate. Several nutritional ergogenic aids can contribute to optimize these processes. In this sense, HMB has been proposed to have an ergogenic effect on athletic

performance without having practically any adverse effect on the athlete's health. **Methods** Ten football players (18-25 yr) were supplemented along two supplementation periods. In the first period, 5 of the 10 subjects were supplemented with 3 grams of HMB per day for 8 days; the other 5 received a placebo (maltodextrin) followed by two weeks wash-out period and then a second supplementation period in a randomized double-blind crossover placebo design. Testing involved the Loughborough Intermittent Shuttle Test (LIST). Blood samples were collected before, after and the day after the LIST to determine muscle damage. Prior to and following supplementation, dietary records and fasting blood samples were also obtained. Lactate and muscle function (handgrip, CMJ and sprinting) was measured between sets and the day after the LIST. Rating of Perceived Exertion and Recovery was taken all along testing sessions. **Results** CK Levels tended to be lower when subjects were supplemented with HMB (916.1 vs 784.9 U/l, placebo vs HMB;  $p < 0.9$ ). On the other hand, we can appreciate that HMB supplementation improved jump capacity (Abalakov test) 24 hours after the LIST when compared to placebo (40.57 vs 42.84 cm + SD, placebo vs HMB;  $p < 0.01$ ). Similarly, HMB supplementation improved the average sprint time compared to placebo (3.3 vs 3.2 s + SD, placebo vs HMB;  $p < 0.02$ ). **Discussion** Trained football players receiving HMB supplementation (3 g/day, 8 days) improved their athletic performance 24 h after a high intensity intermittent exercise and show a tendency to limit their muscle catabolism after an exhaustive exercise test. This effect can contribute to decrease the accumulative effect on muscle damage caused by daily training sessions. These results are in agreement with those studies that support the efficacy of HMB as an effective ergogenic aid for athletes that decreases DOMS, markers of muscle damage, and body fat, while improving various markers of performance (Van Someren et al., 2005). In contrast, there are other studies that did not support the efficacy of HMB supplementation (Kreider et al., 2000). These authors suggest that these conflicting results may in part be attributed to the variability in humans, inadequate sample sizes, and methodological issues (Wilson et al., 2008). **References** • Kreider RB et al. (2000). *J Exerc Physiol* online 3(4): 48-59. • Van Someren K, Edwards A, Howatson G (2005). *Int J Sport Nutr Exerc Metab* 15(4): 413-24. • Wilson GT, Wilson JM, Manninen AH (2008). *Nutr & Metab* 5:1.

### THE EFFECT OF ACUTE BOVINE COLOSTRUM SUPPLEMENTATION ON NEUTROPHIL RESPONSES TO PROLONGED CYCLING

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It has been suggested that in the hours or days following prolonged exercise an individual has increased susceptibility to upper respiratory tract infections (URTI) due to alterations in many immunological components (Nieman, 2001). Bovine colostrum (BC), consumed daily for 4-8 weeks, has been shown to be of benefit to the immune system and URTI risk (Brinkworth & Buckley, 2003; Davison & Diment, 2010). The purpose of this study was to identify whether acute BC supplementation (i.e. hours) prior to a bout of prolonged exercise has any effect on neutrophil function. Five healthy males (age: 21.6 [3.2] years, body mass: 74.0 [5.6] kg,  $\text{VO}_2$  max: 4.3 [0.7] L/min; values are mean [SD]) participated in 2 main trials in a randomised order. Subjects consumed either BC or placebo (PLA) 1 hour prior to 2.5 hours of cycling at approximately 55%  $\text{VO}_2$  max (30g), immediately prior (5g) and midway through the exercise (5g). Venous blood samples were obtained on the morning prior to consumption of the supplement, 1 hour post-drink (immediately pre-exercise), immediately post-exercise and 1 hour post-exercise. Total and differential leukocyte counts were measured using an automated haematology analyser. In-vitro stimulated neutrophil oxidative burst responses (OBA) to PMA and fMLP were measured by chemiluminescence (CL) assay and expressed per neutrophil. To maintain blinding procedures, the effect of trial on cell counts was not investigated so only overall time effects are reported. Repeated measures 1 way ANOVA and post hoc paired t-tests (Bonferroni corrected) revealed significant increases at both post-exercise timepoints for blood neutrophil count ( $P = 0.001$ ) and neutrophil:lymphocyte ratio ( $P \leq 0.001$ ). For fMLP-stimulated OBA 2-way repeated measures ANOVA showed a main effect of time ( $P < 0.001$ ) but no main effect of trial or time  $\times$  trial interaction ( $P > 0.05$ ). For PMA-stimulated OBA there was a main effect of time ( $P = 0.032$ ) and trial ( $P = 0.043$ ) but no time  $\times$  trial interaction ( $P > 0.05$ ). Post hoc comparisons demonstrated significant post-exercise decreases. These results suggest that OBA is generally higher with acute BC supplementation but the overall temporal pattern (a post-exercise decrease) is similar between trials. These preliminary results provide support for the idea that BC may enhance neutrophil functions by a direct and immediate mechanism, in agreement with the in-vitro findings of Sugisawa et al. (2001). At present statistical power is low and the intention is to increase the sample size to 12. Brinkworth & Buckley. (2003). *Eur J Nutr*, 42, 228-332. Davison & Diment. (2010) *Br J Nutr*, 103, 1425-1432. Nieman. (2001) *Can J Appl Physiol*, 26, 45-55. Sugisawa et al. (2001). *Biol Neonate*, 79, 140-144.

### THE EFFECT OF SHORT TERM DIETARY MANIPULATION ON GROSS EFFICIENCY DURING CYCLING.

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To assess the effect of short term dietary manipulation on gross efficiency, 14 trained male cyclists ( $\text{VO}_2\text{max}$   $56.6 \pm 7.2 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ , mean  $\pm$  SD) completed three 2-hour tests at a steady-state submaximal exercise intensity (60% of Power at  $\text{VO}_2\text{max}$ ). In the 3-days preceding each test, participants consumed a diet (~4000kcal.day<sup>-1</sup>) that was either high in carbohydrate (High CHO, [70% carbohydrate, 20% fat, 10% protein]), low in carbohydrate (Low CHO, [70% fat, 20% carbohydrate, 10% protein]) or contained a moderate amount of carbohydrate (Mod CHO, [45% carbohydrate, 45% fat, 10% protein]) in a randomised, crossover designed study. Gross efficiency (GE) along with blood lactate and glucose were assessed at regular intervals (~30mins) and heart rate was measured continuously at 5 second intervals throughout the test. Mean GE was significantly greater following the High CHO diet than the Mod CHO diet. (High CHO =  $20.1\% \pm 0.5\%$ , Mod CHO =  $19.3 \pm 0.6\%$ , mean  $\pm$  SD;  $P < 0.05$ ). More specifically, GE was significantly greater after 25mins, 85mins and 115mins of the test ( $P < 0.05$ ). Dietary manipulation had no effect on blood glucose, blood lactate or heart rate responses during exercise ( $P > 0.05$ ). In conclusion, significant differences in gross efficiency were obtained following alteration of participants' diet in the 3-days preceding assessment. This suggests that before the measurement of gross efficiency takes place, participants' diet should be carefully controlled and monitored to ensure the validity of the results obtained.

### SIX DAYS OF BEETROOT JUICE INGESTION INCREASES MEAN POWER OUTPUT DURING A 10 KM TIME TRIAL IN TRAINED CYCLISTS

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1. MCMASTER UNIVERSITY 2. MAASTRICHT UNIVERSITY

**Introduction:** Recent work in humans suggests that the therapeutic potential of increased nitric oxide bioavailability may extend far beyond the well known hemodynamic effects. Six days of dietary nitrate supplementation using beetroot juice (0.5 L/d) reduces pulmo-

nary oxygen uptake (VO<sub>2</sub>) during submaximal exercise (1,2) and increases tolerance to higher-intensity workloads (1). These findings suggest that inorganic nitrate ingestion has the potential as a potent ergogenic aid. To date, no study has investigated this issue using a practical, performance-based study that simulates normal athletic competition. The primary purpose of this study was to determine whether 6 d of beetroot juice ingestion improves performance during a 10 km cycling time trial in trained athletes. Methods: Using a double-blind, repeated-measures crossover design, 13 trained cyclists or triathletes ( $31 \pm 3$  y; VO<sub>2</sub> peak =  $58 \pm 2$  mL/kg/min; W<sub>max</sub> =  $342 \pm 10$  W) ingested 140 mL/d of concentrated beetroot juice (Beet It, James White Drinks, Suffolk, UK) or a placebo (nitrate depleted beetroot juice, Beet It) for 6 d, separated by a washout period of  $\geq 14$  d. On the last day of supplementation in each trial, subjects performed a 1 h bout of submaximal cycling (30 min at each of 45 and 65% W<sub>max</sub>), followed immediately by a 10 km time trial using a CompuTrainer (RacerMate) and their own bicycle. Results: From 9 subjects that have completed all testing, mean power output during the time trial was higher after beetroot ingestion (BEET) compared with placebo (PLAC) ( $304 \pm 12$  vs  $296 \pm 12$  W, mean  $\pm$  SEM;  $P=0.04$ , 2-tailed t-test) and there was a trend towards an increase in time trial performance ( $950 \pm 21$  vs  $958 \pm 21$  s;  $P=0.09$ ). VO<sub>2</sub> at 65% W<sub>max</sub> was lower after BEET compared with PLAC ( $2.95 \pm 0.13$  vs  $3.16 \pm 0.12$  L/min;  $P=0.03$ ), with no differences observed between treatments at 45% W<sub>max</sub> ( $1.96 \pm 0.05$  vs  $2.05 \pm 0.09$  L/min, respectively;  $P=0.2$ ). Resting systolic and diastolic blood pressures, heart rate, respiratory exchange ratio and perceived exertion during exercise did not differ between treatments. Conclusion: Six days of nitrate-rich beetroot juice ingestion improves mean power output during a 10 km time trial in trained athletes. The mechanism for improved performance remains to be determined, but may be related to improved metabolic efficiency. References: 1. Bailey, SJ et al. (2009). J Appl Physiol 107: 1144-55. 2. Vanhatalo, A et al. (2010). Am J Physiol Integ Comp Physiol 299 (4): R1121-31.

## PROLONGED RESISTANCE TYPE EXERCISE TRAINING AND PROTEIN SUPPLEMENTATION IN THE ELDERLY

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Resistance type exercise training has been well established as an effective treatment strategy to counteract sarcopenia in the elderly (1). Though the relevance of sufficient dietary protein intake has been recognized, it remains to be established whether protein supplementation can further augment the skeletal muscle adaptive response to prolonged resistance type exercise training in the elderly (2,3). In the present study, we aimed to determine the additional effect of protein supplementation with breakfast on muscle mass and strength during prolonged resistance type exercise training (RT) in healthy elderly men and women. A total of 30 men ( $70 \pm 1$ y) and 30 women ( $70 \pm 1$ y) were included in a supervised and progressive whole body RT program, with 3 training sessions per week for 24 weeks. On a daily basis, subjects consumed a drink after breakfast, containing either 15g of protein or a placebo. Muscle strength was determined with 1 repetition maximum (1RM). Body composition was assessed by DEXA scan, cross sectional area of the quadriceps muscle was assessed by CT scan, and muscle biopsies were collected to assess muscle fiber type composition and muscle fiber size. All measurements were performed before, and after 12 and 24 weeks of intervention. So far, 22 subjects completed the intervention program. 1RM strength increased by  $29 \pm 2\%$  for the leg press, and  $45 \pm 4\%$  for the leg extension ( $P < 0.05$ ). In accordance, leg lean mass increased from  $18.1 \pm 0.6$  to  $18.7 \pm 0.7$  kg, and quadriceps muscle cross-sectional area increased from  $63.5 \pm 2.4$  to  $67.9 \pm 2.6$  cm<sup>2</sup> following the intervention. Whole body fat mass decreased from  $21.8 \pm 1.0$  to  $20.2 \pm 0.9$  kg. More results from the entire group of participants, including the impact of additional protein supplementation with breakfast, will be finalized within 3 months and will be presented at the conference. So far, the present study clearly shows that prolonged resistance type exercise training in elderly males and females increases muscle mass, augments muscle strength, and stimulates fat mass loss. References: 1. Frontera et al. J Appl Physiol 64:1038-44, 1988. 2. Verdijk et al. Am J Clin Nutr 89(2):608-16, 2009 3. Esmark et al. J Physiol 535:301-11, 2001

## TWELVE WEEKS OF A WESTERN DIET ENHANCES THE RESPIRATORY CAPACITY OF OXIDATIVE SKELETAL MUSCLE

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Introduction Mitochondrial respiratory capacity is enhanced following both a bout of endurance exercise and a period of high-fat feeding. Both endurance exercise and high-fat diets (HFD's) increase circulating free fatty acids (FFA's), and it is thought that chronic FFA-induced activation of peroxisome proliferator-activated receptor (PPAR) delta and subsequent increases in PPAR gamma coactivator-1 alpha (PGC-1a) are responsible for promoting mitochondrial biogenesis. Combined with endurance training, HFD's have been shown to amplify training adaptation by increasing key enzymes of the beta-oxidation pathway and the overall rate of fat oxidation, however HFD's are also associated with weight gain and disturbances in glucose homeostasis. Similar to a HFD, FFA's also increase following a "Western-style" diet (WD; typically containing ~20% protein, 20% fat and 60% carbohydrate). We hypothesize that skeletal muscle respiratory capacity may therefore be enhanced following a WD. Methods Nine wk old male Long-Evans rats (weight  $273.82 \pm 2.6$  g, values are mean  $\pm$  SEM) consumed a control diet (CON, N=12; 73% carbohydrate, 7% fat, 20% protein; 16.1 kJ/g) or WD (N=12; 60% carbohydrate, 21% fat, 19% protein; 19.4 kJ/g) for 12 wk. Glucose tolerance, body mass and fat pad mass were measured. Mitochondrial respiration was assessed ex vivo in permeabilized fibres from the soleus using high-resolution respirometry. Results From 6 wk, WD rats were heavier than CON ( $379.10 \pm 7.14$  and  $356.66 \pm 3.97$ , respectively;  $P=0.012$ ) and remained heavier throughout the intervention. After 12 wk, epididymal fat pads were heavier in WD compared to CON ( $8.06 \pm 0.35$  and  $6.90 \pm 0.32$ , respectively;  $P=0.028$ ). Fasting serum glucose concentrations were elevated in WD compared to CON (12.5%,  $P=0.013$ ), although glucose tolerance was similar. In the soleus muscle (~87% slow oxidative fibres), respiratory capacity of complex I, complexes I & II together, & maximal uncoupled respiration was greater in WD compared to CON (all  $P < 0.05$ ). Respiratory capacity of complex II did not differ between groups. Conclusion Surplus energy intake through a WD increases the respiratory capacity of oxidative muscle from rodents. It is unknown whether this occurs via the same mechanisms thought to be induced by a bout of endurance exercise or a HFD. Further investigations are necessary to address this question.

## EFFECTS OF ALKALOSIS ON PERFORMANCE AND MUSCULAR OXYGENATION DURING ALL-OUT CYCLING EXERCISES

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Effects of alkalosis on performance and muscular oxygenation during all-out cycling exercises Delfour R 1,2, Hanon C1, Dorel S 1,2, Perrey S 4, Bishop D 5, Leprêtre P-M 3 and Thomas C 1,6 1 French National Institute of Sports (INSEP), Laboratory of biomechanics and physiology - 11 Tremblay Avenue, 75012 PARIS, France 2 University of Nantes, Laboratory « Motricité, Interactions, Performance » (EA 4334), F-44000, Nantes, France 3 University of Picardie Jules Verne, 80025 Amiens cedex, France 4 Laboratoire de Recherche Efficience et Déficience

Motrices, EA-2991, UFR-STAPS, Université de Montpellier 1, Montpellier, France 5 Institute of Sport, Exercise and Active Living (ISEAL), Victoria University, Melbourne, Australia 6 University of Evry Val d'Essonne, STAPS department, UFR SFA, François Mitterrand Boulevard 91025 Evry, France Key words: alkalosis, track-cycling, muscular oxygenation. The aim of this study was to evaluate the performance during all-out exercise tests with or without induced metabolic alkalosis, and to determine the oxygenation pattern of two specific cycling muscles: Biceps Femoris (BF) and Vastus Lateralis (VL). This parameter was measured by Near Infrared Spectroscopy (NIRS), a noninvasive and validated method using the absorption differences of light emitted in the infra-red close relation by the molecules of oxyhaemoglobin (HbO<sub>2</sub>) and deoxyhaemoglobin (HHb) (1). Twelve males, well-trained in cycling, successively performed two 70s identical all-out exercises (delta 30% between P-VO<sub>2</sub>max and Pmax) individually pre-established by a VO<sub>2</sub>max test (P-VO<sub>2</sub>max) and a strength-speed test (Pmax) on cycle ergometer. This study was conducted in a double-blind fashion, either after ingestion of a placebo (PLA) or after 0.3g.kg<sup>-1</sup> of sodium bicarbonate (BIC). Levels of HbO<sub>2</sub> and HHb were recorded on the surface of the BF and VL. Blood samples were taken before exercise and during recovery. The mean power (W) was significantly improved in BIC condition (P<0.01). After a steady state at rest, HHb increased and HbO<sub>2</sub> decreased, both significantly (P<0.001) from the onset of exercise. Although these patterns are previously observed in the literature (2), no significant difference of muscular oxygenation was observed according to experimental conditions. However, we noted a significant increase in HHb between the twentieth second and the end of exercise for the VL in both conditions whereas HHb remained stable for the BF. In conclusion our results suggest that muscular oxygenation of two specific muscles of cycling is not altered with induced alkalosis for this type of exercise, whereas the performance is improved. 1- Grassi B, Pogliaghi S, Rampichini S, Quaresima V, Ferrari M. Muscle oxygenation and pulmonary gas exchange kinetics during cycling exercise on-transitions in humans. *J Appl Physiol* 95:149–158, 2003. 2- Nielsen HB, Hein L, Svendsen LB, Secher NH, Quistorff B. Bicarbonate attenuates intracellular acidosis. *Acta Anaesthesiol Scand* 46:579–84, 2002.

### EFFECTS OF PRE-EXERCISE INGESTION OF SODIUM AND GLUCOSE ON PHYSIOLOGICAL RESPONSES AND PERFORMANCE DURING EXERCISE IN THE HEAT

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**Introduction** It has been suggested that pre-exercise hyperhydration using sodium-containing drinks reduces cardiovascular and heat strain during exercise, thereby improving exercise performance (Sims et al., 2007). Moreover, the effect of pre-exercise hyperhydration might be enhanced by adding glucose to the sodium drink, as the combination could stimulate sodium-glucose co-transporter activity in the intestinal membrane. We therefore examined the effects of pre-exercise ingestion of sodium-only and sodium-glucose drinks on physiological responses and performance during exercise in the heat. **Methods** Nine healthy men ingested a given amount (16-17 ml/kg body weight) of water (W) or a drink containing 0.7% NaCl (Na: 120 mEq/l Na+) or 0.7% NaCl + 6% Dextrin (Na+Dex: 120 mEq/l Na+, 58.34g/l dextrin) before conducting 90-min cycling at 50%VO<sub>2</sub>peak (SubEx), followed by cycling at 100%VO<sub>2</sub>peak until exhaustion (MaxEx) in the heat (35°C, 50%RH). **Results** Plasma volume (PV) was higher in Na and Na+Dex than in W before and during SubEx (P<0.05), and tended to be higher in Na+Dex than in Na before SubEx. Heart rate (HR), esophageal temperature (Tes) and mean arterial pressure (MAP) during SubEx were lower in Na and Na+Dex than in W (P<0.05), and did not differ between Na and Na+Dex during SubEx. MaxEx duration tended to be longer in Na than W, and was significantly longer in Na+Dex than W (P<0.05). MaxEx duration also tended to be longer in Na+Dex than Na. **Discussion** Previous study suggested that restoration of PV during exercise enhances skin vasodilation (a thermoregulatory response) and reduces Tes. Similarly, the higher PV in Na and Na+Dex may have induced greater skin vasodilation, contributing to a lower Tes in Na and Na+Dex. Moreover, if skin vasodilation was greater in Na and Na+Dex, total peripheral resistance may have been lower, leading to the lower MAP in those groups. On the other hand, Anderson et al. (2001) suggested that glycerol-induced hyperhydration improved 15-min maximal cycling performance following 90-min moderate-intensity cycling due to reductions in thermal and cardiovascular strain. The same mechanism could account for MaxEx duration being longer in Na and Na+Dex than W, since HR and Tes during SubEx were lower in Na and Na+Dex than W. In addition, greater glucose availability in Na+Dex might have increased MaxEx duration in Na+Dex over Na. **References** Anderson MJ, Cotter JD, Garnham AP, Casley DJ, Febbraio MA (2001). *Int J Sport Nutr*, 11, 315-333. Sims ST, van Vleet L, Cotter JD, Rehrer NJ (2007). *Med Sci Sport Exerc*, 39(1), 123-130.

### CAN PROTEINS INFLUENCE BRAIN-DERIVED NEUROTROPHIC FACTOR TYPE 2 DIABETIC PATIENTS?

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**CAN PROTEINS INFLUENCE BRAIN-DERIVED NEUROTROPHIC FACTOR (BDNF) TYPE 2 DIABETIC PATIENTS?** Tonoli, C.1, Hansen, D.2, Heyman, E.3, van Loon, L.J.C.2, Meeusen, R.1 1: VUB (Brussels, Belgium), 2: UM (Maastricht, The Netherlands), 3: UL (Lille, France) **Introduction** Longstanding Type 2 Diabetes Mellitus (T2DM) is associated with impaired cognitive function (Awad et al., 2004). Brain-derived neurotrophic factor (BDNF) is known to regulate synaptic plasticity, neurogenesis and neuronal survival. BDNF has also been suggested to play a major role in glucose metabolism due to its hypoglycaemic effects ascribed to a better insulin sensitivity (Krabbe et al., 2007). Since it is known that the oral ingestion of proteins also lowers blood glucose levels (Manders et al., 2006, 2009), it might be interesting to find out whether the ingestion of proteins also influences BDNF levels. We hypothesized that there is a better absorption of hydrolysed proteins and thus might influence blood glucose and BDNF levels even more. Therefore, we explored whether BDNF levels are influenced by an orally administered protein (hydrolysed) mixture. **Material & Methods** Forty-five T2DM patients (aged 60 ± 7.6y, BMI 29.93 ± 3.49 kg/m<sup>2</sup>) underwent 3 experimental trials in which either 0.7 g.kg<sup>-1</sup>.h carbohydrates (CHO), CHO + protein (PRO) (0.35 g.kg<sup>-1</sup>.h) or CHO + hydrolysed (H) protein (0.35 g.kg<sup>-1</sup>.h) were administered. During 4 hours, glucose levels, insulin levels and BDNF levels were measured. Statistical analysis of the data were performed using a two factor repeated measures analysis of variance (ANOVA). Correlations were calculated using Pearson's analysis. **Results** BDNF levels were not significantly increased in the CHO trial compared with the CHO + H PRO trial. In accordance with previous research, a significant decrease of all blood glucose values in the CHO + PRO trial and CHO + H PRO trial comparing the CHO trial (p<0.01), suggesting proteins stimulate a higher sensitivity for insulin. The hydrolyzed protein trial did not produce significant lower blood glucose levels compared to the not hydrolyzed protein trial. Further, an inverse relationship between BDNF levels and glucose concentrations was found in all trials after ingestion of the carbohydrate fluid, although they were not significant. **Discussion** Because of the significant decrease of blood glucose values in the protein trials, we demonstrated that proteins stimulate a higher sensitivity for insulin and play, like BDNF, also a role in glucose metabolism. Although, BDNF levels were not significantly increased in the CHO trial compared with the CHO + H PRO trial, this can suggest that proteins do not play a role in increasing BDNF levels and therefore we have to reject our hypothesis. **References** Awad N, et al. (2004). *J Clin Exp Neuropsychol* 26, 1044-1080. Krabbe K, et al. (2007). *Diabetologia* 50, 431-438. Manders RJ, et al. (2006). *J Nutr* 136, 1294-9. Manders RJ, et al. (2009). *Eur J Clin Nutr* 63, 121-6.

## DIETARY NITRATE IMPROVES OXYGEN EFFICIENCY AND EXERCISE PERFORMANCE AT EXTREME ALTITUDE

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**Purpose:** Recent studies have shown that dietary nitrate supplementation reduces the oxygen cost of muscle contractions and enhances endurance exercise performance (1; 2). We hypothesized that these effects may be particularly relevant during exercise in hypoxia. Therefore, we investigated the effects of nitrate intake on muscle and brain oxygenation status and exercise performance at simulated altitude corresponding to Everest Base Camp (5,300m). **Methods:** In a randomized single-blind cross-over design ten male subjects (age  $25.6 \pm 1.4$  yr,  $\text{VO}_2\text{peak}$   $63 \pm 2.5$  mL.kg<sup>-1</sup>.min<sup>-1</sup>) received either beetroot juice containing 0.07mmol nitrate per kg b.w. per day (BR), or apple-black current juice serving as a placebo (PL), for 6 days preceding the experimental sessions. Subjects participated in two experimental sessions in a hypoxic facility @ 11% oxygen content, separated by a 2-weeks wash-out period. In each session and after a 2-hr rest period they performed a submaximal cycling test (EX30%, 20 min @ 30% sea level  $\text{W}_{\text{max}}$ ) as well as an incremental  $\text{VO}_2\text{max}$  test (EXmax, 50W + 20W.min<sup>-1</sup>). During exercise, oxygen uptake ( $\text{VO}_2$ ) (Cortex Metalyzer II) and blood lactate (Lactate Pro) were measured. Furthermore, tissue oxygenation status (TOI) in m. vastus lateralis and frontal cerebral cortex were assessed using near-infrared spectroscopy (Niro-200, Hamamatsu). **Results:** Compared with PL, during EX30% BR slightly reduced  $\text{VO}_2$  during the initial stage of exercise (-5%,  $P < 0.05$ ) but not during final stage. BR increased muscle TOI by 6% ( $P < 0.05$ ), while cerebral TOI was not significantly changed. BR reduced blood lactate during EX30% by ~10% ( $P < 0.05$ ). Compared with PL, during EXmax BR increased time-to-exhaustion by 4% ( $P < 0.05$ ) whilst  $\text{VO}_2\text{max}$  was 5% lower ( $P < 0.05$ ). Furthermore, BR also reduced systolic blood pressure (BR:  $123 \pm 2$  vs. PL:  $129 \pm 3$  mmHg,  $P < 0.01$ ). **Conclusion:** Six days of dietary nitrate supplementation improves oxygen efficiency during exercise at extreme altitude. **References:** 1. Ferreira LF and Behnke BJ. A toast to health and performance! Beetroot juice lowers blood pressure and the O<sub>2</sub> cost of exercise. *J Appl Physiol* 2010. 2. Vanhatalo A, Bailey SJ, Blackwell JR, Dimenna FJ, Pavey TG, Wilkerson DP, Benjamin N, Winyard PG and Jones AM. Acute and chronic effects of dietary nitrate supplementation on blood pressure and the physiological responses to moderate-intensity and incremental exercise. *Am J Physiol Regul Integr Comp Physiol* 299: R1121-R1131, 2010.

## DOES COINCIDING EXERCISE ONSET WITH PEAK CAFFEINE LEVELS IMPROVE CYCLING PERFORMANCE?

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**Introduction** Although the use of caffeine to enhance endurance performance is well documented, the optimal dose and timing of supplementation remains unclear. The ergogenic effect of caffeine is often assumed to be related to the levels of circulating drug present within the blood. The aim of this study was therefore to determine whether coinciding peak serum caffeine concentration with the onset of exercise would result in further improvements in performance compared with beginning exercise a standard one hour post-supplementation. **Methods** In this randomised, placebo controlled, double-blind crossover study, 14 male trained cyclists and triathletes (age  $31 \pm 5$  yr, body mass  $75.4 \pm 5.7$  kg,  $\text{VO}_2\text{max}$   $69.5 \pm 6.1$  mL.kg<sup>-1</sup>.min<sup>-1</sup> and peak power output  $420 \pm 35$  W, mean  $\pm$  SD) consumed 6 mg.kg<sup>-1</sup> caffeine or a placebo either 1 hour (C1h) prior to completing a 40 km time trial (TT40) in the laboratory or when the start of exercise coincided with individual peak serum caffeine concentrations (Cpeak). Cpeak was determined from a separate 'caffeine profiling' session that involved monitoring caffeine concentrations in the blood every 30 min over a 4-hour period. The trials were preceded by a standardised pre-exercise meal (2 g.kg<sup>-1</sup> carbohydrates) and subjects were tested for hydration and caffeine abstinence. Venous blood was sampled at baseline, 65 and 20 min prior to exercise and 6 min post-exercise for the measurement of serum caffeine, plasma glucose, catecholamine and blood lactate concentrations. **Results** Following caffeine ingestion, peak serum caffeine occurred 120 min in 12 participants and 150 min in 2 participants. Time to complete TT40 was significantly faster (2%;  $p = 0.002$ ) in C1h compared to placebo. A 1% improvement in performance was noted in Cpeak versus placebo, although this was not statistically significant ( $p = 0.240$ ). Whilst no differences in metabolic markers were found between Cpeak and placebo conditions, significant increases in glucose ( $p = 0.005$ ), norepinephrine and epinephrine ( $p = 0.002$ ) were observed in the C1h trial 6 min post-exercise versus placebo. **Discussion** The present study suggests that endurance cycling performance is enhanced when caffeine is ingested one hour prior to exercise. However, no significant improvements in performance were observed when peak serum caffeine concentrations coincided with the onset of exercise. Consequently, it appears that it is the temporal proximity of caffeine supplementation to the commencement of endurance exercise, rather than the achievement of peak serum caffeine concentration, that influences the ergogenic potential of caffeine.

## THE EFFECT OF VITAMIN C SUPPLEMENTATION ON THE AEROBIC PERFORMANCE

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**Introduction** It is beyond controversy that physical activity leads to an endogenous production of free radicals, namely and most importantly reactive oxygen species (ROS). It is assumed that the formation of ROS occurs during cellular respiration when a small share of the metabolized oxygen is converted to free radicals (Clarkson, 1995). The production of free radicals has been shown to affect the mitochondrial adaptation. Vitamin C has antioxidative properties and can reduce oxidative stress (Clarkson & Thompson, 2000) by neutralizing ROS action, which may affect exercise-induced mitochondrial adaptation (Finaud et al., 2006; Gomez-Cabrera et al., 2008). Hence, the aim of the present study was to investigate whether vitamin C supplementation during endurance training has a negative effect on aerobic performance capacity. **Methods** Fifteen subjects (weight:  $73.5 \pm 11.1$  kg, age:  $22.7 \pm 3$  y) participated in a placebo-controlled training study. Subjects were randomly assigned to the vitamin C-group (dose: 1000mg/d) or placebo-group. The subjects were enrolled in an interval training regimen with three exercise units per week. Before and after the 9-week supplementation period, each participant performed a  $\text{VO}_2\text{max}$ -test on a treadmill, a  $\text{VO}_2\text{max}$ -test on a bicycle ergometer and a submaximal (incremental) running test for the assessment of the running velocity at capillary blood lactate concentration of 4 mmol/l (v4). **Results** In both groups endurance performance capacity was significantly improved following the training -regimen. There was a non-significant tendency in favor of larger increases in the placebo-group when compared with the vitamin C-group. Absolute  $\text{VO}_2\text{max}$  (running):  $9.4 \pm 3.1\%$  vs.  $8.7 \pm 7.6\%$ ; relative  $\text{VO}_2\text{max}$  (running):  $10.9 \pm 2.9\%$  vs.  $9.1 \pm 7.7\%$ ; v4:  $12.8 \pm 8.3\%$  vs.  $10.4 \pm 7.3\%$ .  $\text{VO}_2\text{max}$  (cycling) and heart rate curves in the sub maximal running test showed inconclusive results. **Discussion** We did not find any significant differences with respect to the adaptation of endurance performance following vitamin C-supplementation. However, the tendency towards better improvements following placebo application indicates, that vitamin C-supplementation may neutralize ROS and lead to suboptimal mitochondrial adaptation. Further studies are neces-



sary to identify these effects with sufficient statistical power. References Clarkson P.M. (1995). *Crit Rev Food Sci Nutr*, 35, 131-41. Clarkson P.M., Thompson H.S. (2000). *Am J Clin Nutr*, 72, 637S-46S. Finaud J., Lac G., Filaire E. (2006). *Sports Med*, 36, 327-358. Gomez-Cabrera, M.G., Domenech, E., Romagnoli, M., Arduini, A., Borrás, C., Pallardo, F. V., Sastre, J., Vina, J. (2008). *Am J Clin Nutr*, 87, 142-149.

### ATTITUDES, KNOWLEDGE AND AWARENESS OF DIRECTORS OF PHYSICAL EDUCATION ON THE USE OF DIETARY SUPPLEMENTS AND ERGOGENIC AIDS BY ADOLESCENT ATHLETES – IS THERE A POLICY NEED?

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The efficacy and long-term safety of dietary supplement (DS) and ergogenic aid (EA) use by adolescent athletes are factors largely unknown due to the ethical complications of testing such products on this population. Despite this, the use of DS and EA, by adolescent athletes is common. How adolescents, within the Australian school environment, are guided with respect to DS and EA use remains unclear. This study aimed to reveal Heads/Directors of PE/Sports current attitudes, knowledge and awareness of DS and EA use by adolescent athletes. Additionally, the study aimed to investigate school policies and/or guidelines associated with DS and EA use by adolescent athletes. Initially 35 private secondary schools and public secondary schools with sporting excellence programs from south east Queensland were invited to participate. Representatives from 13 schools (37% response) agreed to an individual semi-structured interview which were subsequently thematically analysed. Results indicated an awareness of supplement use by students. Prevalence of supplement use was largely unknown. Sports drinks were the most commonly reported DS and/or EA provided to adolescent athletes within the school setting, while one school indicated the provision of protein powder. Awareness by Heads/Directors of PE/Sport of credible and reliable information on DS and EA is limited. The investigation did not identify a school policy of any kind regarding DS and EA use. The majority of Heads/Directors of PE/Sport were supportive of a school policy of some kind. The primary expected outcome of such a policy, as indicated by Heads/Directors of PE/Sport, would be the ability to provide more consistent advice and/or guidelines to adolescent athletes, across all school staff and in particular, school appointed coaches.

### DEVELOPMENT OF A SPORTS NUTRITION KNOWLEDGE QUESTIONNAIRE FOR SOCCER

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**Introduction** The purpose of the study was to design a specific sports nutrition knowledge questionnaire (Q) for soccer. **Methods** The Q was designed in Greek by five experts (2 sports dietitians, 2 exercise physiologists and 1 exercise biochemist) and consisted of two sections, that is, a section of 40 questions on general nutrition concepts (GS), and a specific section of 60 questions on sports nutrition (SS). To test the validity the Q was distributed to 4 groups of 50 persons each: 1) dietitians, 2) sports scientists specialized in exercise physiology or/and sports nutrition, 3) physical education and sports science students (PES) and 4) life insurance employees. Furthermore, a group of 23 PES completed the Q before and after a 10-week course on sports nutrition (SN). Groups 1 and 4 completed the Q twice in order to test its reliability. The Q was also translated in English, and the two versions were administered to 50 Greek native speakers with a British university degree or a university degree in English literature (group 5). **Results** The overall, GS and SS scores were higher ( $p < 0.01$ ) in groups 1 (Overall:  $84.7 \pm 1.2$ ; GS:  $37.1 \pm 0.3$ ; SS:  $47.6 \pm 1.2$ ) and 2 (Overall:  $83.5 \pm 1.0$ ; GS:  $35.6 \pm 0.3$ ; SS:  $47.9 \pm 0.8$ ) compared to groups 3 (Overall:  $54.3 \pm 1.2$ ; GS:  $24.3 \pm 0.7$ ; SS:  $30.0 \pm 0.7$ ) and 4 (Overall:  $44.5 \pm 1.6$ ; GS:  $22.4 \pm 0.8$ ; SS:  $22.1 \pm 1.2$ ) (mean  $\pm$  SE). The overall and SS scores in group 3 were higher ( $p < 0.01$ ) compared to group 4. Also, the SN group scored higher ( $p < 0.01$ ) after the 10-week sports nutrition course (Overall:  $73.6 \pm 2.0$ ; GS:  $32.3 \pm 1.0$ ; SS:  $41.3 \pm 1.3$ ) compared to before (Overall:  $64.3 \pm 1.7$ ; GS:  $29.7 \pm 0.9$ ; SS:  $34.6 \pm 1.5$ ). The correlation coefficients between the first and second time of completion of the Q in groups 1 and 4 for the overall, GS, and SS scores were 0.98, 0.96, and 0.98, respectively. The corresponding correlations between the Greek and English versions in group 5 were 0.94, 0.84, and 0.94 ( $p < 0.01$ ). **Discussion** These data suggest that the Q developed is valid and reliable; thus, it can be used to test the sports nutrition knowledge of soccer players and coaches.

## Poster presentations

### PP-PM02 Vascular/Heart Rate/Control

#### AEROBIC EXERCISE TRAINING FOR PATIENTS WITH EARLY ABDOMINAL AORTIC ANEURYSM DISEASE: A FEASIBILITY STUDY

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At present, no effective medical strategy exists for patients with early abdominal aortic aneurysm (AAA) disease (i.e., those with an AAA diameter 30-55 mm); most of these individuals enter a serial surveillance programme under the guise of 'watchful waiting'. Aerobic exercise training might be a useful therapeutic tool for these patients, because it has the potential to reduce aneurysm progression via improved aortic haemodynamics and reduced inflammation (Dalman et al., 2006: *Annals of the New York Academy of Sciences*, 1085, 92-109), reduce the risk of many chronic diseases (e.g. coronary artery disease), and increase cardiopulmonary fitness. However, the role of exercise training for patients with early AAA disease is currently unclear. The purpose of this preliminary study was to investigate the safety of aerobic exercise training and its effect on cardiopulmonary fitness in patients with early AAA disease. With Local Research Ethics Committee approval, 23 patients with early AAA disease (age  $71.5 \pm 6.8$  y, AAA diameter  $40 \pm 7$  mm) were randomly allocated either to a supervised exercise training group or a no-exercise control group. Patients in the exercise group completed three 35-45 minute sessions of aerobic exercise per week for 12 weeks. The exercise involved treadmill walking and stationary cycling at a light-to-moderate intensity (11-13 on Borg's 6-20 Rating of Perceived Exertion Scale; Borg, 1998: Borg's rating of perceived exertion and pain scales. Leeds: Human Kinetics). The safety of the exercise intervention was assessed by monitoring changes in aneurysm diameter (B-mode ultrasonography) between baseline and 12 weeks, as well as the frequency of exercise-related adverse events. The effectiveness of the exercise programme was primarily determined by assessing changes in ventilatory threshold (breath-by-breath gas analysis during an incremental cycling protocol) between baseline and 12 weeks. Effect sizes (Cohen's d) were calculated as the difference between the standardised

mean changes for the exercise and control groups (Morris, 2008: Organizational Research Methods, 11, 364–386), with 0.2, 0.5 and 0.8 considered small, moderate and large effects, respectively. Eighteen patients completed the study (exercise  $n = 7$ , control  $n = 11$ ). Mean compliance to the exercise programme was 98%. There was no evidence of exercise-related aneurysm enlargement (e.g., AAA diameter: exercise  $43 \pm 7$  to  $44 \pm 7$  mm, control  $38 \pm 6$  to  $39 \pm 6$  mm;  $d = 0$ ) and no exercise-related adverse events. There was a larger increase in ventilatory threshold in the exercise group than the control group (exercise  $14.2 \pm 3.0$  to  $16.5 \pm 3.9$  mL $\cdot$ kg $^{-1}$  $\cdot$ min $^{-1}$ , control  $12.9 \pm 3.7$  to  $13.2 \pm 3.8$  mL $\cdot$ kg $^{-1}$  $\cdot$ min $^{-1}$ ;  $d = 0.54$ ). Our preliminary findings suggest that light-to-moderate aerobic exercise training in the form of treadmill walking and stationary cycling is safe and can improve cardiopulmonary fitness in patients with early AAA disease. More patients will be recruited to test the consistency of this finding.

## CEREBROVASCULAR RESPONSES DURING HEAD-UP TILT ARE WELL-MAINTAINED FOLLOWING INTERMITTENT EXERCISE

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**Introduction** Postural syncope is common following prolonged, continuous-exercise (CON). Postural-related reductions in middle cerebral artery velocity (MCAv), mean arterial blood pressure (MAP) and stroke volume (SV) are exaggerated after 30 min of CON, but orthostatic tolerance itself is not compromised (Murrell et al., 2010). Daily living and many team sports involve intermittent-exercise (INT) rather than CON. Although it is emerging that INT can elicit very different physiological responses than CON (Jones et al., 2009), the specific responses to a postural change following INT are unknown. Therefore, this study is the first to examine the cardiovascular and cerebrovascular responses to a head up-tilt following 30 min of INT. We hypothesised that the postural-related reductions in MCAv would be greater following INT. **Methods** Nine healthy participants aged  $27 \pm 3$  yrs, completed three 10-min bouts of cycling at 60% of max work rate (MWR), with each bout separated by 10 min of rest. Another sample of 12 healthy participants aged  $25 \pm 1$  yrs completed a single 10-min bout of cycling at 50% MWR. Continuous beat-to-beat recordings of MCAv, MAP, SV, cardiac output (CO), heart rate (HR), and end-tidal carbon dioxide (PETCO<sub>2</sub>) were obtained during supine rest and a 60° head up-tilt (15 min) prior to and following the exercise protocols. Pre-post-exercise differences were analysed using paired t-tests and reported as mean $\pm$ SE. **Results** Tolerance to the head up-tilt was unaffected by both INT and CON ( $P > 0.10$ ). Following INT, resting HR and CO were elevated by  $8 \pm 2$  beats $\cdot$ min $^{-1}$  and  $1.2 \pm 0.03$  L $\cdot$ min $^{-1}$  respectively ( $P \leq 0.02$ ). The postural reductions in mean MCAv, MAP, SV, CO, and PETCO<sub>2</sub> were unaffected by INT ( $P \geq 0.12$ ). Following CON, resting mean MCAv, and HR were elevated by  $8 \pm 0$  cm $\cdot$ s $^{-1}$  and  $7 \pm 0$  beats $\cdot$ min $^{-1}$  respectively, whereas MAP was reduced by  $6 \pm 0$  mm Hg ( $P \leq 0.04$ ). Postural reductions in mean MCAv and CO were  $8 \pm 3$  cm $\cdot$ s $^{-1}$  and  $0.6 \pm 0.1$  L $\cdot$ min $^{-1}$  greater respectively following CON ( $P \leq 0.03$ ). **Discussion** Unlike after CON, our data indicate that the cerebrovascular and cardiovascular responses to head-up tilt are well-maintained following INT, even if the total exercise duration is longer. This differential influence of exercise type on cardiovascular and cerebrovascular control during orthostatic stress has implications for exercise prescription to individuals with an underlying medical condition (e.g. autonomic failure) which may increase the risk of cerebral hypoperfusion and the onset of postural syncope following exercise. **References** Jones H et al. (2009). Chronobiol Int, 26, 293-306. Murrell CJ et al. (2010). Exp Gerontol, 46, 1-8.

## SEDENTARY BEHAVIOUR OR PHYSICAL ACTIVITY: WHAT'S IMPORTANT FOR VASCULAR HEALTH IN CHILDREN?

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**Background:** Vascular dysfunction is the earliest detectable manifestation of cardiovascular disease (CVD) and is a strong independent predictor of CV events. We have previously demonstrated both a cross sectional (Hopkins et al., 2009) and longitudinal (Hopkins et al., 2010) relationship between physical activity (PA) and vascular function in children. Some recent evidence suggests that sedentary behaviour (SB) is independently associated with CVD risk and mortality. This may lead to future public health campaigns that promote a reduction in SB rather than an increase PA. We therefore sought to determine the relationship between SB and vascular function in children. To this end we assessed basal associations between SB and vascular function, along with the relationship between changes in SB and vascular function. **Study Design and methods:** We studied 116 children (70♀:  $10.7 \pm 0.3$ ; 46♂:  $10.7 \pm 0.3$  yrs) on two occasions; in the summer (June) and late autumn (November). We assessed vascular function via flow-mediated dilation (FMD) using high resolution Doppler ultrasound. Sedentary behaviour was assessed using objective uni-axial accelerometry. Data was adjusted for age, maturation and physical activity level. **Results:** At baseline there were no significant differences between girls and boys. FMD, a preclinical marker of atherosclerosis, was not associated with SB in either group or in the cohort as a whole. Although FMD decreased significantly ( $10.0 \pm 4.3$  to  $7.9 \pm 3.9\%$ ,  $P < 0.001$ ) and SB significantly increased ( $499.1 \pm 103.5$  to  $559 \pm 81.6$  min/day,  $P < 0.001$ ) between the seasons, no relationship existed between changes in these variables. **Conclusions:** Our findings suggest that SB, and changes in SB, are not associated with vascular function in children. When taken with our previous findings which demonstrate a relationship between vascular function and PA, these results suggest that promotion of increased PA, rather than avoidance of SB, may yield the greatest results in terms of improving vascular health. **References** Hopkins N, Stratton G, Tinken TM, McWhannell N, Ridgers ND, Graves LEF, Cable NT, Green DJ (2009). Atherosclerosis 204: 244-249. Hopkins N, Stratton G, Tinken T, Ridgers N, Graves L, McWhannell N, Cable N, Green D (2010) Med Sci Sports Exerc 43 (2): 232-238.

## ACUTE INTERVAL AND CONTINUOUS MODERATE INTENSITY AEROBIC EXERCISE DOES NOT IMPROVE CAROTID ARTERIAL STIFFNESS IN POSTMENOPAUSAL WOMEN

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**Introduction** Postmenopausal women have greater arterial stiffness than premenopausal women due to the loss of oestrogen, increasing cardiovascular disease risk (2). Acute bouts of moderate intensity exercise improve arterial stiffness (1), with greater improvements produced after interval exercise (IE) when compared with continuous exercise (CE; 3). However, these sessions are rarely matched for duration, work completed and O<sub>2</sub> consumption and have not been studied in postmenopausal women. We designed a study that matched IE and CE for total work and duration and hypothesised that IE would exert greater improvements on carotid arterial vascular parameters than CE. **Methods** Eleven sedentary postmenopausal women ( $63 \pm 3$  years) performed a 30 min continuous moderate intensity exercise session at 80% of lactate threshold on a cycle ergometer. On a separate day, participants completed a work matched IE

session, (10s at a work rate equivalent to 90% VO<sub>2</sub>peak with 20s recovery repeated for 30 min). Carotid arterial stiffness measures were collected using ultrasound imaging and applanation tonometry before and at 20 minutes post exercise. Results An acute session of CE or IE did not improve carotid arterial stiffness parameters in postmenopausal women at 20 minutes post exercise, (Brachial SBP Pre CE:136±15 mmHg, Post CE:135±12 mmHg, Pre IE:138±19 mmHg, Post IE:134±15 mmHg, P=0.37; Carotid SBP Pre CE:126±11 mmHg, Post CE:121±11 mmHg, Pre IE:125±16 mmHg, Post IE:121±12 mmHg, P=0.84; Carotid Pulse Pressure Pre CE:43±9 mmHg, Post CE:40±9 mmHg, Pre IE:43±14 mmHg, Post IE:39±9 mmHg, P=0.61; Carotid delta cross-sectional area Pre CE:4.3±1.7 mm<sup>2</sup>, Post CE:4.4±1.1 mm<sup>2</sup>, Pre IE:4.4±1.7 mm<sup>2</sup>, Post IE:4.1±0.9 mm<sup>2</sup>, P=0.23; Carotid compliance Pre CE:0.10±0.05 mm<sup>2</sup>/mmHg, Post CE:0.11±0.02 mm<sup>2</sup>/mmHg, Pre IE:0.11±0.04 mm<sup>2</sup>/mmHg, Post IE:0.11±0.03 mm<sup>2</sup>/mmHg, P=0.71; Carotid distensibility Pre CE:0.003±0.001 mm/mmHg, Post CE:0.003±0.001 mm/mmHg, Pre IE:0.003±0.002 mm/mmHg, Post IE:0.003±0.001 mm/mmHg, P=0.23). Discussion An acute bout of moderate intensity aerobic exercise does not alter carotid arterial stiffness in postmenopausal women and is not any lower after IE when compared to CE. These findings do not support the hypothesis or previous studies. However, our study measured arterial stiffness in postmenopausal women, which unlike the individuals used in previous studies, is a population prone to higher arterial stiffness. Thus, postmenopausal women may require a higher exercise intensity to initiate vascular improvements. References 1 Kingwell, B.A. et al. (1997). *Am J Physiol* 273, H2186- H2191 2 Moreau, K.L. et al. (2003). *Cardiovas Res* 57, 861-868 3 Tordi, N. et al. (2010). *Eur J Appl Physiol* 108, 801-809

## ENDOTHELIAL FUNCTION IS IMPAIRED IN POLYCYSTIC OVARIAN SYNDROME AND CAN BE IMPROVED WITH EXERCISE TRAINING

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Introduction Polycystic ovarian syndrome (PCOS) is associated with abdominal obesity, insulin resistance and elevated hepatic fat. This adverse cardiovascular disease (CVD) risk profile is associated with ~2 fold increased risk of coronary artery disease. Limited research exists regarding the cardiometabolic effects of exercise in PCOS, and its impact on endothelial function, an early indicator of CVD risk, has not been explored. We hypothesised that PCOS patients would exhibit decreased endothelial function when compared to matched controls and that an exercise intervention would improve endothelial function and reduce fat deposition in PCOS. Methods PCOS (n=9, age 27±2 yrs, BMI 30±2 kg/m<sup>2</sup>) and control (n=9, age 27±2 yrs, BMI 29±2 kg/m<sup>2</sup>) subjects were matched for age and BMI. Brachial artery endothelial function was assessed using flow mediated dilation (FMD). Visceral and subcutaneous fat was quantified by whole body magnetic resonance imaging and <sup>1</sup>H magnetic resonance spectroscopy determined hepatic fat. All PCOS women completed a 16-week supervised exercise program (93% exercise compliance), after which all assessments were repeated. Differences between PCOS and controls, and changes with exercise in the PCOS group were analysed using t-tests. Data are presented as mean±SE. Results FMD was impaired in PCOS compared to controls (7.1±1.1 vs 11.8±1.1%; P=0.02). FMD improved following exercise training (7.1±1.1 vs 10.3±0.8%; P=0.04) and was accompanied by a reduction in abdominal subcutaneous fat (12.0±1.6 vs 11.0±1.6 l; P=0.03). Cardiorespiratory fitness improved by 4.7 ml.kg<sup>-1</sup>.min<sup>-1</sup> (P=0.01) and waist circumference tended towards a reduction (98.2±4.5 vs 94.1±5.5 cm; P=0.09). Favourable effects were observed in hepatic fat, total subcutaneous fat, total and abdominal visceral fat, BMI, and body mass; however these reductions were not statistically significant. Discussion The novel finding of this study is that impaired endothelial function in PCOS patients can be improved by 45% with an exercise intervention. This was accompanied by a reduction in abdominal subcutaneous fat. These data suggest that the utilisation of exercise as a non-pharmacological management strategy has multiple therapeutic effects on CVD risk and the recurrent issue of abdominal obesity in this high risk patient group.

## CONDUIT ARTERY REMODELLING IN ELITE ATHLETES: INSIGHTS INTO LOCALISED AND SYSTEMIC ADAPTATIONS

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Rowley N.J.1, Thijssen D.1,2, Dawson E.1, Cable T.1, George K.1, Whyte G.1, Green D.J.1,3 1:LJMU(Liverpool, UK), 2:RUMC(Nijmegen, Netherlands), 3:UWA(Perth, Australia) Introduction The effects of exercise on conduit artery structure are directly relevant to explaining the cardiovascular benefits of exercise. However, the impact of training on arterial remodelling in humans, particularly the effect of different haemodynamic stimuli, has not been fully characterised. Methods To examine localised versus systemic effects of chronic exercise training on arterial wall thickness (WT) and diameter, we recruited distinct groups of elite athlete including squash players (Sq n=13), lower limb endurance athletes (LE, n=13), canoe paddlers (CP, n=12) and matched healthy inactive controls (C, n=16). Spinal cord injured patients (SCI, n=9) were also included. Brachial and superficial femoral artery (SFA) characteristics were assessed in all groups using high resolution duplex ultrasound, with dominant and non-dominant brachial arteries also assessed in the Sq group. Results Brachial diameters were significantly larger in dominant versus non-dominant limb of Sq at rest (4.9±0.5 vs 4.3±0.4mm, P<0.05) and in response to a dilator stimulus (5.5±0.5 versus 4.8±0.4, P<0.05). Similar effects were apparent in peak blood flow responses (1118±326 vs 737±219ml/min, P<0.01). In addition, CP (4.9±0.8) and Sq (4.9±0.5) possessed significantly larger brachial diameters than C (4.1±0.5, P<0.05). LE and SCI subjects' brachial diameters did not differ significantly from C. These findings suggest that both conduit and resistance artery remodelling of diameter occurs in response to localised effects of training. Athletic groups demonstrated lower WT than C and SCI subjects across all arteries studied (carotid: Sq 510±60µm, LE 530±110, CP 560±70µm vs SCI 660±70µm, C: 620±70µm, all P<0.05; brachial: Sq 239±100, LE 270±80, CP 370±110 vs SCI 488±70, C 520±100, all P<0.01; SFA: Sq 480±40, LE 490±60, CP 480±70 vs SCI 580±60, C 630±120, all P<0.01). In contrast to the arterial diameter data, no differences in WT were evident between dominant and non-dominant limbs of the Sq group (239±100 vs 234±133). These findings suggest that remodelling of the conduit artery wall occurs systemically in response to exercise training in humans. Discussion This is the first study in humans to attempt to uncouple localised and systemic effects on artery size and WT in response to exercise. We provide evidence for systemic effects of exercise training on arterial WT, possibly mediated by the impact of training on arterial pressure. In contrast, the impacts of exercise on conduit and resistance artery cross sectional size appear to be dictated more by localized, and possibly shear-stress mediated, effects. These findings have implications for our understanding of the anti-atherogenic effects of exercise training in humans.

### EFFECT OF DEGREE OF 6-MONTH WEIGHT-LOSS SUPPORT PROGRAM ON ARTERIAL STIFFNESS: A RANDOMIZED CONTROLLED TRIAL IN MIDDLE-AGED OVERWEIGHT HUMANS

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**BACKGROUND:** Increase in arterial stiffness has been identified as powerful and independent risk factor for cardiovascular disease. Arterial stiffness in obese humans is higher than that in normal weight humans. Weight reduction by lifestyle modification, i.e., low-calorie diet and/or habitual exercise, decreases in arterial stiffness in obese subjects. However, the effect of degree of weight-loss support on arterial stiffness in obese subjects has not yet been clarified. Therefore, we investigated whether degree of weight-loss support affects arterial stiffness in middle-aged overweight humans. **METHODS:** A total of 188 middle-aged overweight men and women participated in a 6-month randomised controlled trial with body weight as the primary outcome measure ( $51 \pm 7$  years, BMI:  $29.0 \pm 3.2$  kg/m<sup>2</sup>). Participants were randomly assigned to the control (CON, n=63), moderate intervention (MI, n=62), and intensive intervention (II, n=63) groups. We provided a single motivational lecture on weight loss to all 3 groups, educational materials (textbooks, notebooks, and a pedometer) to groups MI and II, and group-based support programme to the II group. Before and after the 6-month intervention, body weight and arterial stiffness were measured. The arterial stiffness was evaluated by brachial-ankle pulse wave velocity (baPWV). One participant in MI group was excluded for the incomplete evaluation of baPWV. **RESULT:** After the 6-month intervention, the participants decreased their body weight by  $2.9 \pm 4.1$  kg,  $4.7 \pm 4.0$  kg, and  $7.7 \pm 4.1$  kg in groups CON, MI, and II, respectively with intention-to-treat analysis. All between-group differences were significant. Although baPWV significantly decreased in all groups, there were no significant differences in the changes of baPWV among the groups. **CONCLUSION:** The present study demonstrates that lifestyle modification decreases body weight and arterial stiffness in middle-aged overweight humans. However, the degree of weight reduction or weight-loss support does not affect arterial stiffness. Therefore, mild weight loss may be sufficient to improve arterial stiffness in middle-aged overweight humans. This work was supported by the JA Ibaraki Public Welfare Federation and Grants-in-Aid for Scientific Research 21300234 and 21650179 from Japan Society for the Promotion of Science.

### AEROBIC EXERCISE TRAINING INCREASES MIDDLE CEREBRAL BLOOD FLOW VELOCITY IN POSTMENOPAUSAL WOMEN

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**Background:** It is known that cerebral blood flow declines with aging. As low cerebral blood flow is associated with cognitive decline, cerebral hypoperfusion may precede and possibly contribute to dementia. Aerobic exercise training increases cognitive function, brain volume, and the number of cerebrovascular vessel in older subjects. Recently, a cross-sectional study demonstrates that regular aerobic exercise elevates middle cerebral blood flow velocity. To provide direct evidence that regular aerobic exercise increases middle cerebral blood flow velocity, the present study investigated whether aerobic exercise training increases middle cerebral blood flow velocity in postmenopausal women. **Methods:** Twenty-two healthy postmenopausal women (53-77 yr old) were assigned to the exercise group (n=12) and the control group (n=10). The exercise group completed an 8-week moderate aerobic exercise intervention (60-75% of maximal heart rate, 30-45 min/day, 3-5 days/week). Before and after intervention, we measured middle cerebral blood flow velocity with Transcranial Doppler ultrasonography. **Results:** There was no difference in baseline middle cerebral blood flow velocity and most other key dependent variables between the groups. Maximal oxygen uptake in the exercise group increased after exercise intervention. Middle cerebral blood flow velocity increased significantly in the exercise group, whereas no such change was observed in the control group. **Conclusion:** We demonstrated that aerobic exercise training increases middle cerebral blood flow velocity in postmenopausal women. This finding suggests that regular aerobic exercise may depress the decrease in aging-induced cerebral blood flow. This work was supported by Grants-in-Aid for Scientific Research 21300234 and 21650179 from Japan Society for the Promotion of Science.

### HEART RATE COMPLEXITY AND VARIABILITY AFTER ENDURANCE, STRENGTH AND COMBINED ENDURANCE AND STRENGTH TRAINING IN AGEING WOMEN

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**HEART RATE COMPLEXITY AND VARIABILITY AFTER ENDURANCE, STRENGTH AND COMBINED ENDURANCE AND STRENGTH TRAINING IN AGEING WOMEN** Karavirta, L. 1, Costa, M.D. 2, Goldberger, A.L. 2, Mietus, J.E. 2, Tulppo, M.P. 3, Laaksonen, D.E. 4, Nyman, K. 5, Keskitalo, M. 1, Häkkinen, A. 1,5, Häkkinen, K. 1 1 University of Jyväskylä (Jyväskylä, Finland), 2 Harvard Medical School (Boston, MA, USA), 3 Verve Research (Oulu, Finland), 4 Kuopio University Hospital and University of Eastern Finland (Kuopio, Finland), 5 Central Finland Central Hospital (Jyväskylä, Finland) **Introduction** Age-related structural and functional changes in the cardiovascular system decrease the complexity of heart rate (HR) control, leading to impaired ability to adapt to physiological stress (Lipsitz 2004). In the present study, training mode-specific effects of endurance and strength training and their combination on HR complexity and HR variability were examined in ageing women. **Methods** 90 previously untrained female volunteers aged 40 to 65 years completed a 21-week progressive training period of either endurance training twice a week, strength training twice a week, a combination of endurance and strength training on alternate days with a total of four times per week, or served as controls. Training was fully supervised and carefully controlled. Training adaptations of physical performance were quantified as maximal aerobic power output in a bicycle ergometer test to exhaustion and as one repetition maximum (1RM) in dynamic leg press. Short-term HR dynamics were determined at supine rest and during submaximal steady state exercise using standard time and frequency domain measures as well as complexity index (CI) derived from multiscale entropy analysis (Costa et al. 2002). **Results** Endurance training led to increases in CI and time and frequency domain measures of HR variability ( $P < 0.01$ ) when measured during exercise, whereas strength training alone or combined endurance and strength training did not produce significant changes in HR dynamics. Endurance training adaptations mainly occurred during the first ten weeks of training. At rest no training-induced changes were observed. In terms of physical performance, endurance and strength training led to expected training mode-specific improvements ( $P < 0.001$ ) in maximal aerobic power output and 1RM of leg press, respectively. **Discussion** The present findings emphasise the potential of endurance training to increase the complexity and variability of HR in ageing women. Regardless of the larger training volume in the combined training group, simultaneous training for endurance and strength did not produce further benefits for HR control but rather, might have impaired the endurance training-induced adaptations. **References** Lipsitz LA (2004). *Sci Aging Knowl Environ* 2004(16), pe16. Costa MD, Goldberger AL, Peng CK (2002). *Phys Rev Lett* 89(6), 068102.

## SPONTANEOUS BAROREFLEX CONTROL OF HEART RATE DURING ACTIVATION OF THE MUSCLE METABOREFLEX IN THE FOREARM AND CALF IN HUMANS

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**Introduction** We previously suggested that, in humans, muscle metaboreflex (MMR) activation induced by postexercise muscle ischemia (PEMI) increases cardiac parasympathetic tone (Nishiyasu et al., 1994) as well as the sensitivity of the spontaneous baroreflex control of heart rate (SBRS) (Ichinose et al., 2007). The aim of the present study was to test the hypothesis that changes in cardiac autonomic tone and SBRS induced by PEMI following isometric handgrip and plantar flexion exercises are not identical. **Methods** Eleven healthy subjects performed 90-s isometric handgrip (FOREARM) and plantar flexion (CALF) exercises at 30% maximal voluntary contraction (MVC). Subjects also performed an isometric plantar flexion exercise at 70% MVC, which elicited a PEMI-induced pressor response that matched the response elicited by FOREARM (CALF-matched). Each bout of exercise was followed by a 5-min period of imposed PEMI. We estimated cardiac autonomic tone using spectral analysis of beat-to-beat variation in the R-R interval, while SBRS was evaluated using transfer function analysis of systolic arterial pressure and R-R interval. **Results** Although mean arterial pressure (MAP) during PEMI was higher than during rest in all trials, MAP during PEMI was lower in CALF than FOREARM, and there was no difference between CALF-matched and FOREARM. Also during PEMI, cardiac parasympathetic tone and SBRS were higher in FOREARM than during rest, but did not differ from rest in CALF or CALF-matched. **Discussion** Consistent with an earlier study (Carrington et al., 2004), we found that PEMI-induced pressor responses after forearm exercises were greater than after calf exercises of the same relative intensity. We also confirmed that PEMI increases cardiac parasympathetic tone and SBRS following forearm exercise. That was not the case with PEMI after calf exercise, even though the relative intensity of the exercise or the degree of the PEMI-induced pressor response was comparable to the forearm exercise. This suggests the effects of MMR on cardiac autonomic nervous system and arterial baroreflex functions differ, depending upon whether the MMR is engaged in the forearm or calf muscles. **References** Carrington CA, Fisher JP, Davies MK, White MJ (2004). Clin Sci, 107, 197-204. Ichinose M, Koga S, Fujii N, Kondo N, Nishiyasu T (2007). Am J Physiol Heart Circ Physiol, 293, H416-H424. Nishiyasu T, Tan N, Morimoto K, Nishiyasu M, Yamaguchi Y, Murakami N (1994). J Appl Physiol, 77, 2778-2783.

## A COMPARISON BETWEEN GOW HEART RATE MONITOR AND A COMMERCIAL ECG FOR MEASUREMENT OF HEART RATE VARIABILITY DURING EXERCISE.

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**Introduction** Heart rate variability (HRV) is the oscillation of the time interval between consecutive heartbeats (Task Force 1996). It's a useful tool that provides information of the autonomic regulation of cardiac function (Buchheit and Gindre 2006). Its usefulness is recognized in many areas, from cardiology (Karp, Shiyovich et al. 2009), to the sports field (Hedelin, Wiklund et al. 2000; Mourrot, Bouhaddi et al. 2004; Cottin 2006). In this study we try to compare HRV data from a smart textile system for recording heart rate variability (GOW) and an electrocardiogram machine (LYNX® signal conditioner) commonly used in hospitals, during a continuous cycling test. **Methods** 6 cardiology patients performed a cycling test at stable intensity, heart rate variability data was recorded by the two systems during the test. 3' RR segments were taken to compare time intervals between beats and HRV variables, using Bland-Altman analysis and intraclass correlation coefficient (ICC). **Results** Limits of agreement (LoA) were stable on RR intervals around 4 ms (Widest LoA: -7.979 to 7.457; Tightest LoA: -4.351 to 3.553; Medium LoA, -4.39 to 4.90). HRV variables present ICC to ensure interchangeability of the methods in 5 of 7 variables. However RMSSD, HF and SD1 have large LoA. **Discussion** Time intervals between heartbeats recorded by two methods were similar, LoA was about the difference on sampling times (1ms for Lynx and 4 ms for GOW) (Weippert, Kumar et al. 2010). Correlation on HRV variables between the two methods is good except for RMSSD, HF and SD1, related to short-term variability (Task Force 1996), and sensitive to different sampling times (Gamelin, Berthoin et al. 2006). We conclude that both systems have excellent agreement in the register of RR intervals, but they are not so great for HRV variables related to the short time. **References** Buchheit, M. Buchheit, M. and C. and C. Gindre (2006). American Journal of Physiology - Heart and Circulatory Physiology 291 (1): H451-H458. Cottin, F., Leprêtre, P.-M., Lopes, P., Papellier, Y., Medigue, C., Billat, (2006). International Journal of Sports Medicine Gamelin, F. X., S. Berthoin, et al. (2006). Medicine & Science in Sports & Exercise 38(5): 887-893 Hedelin, R., U., Wiklund, et al. (2000). Medicine & Science in Sports & Exercise 32 (9): 1531-1533. Karp, E., Shiyovich, et al. (2009). Cardiology 114 (4): 275-283 Mourrot, L., M., Bouhaddi, et al. (2004). Clinical Physiology and Functional Imaging 24 (1): 10-18 Task Force (1996). European Heart Journal 17 (3): 354-381 Weippert, M., Kumar, et al. (2010). European Journal of Applied Physiology 109 (4): 779-786

## ELEVATION BLOOD FLOW IN COMMON CAROTID ARTERY WITH AEROBIC FITNESS IN ELDERLY WOMEN

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**Introduction** It is known that cerebral blood flow (CBF) declines with aging in sedentary adults. Previous studies suggested that habitual aerobic-endurance exercise elevates the resting CBF in healthy male adults (Ainslie et al. 2008) and middle-aged monkeys (Rhyu et al. 2010). However it has not yet been examined in elderly women whether aerobic fitness level affects the CBF. The aim of the present study was to determine the relationship between CBF and aerobic fitness in elderly women over 65 years old. **Methods** The subjects comprised 92 healthy elderly women (range 66 to 88 years). The blood flow in common carotid artery (CCA) measurements were performed with subjects in the spine position following 3-min of rest. The right CCA blood flow velocity and mean vessel diameter were measured using a Doppler Ultrasound system (Vivid-e, GE Healthcare, Japan). The CCA blood flow volume was calculated  $\pi \times (\text{mean vessel diameter} / 2)^2 \times \text{blood flow velocity} \times 60$ . The ratio of mean arterial pressure to CCA blood flow volume was to calculate as index of cerebrovascular resistance. In addition, aerobic fitness was measured using a 6-min walking distance test. Subjects were divided into either high (FIT) or low (UNFIT) aerobic fitness groups based on a walk distance result of 6-min walking distance test. FIT and UNFIT of mean walking distance was  $547 \pm 27$  m (N=45) and  $421 \pm 88$  m (N=47), respectively. **Results** CCA blood flow velocity was not different FIT and UNFIT. CCA mean vessel diameter in the FIT was significantly larger than in the UNFIT group ( $7.0 \pm 0.7$  vs.  $6.7 \pm 0.7$  mm,  $p < 0.05$ ). CCA blood flow volume in the FIT was significantly higher than in the UNFIT group ( $438 \pm 104$  vs.  $381 \pm 87$  ml/min,  $p < 0.05$ ). On the other hand, mean arterial pressure in the FIT was significantly lower than in the UNFIT group ( $94 \pm 13$  vs.  $99 \pm 16$  mmHg,  $p < 0.05$ ). Therefore, cerebrovascular resistance was significantly lower in the FIT than in the UNFIT group ( $0.22 \pm 0.06$  vs.  $0.27 \pm 0.07$  mmHg/ml.min<sup>-1</sup>,  $p < 0.01$ ). **Discussion** In elderly women, we found that CCA blood flow volume in the high aerobic fitness subjects was significantly higher as compared with

low aerobic fitness subjects. The significant low cerebrovascular resistance in high aerobic subjects probably reflects a lower vasoconstriction in the brain vasculature. These results suggest that habitual aerobic-endurance exercise in elderly women also contributes to reduce the risk of cerebrovascular disease. References Ainslie PN et al. *J Physiol*, 586, 4005-4010, 2008. Rhyu IJ et al. *Neuroscience*, 167, 1239-1248, 2010.

## THE EFFECTS OF SLEEP AND INTERMITTENT EXERCISE ON VASCULAR FUNCTION IN HUMANS

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**Introduction** An effect of intermittent exercise on vascular function is apparent in the afternoon, but not the morning (Jones et al., 2010). It is unclear whether this is due to a true diurnal effect (i.e. mediated by the body clock), or the impact of prior sleep on the vasculature. We therefore examined the effect of prior sleep on vascular endothelial function before and after an acute bout of intermittent exercise undertaken in the morning and afternoon. **Methods** Nine healthy, physically active males (aged 27±9 yrs) completed three 10-min bouts of cycling at 60% maximum work-rate, separated by 10-min rest periods. The exercise was performed on separate days beginning at either 08:00 or 16:00 h. To assess the impact of prior sleep, 4-hours of nocturnal or daytime sleep preceded the 08:00 and 16:00 h protocols. Ten minutes before and after each exercise bout, brachial artery vascular function was assessed using the flow-mediated dilation technique (FMD). Heart rate (HR), systolic and diastolic blood pressure (BP) was also monitored continuously. Data were analysed using general linear models and Newman-Keuls multiple comparisons and presented as mean±SD. **Results** When prior sleep was controlled, no morning vs afternoon difference in FMD was found at rest (6±3 vs 7±2%) or following exercise (9±4 vs 9±4 %; P=0.68). Baseline artery diameter was significantly greater in the morning compared with the afternoon (4.35±0.51 vs 4.20±0.54 mm; P=0.05) but was not affected by exercise (P=0.16). HR was 4±4 beats/min higher in the morning (P=0.05) and also 11±9 beats/min higher after exercise compared to before (P=0.01). Systolic and diastolic BP were not affected by sleep or exercise (P>0.10). **Discussion** A bout of sleep in the afternoon abolished the effect of exercise on vascular function by reducing resting FMD to similar values observed in the morning. This finding suggests that the diurnal variation in resting FMD is explained by the impact of prior sleep in the supine position on the vasculature, rather than an endogenous influence of the human body clock. As vascular endothelial function is a strong predictor of cardiovascular events, this data infers that classically observed increase in cardiovascular events in the morning is related to the prior effect of sleep. **References** Jones et al., (2010) *AJP-Regul Inter Comp Physiol* 298: R427-432.

## Poster presentations

### PP-PM03 Oxidative Stress

## INFLUENCE OF SPORT EXPERIENCE TO APPEARANCE OF OXIDATIVE STRESS IN MALE JUDOKAS

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**Abstract Introduction** Physical activity can result in a number of metabolic changes in the body. To determine, whether endurance training induce oxidative stress in athletes with different sport experience (same age), twenty judokas were studied in four week training program. Subjects were divided into 2 groups (1: below-average training experience between 4.0 and 6.0 years, 2: average training experience between 6.0 and 8.5 years). The aim of the study was to compare biomarkers of oxidative stress and total antioxidant activity in male judokas, different sport experience. **Methods** Blood samples were taken from the antecubital vein inside of the elbow into plain vacutainer tubes. First blood samples were taken from all subjects, in the morning at 07:00pm one day before training program. Second blood samples were taken one day after training program, which followed a period of four weeks. The following parameters were measured: superoxide dismutase (SOD), glutathione reductase (GSH-R), glutathione peroxidase (GSH-Px), catalase (CAT) and total antioxidant activity (TAS). **Results** Results of research has shown that applied endurance training program induced a statistically significant decrease in TAS (p <0.05) in judokas with lower sport experience, in compared with judokas with higher sport experience, after the final measurement. Also, statistically significant higher value of CAT and GSH-R were noted in athletes with lower sport experience. **Discussion** Result of training in booth aerobic (Chavi et al., 2007) and anaerobic activities (Bailey et al., 2007) induce elevated oxidative processes. Endurance athletes consume large amounts of oxygen which increases the production of reactive oxygen species (ROS) and leads to oxidative stress (Williams et al., 2006). Results of this research suggest that oxidative status parameters are adequately changeable in judokas, with different sport experience. Therefore, athletes with lower sport experience, require higher intakes of antioxidants to defend against increased oxidative stress. Currently, from obtained results it is clear that judokas with lower sport experience have potential to result in increased free radical production, which may or may not result in acute oxidative stress. **References** Bailey DM, Lawrenson L, McEneny J, Young IS, James PE, Jackson SK, Henry RR, Mathieu-Costello O, McCord JM, Richardson RS. (2007). *Free Radic Res.* 41(2), 182-190. Chhavi L, Pradeep HG, Balwant S. (2007). *Br J Sports Med.* 41, 691-693. Williams SL, Strobel NA, Lexis LA, Coombes JS. (2006). *Nutr Rev.* 64(3), 93 - 108.

## INFLUENCE OF SPORTS MASSAGE ON IMMUNOLOGICAL PARAMETERS AFTER HIGH-INTENSITY INTERVAL TRAINING

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**Introduction** Sports massage is frequently used by athletes to improve recovery from strenuous exercise. Data from randomized controlled trials provide moderate evidence for the efficacy of massage therapy to facilitate recovery from repetitive muscular contractions (Best et al., 2008). It is unclear whether sports massage is able to affect the immunological response after high-intensity interval training. **Methods** This study was planned as a randomized, single-blind, controlled crossover intervention study with a wash-out period of 4 weeks. Twelve male, active subjects (age: 25±2 years, BMI:22.6±2.7kg/m<sup>2</sup>) were included after obtaining written informed consent. Allocation to one of the study groups (A:massage-control; B:control-massage) was performed using an online generated randomization list. The exercise consisted of high-intensity interval training (7min warm up; 4x4min at 90-95% and 50% iHRmax, respectively; 7min cool down). After the exercise the participants received a standardised massage on legs and back or rested for 35min (control). Blood samples were

taken before exercise (t0), directly after exercise (t1), after intervention (t2), one hour (t3) and 22 hours (t4) after intervention. Leukocyte counts as well as plasma IL-1ra, IL-6, sIL-6R, IL10, TNF- $\alpha$ , sTNF- $\alpha$ R1, CK and myoglobin concentrations were measured. Statistical differences between time points, groups and interaction effects were determined using repeated measured ANOVA. Results There was a significant increase in leukocyte counts (up to 120% for granulocytes,  $p < 0.001$ ), muscle damage markers (myoglobin+120%,  $p < 0.001$ ), and cytokines (up to 3-fold for IL-10,  $p < 0.001$ ) after the exercise. Almost all parameters showed their maximum increase directly after exercise (t1) with the exemption of IL-1ra and CK concentrations and granulocyte counts which peaked at later time points (t3 and t4). Sports massage did not affect any of the measured parameters. Additionally, we did not detect any time x group interactions. Discussion In our study we could confirm previous results showing a challenge of the immune system by strenuous exercise (Nieman, 1997, Suzuki et al., 2000). However, sports massage as recovery measure did not affect these parameters. This is slightly in contrast to a study by Arrayo-Morales et al. (2009) showing higher secretion rates of salivary IgA after massage recovery intervention. In conclusion sports massage might improve subjective parameters and delayed onset of muscle soreness but is not able to improve immunological parameters. References Best TM, Hunter R, Wilcox A, Haq F (2008). Clin J Sport Med, 18(5):446-60. Arrayo-Morales M, Olea N, Ruiz C, et al. (2009) Strength Cond Res, 23(2):638-44. Nieman D.C. (1997) J ApplPhysiol, 82(5),1385-94. Suzuki K, Yamada M, Kurakake S, et al. (2000). Eur J ApplPhysiol, 81(4),281-7.

## EFFECTS OF ACUTE SLEEP DEPRIVATION ON EXERCISE TOLERANCE AND STRESS HORMONES DURING MAXIMAL EXERCISE

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Introduction Exercise is beneficial for health, but there is a risk of sudden death during strenuous exercise (Boraita, 2002). Sleep deprivation is associated with cardiac arrest (Murayama, 1994). Overworks of the circulatory system and exposure to stress under sleep deprivation may contribute to cardiac arrest. However, the effects of sleep deprivation on the circulatory system and stress responses during exercise are unclear. The purpose of this study was to investigate the effects of 34 hours of sleep deprivation on exercise tolerance and stress hormones during maximal exercise. Methods Ten healthy young males completed two, 2-day trials (i.e. control and sleep deprivation trials) separated by more than five days each. For the control trial, participants were allowed normal sleep from 23:00 to 7:00; for the sleep deprivation trial, they did not sleep for 34 hours. These experimental trials were performed under supervision by the investigators. On both trials, venous blood samples were collected at 9:00, 13:00, 17:00 (before exercise stress tests) and immediately after exercise stress tests to determine plasma adrenaline, noradrenaline, adrenocorticotrophic hormone (ACTH) and cortisol concentrations. Exercise tolerance testing was performed on a treadmill until exhaustion by ramp protocol at 17:00 on day 2. Oxygen uptake and heart rate were measured at rest and during exercise. Results ACTH concentrations at 9:00 and 13:00 were significantly higher in the sleep deprivation trial than the sleep trial on day 2 (9:00: Sleep trial,  $35.3 \pm 18.5$ ; Sleep deprivation trial,  $48.6 \pm 17.7$ , 13:00: Sleep trial,  $24.2 \pm 6.3$ ; Sleep deprivation trial,  $30.1 \pm 7.3$  pg/ml,  $P < 0.05$ ). No differences were found in the other stress hormones at rest and immediately after exercise between trials. Oxygen uptake during exercise was tended to be higher by sleep deprivation ( $P = 0.08$ ). Heart rate during exercise was significantly decreased by sleep deprivation ( $P < 0.05$ ). Discussion The present study indicated an increase in ACTH concentrations at rest, a slightly increase in oxygen uptake and a decrease in heart rate during maximal exercise in the sleep deprivation trial. These data suggest that sleep deprivation induces ACTH secretion at rest and impairs exercise tolerance during exercise. References Boraita A. (2002). Rev Esp Cardiol, 55, 333-336. Murayama M. (1994). J Jap Society Internal Med, 83, 208-214.

## EFFECTS OF RESISTANCE AND AEROBIC EXERCISE TRAINING ON PROINFLAMMATORY CYTOKINES

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Introduction Elevated levels of inflammatory mediators have been associated with an increased risk and severity of chronic disease. Atherosclerosis and coronary artery disease are associated with greater levels of interleukin (IL)-6 and tumor necrosis factor (TNF)- $\alpha$  (Larsson et al., 2005). Furthermore, the purpose of the present study was to determine the effects of 10 wk of resistance and aerobic exercise training on interleukin-6 (IL-6), interleukin-1 $\beta$  (IL-1 $\beta$ ) and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ). Further, to determine pretraining and posttraining associations between alterations of IL-6, IL-1 $\beta$  and TNF- $\alpha$  with body composition. Methods A sample of 29 sedentary males (age (mean  $\pm$  SD) =  $31.7 \pm 8.1$  yr, BMI =  $29.3 \pm 4.3$  kg / m<sup>2</sup>) were assigned to a resistance group (n = 9), an aerobic group (n = 11) and a control group (n = 9). Before and after intervention, subjects were involved in muscular strength and aerobic fitness, measurements and further provided a resting fasted venous blood sample for measures of IL-6, IL-1 $\beta$  and TNF- $\alpha$ . The resistance and the aerobic groups completed a respective 10-wk supervised and periodized training program, whereas the control group maintained sedentary lifestyle and dietary patterns. Results Both exercise training programs did not reduce in IL-6, IL-1 $\beta$  and TNF- $\alpha$ . Compared with the control group, the aerobic and resistance groups exhibited significant ( $P \leq 0.05$ ) improvements in VO<sub>2</sub> max and significant reductions in body fat percentage and waist to hip ratio. Compared with the aerobic and the control groups, the resistance group significantly ( $P \leq 0.05$ ) improved upper (27.6%) and lower (39.8%) body strength. Discussion 10 wk of resistance and aerobic exercise training in sedentary disease-free males did not affect elevated baseline IL-6, IL-1 $\beta$  and TNF- $\alpha$ , and this is consistent with data obtained by Donges C.E, et al. (2009), that was shown after the 10-wk exercise training period, the IL-6 concentration of both the exercise groups and the control group remained unchanged. On the other hand, Kohut M.L et al. (2006), have observed that 10 months an aerobic exercise intervention can significantly reduce serum inflammatory mediators. It has been suggested that to reduce proinflammatory cytokines, the exercise training have to complete for more than a few months. References Larsson, P.T., Hallerstrom, S., Rosfors, S., Wallen, N.H. (2005). Int. Angiol. 24, 43-51. Cheyne E. Donges, Rob Duffield, and Eric J. Drinkwater. (2009). Medicine & Science in Sports & Exercise, 42, 2: 304-313. Kohut M.L, D.A. McCann, D.W. Russell, D.N. Konopka, J.E. Cunnick, W.D. Franke, M.C. Castillo, A.E. Reighard, E. Vanderah. (2006), Brain, Behavior, and Immunity 20, 201-209.

## ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND OXIDATIVE STRESS AND INFLAMMATORY CYTOKINES IN OLDER ADULTS

TAKAHASHI, M.1, MIYASHITA, M.2, PARK, J.H.1, KIM, H.S.1, SUZUKI, K.2, NAKAMURA, Y.2, SAKAMOTO, S.2

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**Introduction** Oxidative stress and chronic inflammation are mediators of several diseases such as cancer, cardiovascular disease and diabetes. A previous study has shown that oxidative stress or pro-inflammatory cytokines increase with age (Ferrucci et al., 2005). Another study has reported that aerobic exercise training decreases oxidative stress and pro-inflammatory cytokines in older men (Fatouros et al., 2004). However, there is no definitive evidence for the effects of daily physical activity on oxidative stress and various cytokines. The purpose of this study was to examine the relationship between the amount of physical activity and oxidative stress markers and inflammatory cytokines in older adults. **Methods** Total of 29 older adults (aged  $70.1 \pm 5.2$  years, mean  $\pm$  SD; 17 females and 12 males) were analysed in the cross-sectional design. Prior to the blood collection, participants were asked to wear an uniaxial accelerometer for 4 consecutive weeks for the determination of physical activity status. After a 48-h period of physical activity avoidance and a 10-h overnight fast, fasting venous blood samples were obtained from each participant. Results Fasting plasma derivatives of reactive oxygen metabolites (d-ROMs) concentrations were negatively correlated with the amount of physical activity ( $r = -0.488$ ,  $P < 0.01$ ). Fasting plasma biological antioxidant potential (BAP) concentrations were positively correlated with the amount of physical activity ( $r = 0.607$ ,  $P < 0.01$ ). Moreover, fasting plasma d-ROMs concentrations were tend to be negatively correlated with fasting plasma BAP concentrations ( $r = -0.320$ ,  $P < 0.1$ ). There were no associations between physical activity and other oxidative stress markers (superoxide dismutase, catalase, glutathione peroxidase) or cytokines (IL-6, IL-8, IL-10, IL-1 $\beta$ , thioredoxin, TNF- $\alpha$ , myeloperoxidase, calprotectin and neutrophil gelatinase-associated lipocalin). **Discussion** This study shows that regular physical activity may provide a protective effect on oxidative stress by increasing total antioxidant capacity (i.e. estimated by the concentrations of BAP) in older adults, but no association was observed between regular physical activity and several cytokines. **References** Fatouros IG, Jamurtas AZ, Villiotou V, Pouliopoulou S, Fotinakis P, Taxildaris K, Deliconstantinos G. (2004). *Med Sci Sports Exerc*, 36, 2065-2072. Ferrucci L, Corsi A, Lauretani F, Bandinelli S, Bartali B, Taub DD, Guralnik JM, Longo DL. (2005). *Blood*, 105, 2294-2299.

## THE EFFECTS OF ACUTE EXERCISE ON BLOOD PRO/ANTIOXIDANT LEVELS IN ATHLETES AND NON-ATHLETES

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**Introduction** Sports engagement includes upregulation of many cell processes and physiological functions including upregulation of the antioxidant defence system (ADS). It was previously shown that well trained subjects have more efficient ADS compared with sedentary subjects (Finaud et al. 2006; Fisher-Wellman and Bloomer 2009), however those studies compared only the basal (rest) levels of pro/antioxidants in blood of athletes and non-athletes. Thus, we sought to investigate the effects of acute maximal intensity exercise on pro/antioxidant response in both athletes and non-athletes and to find correlations between morphofunctional characteristics of subjects and parameters of redox homeostasis. **Methods** 58 young handball players and 19 non-athletes were subjected to body composition analysis, measuring of maximal oxygen consumption and blood sampling immediately before and after maximal progressive exercise test. Blood samples were used for redox state analysis which included measurement of nitric oxide (estimated through nitrites), superoxide anion radical, hydrogen peroxide, lipid peroxidation (estimated through thiobarbituric reactive substances), superoxide dismutase activity, catalase activity and glutathione levels. Results In rest, athletes had significantly higher superoxide dismutase activity, higher glutathione levels and lower levels of index of lipid peroxidation compared with non-athletes. Maximal exercise test induced statistically significant rise of superoxide anion radical and hydrogen peroxide levels in non-athletes, while nitrite levels decreased both in athletes and non-athletes. Athletes also had decreased catalase activity after exercise. After exercise, athletes had significantly lower levels of superoxide anion radical compared with non-athletes. Significant correlations between morphofunctional (fat %, muscle %, aerobic power) and redox parameters were found. **Discussion** The initial hypothesis that athletes would have not only higher activity of antioxidants in rest, but that the extent of redox disturbance induced by maximal progressive exercise test would be lower in athletes compared with non-athletes was confirmed in this study. The results of our study prove that regular exercise training leads towards positive adaptations that alleviate the risk of oxidative stress in athletes, both during training sessions and during non-exercise related conditions. Sports engagement and physical fitness are important factors in inducing desirable changes in redox status. **References** 1. Finaud J, Lac G and Filaire E. (2006). *Sports Med*, 36, 327-358. 2. Fisher-Wellman K, Bloomer RJ. (2009). *Dyn Med* 8, 1-25.

## RESISTANCE TRAINING AND OXIDATIVE STRESS MARKERS IN PANCREAS OF RATS AFTER NEONATAL ALLOXAN ADMINISTRATION

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**Introduction:** Studies suggest that oxidative stress plays a major role in the in the pathogenesis of both types 1 and 2 diabetes mellitus (Sato et al., 1979). Abnormally high levels of free radicals and the simultaneous decline of antioxidant defense mechanisms can lead to damage of cellular organelles and enzymes and increased membrane lipid peroxidation. However It has been suggested that regular exercise might improve the antioxidant defense capacity against the oxidative stress (Radak et al., 2008). Therefore, the present study was designed to investigate whether resistance training is an effective form of exercise for managing oxidative stress biomarkers in the pancreas of rats after neonatal alloxan administration. **Methods:** Alloxan was injected in newborn rats at 6 days of age (250 mg/kg bw). At 28 days of age, the animals were divided into alloxan (A), control (C), trained alloxan (TA) and trained control (TC) groups. The resistance training consisted of 4 series of 10 jumps in the water, with a 1 min interval between them, while supporting a load of 50% of b.w, during 12 weeks. The animals were killed for analysis of pancreas lipid peroxidation markers concentration (substances that react to the barbituric acid – TBARS), and antioxidant enzymes activity (Superoxide dismutase (SOD) and Catalase) in the pancreas. Results: At 28 days of age the total area under the serum glucose (mg/dLx120min) curve during glucose tolerance test (GTT) was higher (t test,  $p < 0.05$ ) in alloxan rats than in controls (A:  $18138 \pm 1992$ , C:  $14792 \pm 624$ ). No difference between the groups (two-way ANOVA,  $p < 0.05$ ) was observed in TBARS content as well in SOD and Catalase activity between the groups: TBARS (nmol of mda/mg): TC:  $0.880 \pm 0.466$ , TA:  $0.682 \pm 0.226$ , C:  $0.875 \pm 0.397$ , A:  $0.980 \pm 0.620$ ; SOD (U/100mg): TC:  $2.39 \pm 0.95$ , TA:  $2.09 \pm 0.80$ , C:  $1.92 \pm 0.70$ , A:  $1.89 \pm 0.75$  and Catalase activity (umol/min.g): TC:  $1.43 \pm 0.81$ , TA:  $2.11 \pm 1.39$ , C:  $1.71 \pm 0.49$  and A:  $1.58 \pm 0.89$ . **Discussion:** The results suggest that the high intensity resis-



tance training as well as the alloxan administration protocols were not effective in changing oxidative stress biomarkers in the pancreas of rats. Alternative procedures for diabetes induction and exercise training must be employed for the study of this matter. Support: Fapesp (proc. 09/51538-5), Capes. References Radak Z, Chung HY, Goto S. (2008). Systemic adaptation to oxidative challenge induced by regular exercise. *Free Radic Biol Med* 44, 153–159. Sato Y, Hotta N, Sakamoto N, Matsuoka S, Ohishi N and Yagi, K. (1979). Lipid peroxide level in the plasma of diabetic patients. *Biochemical Medicine and Metabolic Biology* 21(1), 104–107.

### HIGH LEVELS OF OXIDATIVE LDL AFTER A MARATHON RACE AND ATHEROGENESIS IN ATHLETES

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**Introduction:** Recently it has been shown that marathon runners can show a coronary artery calcification (CAC) index similar to sedentary match controls. This unexpected finding can be caused by some factors. Levels of plasmatic oxidized LDL are important due to their participation on atherogenic process and levels of the auto-antibody anti-LDL also are important because they participate in the control of the action of LDL. **Methods:** We studied marathon runners with and without coronary artery calcification, comparing levels of plasmatic ox-LDL and anti-LDL. The group of marathon runners was composed by 28 male runners from São Paulo, with a range of age from (25 to 60) means 41.4 years old. The marathon runners were separated by angiotomography in two groups: with atherosclerosis process (AP, n=5) or without atherosclerosis process (WAP, n=23). We evaluated the level of oxidative LDL cholesterol fraction (oxLDL – U/L) and anti-LDL auto-antibody (U/L) in both groups at rest, immediately and 72 hours after a marathon. **Results:** We observed that the levels of oxLDL ( $99.46 \pm 23.31$ ) and anti-oxLDL ( $471.1 \pm 213.7$ ) in AP group at rest did not differ in relation to WAP group ( $86.55 \pm 19.67$  and  $422.7 \pm 75.92$ , respectively). The results observed immediately after a marathon showed that the levels of oxLDL in AP ( $166.5 \pm 40.53$ ) and WAP ( $146.6 \pm 74.27$ ) groups were significantly higher than basal levels ( $p < 0.01$ ), but didn't show statistical significance when comparing values between these two groups. Although levels of anti-oxLDL in AP ( $372 \pm 83.91$ ) and WAP ( $366.8 \pm 68.77$ ) groups were reduced, they have not show statistically significant differences nor to basal level neither between the groups. The analysis of results obtained 72 hours after a marathon, shows that the levels of oxidative LDL in the NAP ( $93.68 \pm 26.04$ ) group return to basal levels, however the concentration in AP group ( $115.4 \pm 23.70$ ,  $p < 0.05$ ) kept statistically increase in comparison to levels at rest. No statistical difference was observed between groups. The concentration of Anti-oxLDL in AP ( $216.2 \pm 193.8$ ) and WAP ( $294.7 \pm 75.92$ ) groups showed a tendency toward decrease but didn't show any statistically significant difference. **Discussion:** In this research we were able to demonstrate a difference between athletes with or without coronary artery calcification, based on the maintenance of elevated levels of oxLDL after a marathon, a factor that can be implied with the process of atherogenesis.

### OXIDATIVE STRESS STATUS IN FEMALE INTERNATIONAL-LEVEL SPRINTERS DURING TAPERING

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**PURPOSE:** Oxidative stress increases during intense exercise and affects the athlete's physical condition. Therefore, it is important to continuously measure oxidative stress and antioxidant ability with respect to physical condition for evaluating the athlete's whole-body fatigue. The purpose of this study was to analyse the physical condition of international-level athletes by continuous measurement of oxidative stress and antioxidant ability. **METHODS:** The study population comprised 8 female international-level sprinters. Their oxidative stress levels and antioxidant ability were measured every week for 2 months before the competition. We collected blood samples from their earlobes before each training session was initiated. The sprinters trained for 3 hours per day for 5 days per week. They had a tapering period for the 10 days before the competition. We measured the total plasma hydroperoxide concentration (derivatives of reactive oxygen metabolites [d-ROMs] test; FREE, Diacron) as a barometer of oxidative stress and the ferric-reducing ability of plasma as a barometer of antioxidant ability (biological antioxidant potential [BAP] test; FREE, Diacron). Furthermore, we calculated the BAP test:d-ROMs test ratio by using the equation described by NAGATA et al (2008) and considered this ratio as the oxidative stress status. **RESULTS:** The total hydroperoxide concentration remained between  $276.3 \pm 21.1$  U.CARR (normal) and  $305.5 \pm 46.9$  U.CARR (slightly higher than normal) from 8 weeks to 1 week before the competition. However, it decreased to  $231.9 \pm 21.4$  U.CARR immediately before the competition because the athletes had a tapering period for 10 days before the competition. The ferric-reducing ability decreased slowly during the 8 weeks before the competition, i.e. from  $2.634 \pm 0.148$  mmol/l to  $2.204 \pm 0.205$  mmol/l; these levels are considered normal ( $> 2.2$  mmol/l). The BAP test:d-ROMs test ratio decreased from  $1.31 \pm 0.32$  to  $0.98 \pm 0.10$  during the first month and increased slowly until it reached  $1.26 \pm 0.10$  (normal level  $> 1.0$ ) immediately before the competition because of tapering. **CONCLUSIONS:** The oxidative stress levels (measured using the d-ROMs test) increased and the BAP test:d-ROMs test ratio decreased during intense training sessions; these values returned to normal levels after tapering. Because the oxidative stress status was controlled, the sprinters' performances improved. Inability to maintain if athletes could not controlled the oxidative stress at normal levels negatively affected the sprinters' performance. These results suggest that continuous measurement of oxidative stress and antioxidant ability is possible for athletes to conditioning.

### THE EFFECTS OF A TRAINING SEASON ON OXIDATIVE STRESS IN YOUNG TRACK AND FIELD ATHLETES

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**Introduction** Data regarding the exercise-induced oxidative stress and adaptations of the antioxidant defense system in adolescent and child athletes is still scarce (Djordjevic et al. 2011; Kabasakalis et al. 2009). The aim of this study was to compare the effects of a training season on indices of oxidative stress and the antioxidant defense system in young track and field athletes. **Methods** Thirteen young athletes (age:  $14.2 \pm 1.1$ ; weight:  $53.5 \pm 8.8$ ; height:  $165.2 \pm 7.7$ ) and 10 control individuals (age:  $14.8 \pm 1.0$ ; weight:  $65.4 \pm 13.0$ ; height:  $172.9 \pm 9.5$ ) participated in this study. Blood was collected three times during the training season. The first blood drawing was performed prior to the training season (PRE), the second one was performed at mid-training season (MID) when the training load was increased and the third blood drawing was performed at the end of the training season (END). Protein carbonyls (PC), thiobarbituric acid reactive substances (TBARS), uric acid and bilirubin were measured as indices of blood redox status. **Results** The results of the present study did not reveal any significant differences between the groups at any timepoint for none of the redox status indices employed. **Discussion** These results indicate that there are no changes in redox status in young track and field athletes during a training season when the training volume is

significantly increased. References Djordjevic D, Cubrilo D, Macura M, Barudzcic N, Djuric D, Jakovljevic V. (2011). Mol Cell Biochem, 25, (In press). Kabasakalis A, Kalitsis K, Nikolaidis MG, Tsalis G, Kouretas D, Loupos D, Mougios V. (2009). J Sci Med Sport, 12, 691-6.

### REGULAR EXERCISE PRODUCE HIGHER ANTIOXIDANT CAPACITY THAN SEDENTARINESS AFTER 3000-METERS JOGGING AEROBIC EXERCISE

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**Introduction** High intensity endurance exercise induces oxidative stress in human erythrocytes. The aim of this study was to explore the effect of aerobic exercise in 3000-meters jogging on antioxidant capacity between college students with different exercise habits. **Methods** Twenty male college students were recruited and divided into sedentary group and regular exercise group. After the participants performed aerobic exercise in 3000-meters run, the blood samples were obtained before aerobic exercise and after aerobic exercise immediately, 24 and 48 hours. Biochemical analysis included total glutathione (TGS), superoxide dismutase (SOD) and uric acid (UA). **Results** The result of sedentary group indicated that total glutathione (TGS) concentration was decreased after aerobic exercise immediately; superoxide dismutase (SOD) activity was decreased after aerobic exercise 24 and 48 hours; uric acid (UA) activity was increased after aerobic exercise 24 and 48 hours ( $p < .05$ ). In the regular exercise group indicated that TGS concentration was increased after aerobic exercise 24 hours; SOD activity was increased after aerobic exercise 48 hours; uric acid (UA) activity was decreased after aerobic exercise 48 hours ( $p < .05$ ). Consequently, after the participants performed aerobic exercise in 3000-meters run, the antioxidant capacity of sedentary group could be increased in 48 hours after aerobic exercise. **Discussion** We concluded that not only TGS was increased in 24 hours but also SOD was increased in 48 hours after aerobic exercise in regular exercise group. Therefore, our results suggest that the antioxidant capacity in regular exercise group would be increased by TGS and SOD respectively after 3000-meters jogging of aerobic exercise 24 and 48 hours. Based upon these results, we suggest people should maintain exercise regularly to increase antioxidant capacity. **References** Centin E, Top EC, Sahin G, Ozkaya YG, Aydin H, Toraman F. (2010). J Nutr Health Aging, 14(9), 763-769. Duthie GG, Robertson JD, Maughan RJ, Morris PC. (1990). Arch Biochem Biophys, 282(1), 78-83. Ji LL. (1999). Proc Soc Exp Biol Med, 222, 283-292. Shin YA, Lee JH, Song W, Jun TW. (2008). Mech Ageing Dev, 129(5), 254-260.

## Poster presentations

### PP-PM04 Exercise and Health in Special Populations 1

#### EFFECT OF CONDITIONING TRAINING COMBINED WITH PLYOMETRIC JUMPS ON PHYSICAL FITNESS IN YOUTHS WITH DOWN SYNDROME

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**Introduction:** Children and adolescents with Down syndrome (DS) have shown lower levels of physical fitness compared with their peers without DS(1). Physical fitness, especially cardiovascular fitness, is an important marker of health during childhood and adolescence. It is well known that training programs improve physical fitness in healthy children and adolescents; however, it is not totally clear what happens in youths with DS(2). Therefore, the aim of this study was to determine whether youths with DS could improve their cardiovascular fitness after 21 weeks of conditioning and plyometric exercise training. **Material and methods:** 28 participants with DS (17 males) aged from 10 to 19 years and 30 sex- and age-matched controls without disabilities joined the study. Participants with DS were divided into two groups, DS-exercise and DS-control. Time of exercise and peak cardiorespiratory values ( $VO_{2peak}$ ,  $HR_{peak}$ ,  $RER_{peak}$ ,  $VE_{peak}$ ) were measured by a maximal effort treadmill test at baseline and after the training program. The conditioning training consisted of 21 weeks, 2 sessions per week of circuits with different kind of jumps, press-ups and exercises with elastic fitness bands and adapted medicine balls, for approximately 15 to 25 minutes/day. Mann-Whitney U and Wilcoxon-Cox tests were used to evaluate the differences between groups, and between evaluations within the same group. **Results:** DS-exercise participants increased their  $VO_{2peak}$ ,  $RER_{peak}$ , time of exercise,  $HR_{peak}$  and  $VE_{peak}$  comparing baseline with post-training ( $p < .05$ ); these differences were not observed in the DS-control exercise. No differences were observed between DS-groups before training, DS-exercise group showed higher  $VO_{2peak}$ ,  $RER_{peak}$  and  $HR_{peak}$  than the DS-control group post-training ( $p < .05$ ). The  $VO_{2peak}$  of DS-exercise girls, after training, did not differ from the  $VO_{2peak}$  of control girls, neither the time of exercise and  $RER_{peak}$  of DS-exercise boys compared with control boys. **Conclusion:** Overall, 21 weeks of conditioning training combined with jumps is an effective method to improve cardiovascular fitness of youths with DS; efforts should be made in order to promote physical activities in youths with DS. **Acknowledge:** This study was supported by Gobierno de Aragón (Project 17/2007) **References:** 1. Baynard T et al. Age-Related Changes in Aerobic Capacity in Individuals with Mental Retardation: A 20-yr Review. Med Sci Sports Exerc 2008; 40: 1984-9. 2. González-Agüero A et al. Health-related physical fitness in children and adolescents with Down syndrome and response to training. Scand J Med Sci Sports 2010; 20: 716-24.

#### THE TEACHING OF MARTIAL ARTS TO PEOPLE WITH DISABILITIES

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The teaching of martial arts to people with disabilities Mariana S.P.Gomes<sup>1,2</sup>, Márcio P.Morato<sup>1</sup>, André Terrisse<sup>2</sup>, José J.G.Almeida<sup>1</sup>. Faculty of Physical Education, University of Campinas, Brazil<sup>1</sup> Institute Universitaire de Formation de Maîtres -Université de Toulouse II, France<sup>2</sup> **Introduction** The teaching of martial arts usually emphasizes the perfect technique execution, instead of the logic of combat and its reasons of application (Terrisse, 1991). We suppose that this can lead to the restriction of possibilities martial arts can offer, not contemplating some of the sports pedagogy personages, such as people with disabilities (Winnick, 2005). In this sense, this study seeks to analyze the strategies of teaching martial arts for this group of people. **Methods** We used the qualitative research to comprehend what four physical education teachers and masters in different modalities (Judo, Jiu Jitsu, Taekwondo, Karate and Fencing) think and do when they have students with any disabilities. We used semi-structured interviews that were analyzed by the enunciation technique, one of the

content analysis techniques (Bardin, 1998). Results and Discussion The results suggest that having a student with disability demands adaptation procedures from the teachers, resulting in new teaching methods. Some interviewed teachers related the adaptation of the regular methods according to the type of disabilities. There is a change of the focus on the exclusive technique elements of the combat (Villamón, Molina, 1999), to the tactic and strategy emphasis. In these cases, when they tried to explore the dynamic of the combats, the students were able to solve problems and reach the objectives of the activities, disregarding the perfection of their techniques. However, when the activity demanded the perfect technical gesture, some teachers related that the teaching process was not possible because the students could not execute the proper techniques. Conclusion The results showed that when working with disabled students it is important to privilege the tactical aspects, instead of the single technique, in order to transmit the logic of combat and possibilities to solve the problems of the proposed activities. This method enables the martial arts teaching to anyone, because the focus is in the student's potentiality, in what he is able to do, not in his disability. In this context, they will be stimulated to create different ways to use the traditional techniques as well as develop new ones. References Bardin, L. (1998). *L'analyse de contenu*. Paris. PUF. (9ème édition). Terrisse A. (1991) Pour un enseignement dialectique des sports de combat. *Revue EPS* n° 229, Paris, 23-26. Villamón, M.; Molina, J. P. (1999) La iniciación deportiva en Judo In: Villamón, M. *Introducción al Judo*. Editorial hispano Europea S.A.: Barcelona. Winnick JP, editor. (2005) *Adapted physical education and sport*. 4th ed. Champaign (IL): Human Kinetics.

## REGULAR LEVEL AND DOWNHILL TREADMILL WALKING AT SELF-SELECTED SPEED IMPROVES FUNCTIONAL PERFORMANCE OF OLDER ADULTS

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REGULAR LEVEL AND DOWNHILL TREADMILL WALKING AT SELF-SELECTED SPEED IMPROVES FUNCTIONAL PERFORMANCE IN OLDER ADULTS Gault, ML1, Clements, RE.2, Willems, MET.2 1: University Campus Suffolk (Ipswich, UK), 2: University of Chichester (Chichester, UK) Introduction Older adults experience reductions in muscle strength, functional capacity and quality of life (Doherty, 2003). Exercise programs may preserve muscle strength and physical functioning (Trappe et al., 2002). We examined functional performance and dynamic strength following a program of regular level and downhill treadmill walking (i.e. concentric or eccentric endurance exercise) at self-selected walking speeds. Methods 18 healthy elderly adults ( $67 \pm 5$  yrs,  $170 \pm 9$  cm,  $77.2 \pm 13.9$  kg) volunteered. Participants completed 12-weeks of level (LW: 0% gradient (n=8)) or downhill (DW: -10% gradient (n=10)) treadmill walking (30-mins, 3x week) at a self-selected walking speed (SSWS, re-adjusted every 4-wk). Maximal walking speed (MWS), 5-repetition sit-to-stand (5-RSTS), timed up-and-go (TUG), peak torque of knee extension (concentric: 600/s and 1800/s, eccentric: 1800/s) and angle of peak torque were measured at baseline (B) and following 12-weeks (P) of LW and DW. A two way repeated measures ANOVA with post-hoc pre-planned t-tests were used for data analysis ( $P < 0.05$ ). Results SSWS was similar for both groups and increased from  $1.18 \pm 0.11$  to  $1.53 \pm 0.09$  m·s<sup>-1</sup> (LW) and  $1.26 \pm 0.16$  to  $1.61 \pm 0.12$  m·s<sup>-1</sup> (DW) ( $P < 0.01$ ). Improvements in MWS, 5-RSTS and TUG were similar ( $P < 0.01$ ). MWS (baseline LW:  $2.39 \pm 0.38$  m·s<sup>-1</sup>, DW:  $2.40 \pm 0.33$ ) improved by 22 and 23%. 5-RSTS (baseline LW:  $8.50 \pm 1.19$ s, DW:  $8.54 \pm 1.52$ s) improved by 32 and 34%. TUG (baseline LW:  $5.58 \pm 0.51$ s, DW:  $5.46 \pm 0.89$ s) improved by 22%. Peak torque values did not change. However, in both groups, the angle at which concentric peak torque ( $180^\circ$ ·s<sup>-1</sup>) occurred was decreased after 12-weeks (LW:  $37 \pm 16^\circ$  to  $26 \pm 14^\circ$ ; DW:  $42 \pm 18^\circ$  to  $37 \pm 16^\circ$ ,  $P < 0.05$ ). Discussion Regular level and downhill treadmill walking at a self-selected walking speed resulted in substantial improvements in functional performance. However, changes in functional performance could not be explained by changes in concentric and eccentric strength of knee extensor muscles. A change in concentric peak torque angle may indicate a shift in the knee angle-torque relationship of knee extensor muscles (Narici et al., 2003). This may be explained by an increase in muscle fascicle length due to addition of sarcomeres in series (Goldspink, 1998) as a result of regular level and downhill treadmill walking in older adults. Regular treadmill walking at a self-selected speed may serve as a novel exercise intervention to examine adaptations in elderly people. References Doherty TJ. (2003). *J Appl Physiol*, 95, 1717-1727. Goldspink G. (1998). *Gerontology*, 15, 35-43. Narici MV, Maganaris CN, Reeves ND, Capodaglio P. (2003). *J Appl Physiol*, 95, 2229-2234. Trappe S, Williamson D, Godard, M. (2002). *J Gerontol A Biol Sci Med Sci*, 57, B138-B143.

## PREDICTORS OF FEMORAL NECK BONE MINERAL DENSITY: THE ROLE OF MODIFIABLE AND NON-MODIFIABLE FACTORS

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Introduction Areal bone mineral density (BMD) is a surrogate measure of the breaking strength of bone and is a sensitive predictor for fractures (Cummings, Bates et al. 2002). Taking into account that BMD is a complex trait, influenced by genetic and environmental factors (Kung and Huang 2007), the insight into both parts requires the study of several factors, frequently categorized as modifiable and non-modifiable. Therefore, the present cross-sectional study aimed to examine the relationships between BMD and physical activity, muscle strength, genetic, demographic and dietary factors in older adults. Methods One hundred twenty seven healthy Caucasian older adults (mean age 69 years) free of medications known to affect bone were enrolled. Femoral neck BMD and body composition (lean and fat tissue) were measured by dual X-ray absorptiometry. Dietary intake was assessed by 4-day dietary record. Performance measures included the knee extension strength measured on an isokinetic dynamometer. Physical activity was assessed using accelerometers. Sociodemographic information, lifestyle behaviors and clinical status were also examined by questionnaire. Lactose persistence mutations G/C -14010, T/G -13915, C/T -13910 and C/G -13907 were genotyped by direct sequencing. Net endogenous acid production was also calculated. Results Stepwise multiple linear regression analysis showed that male gender and higher BMI were significant positive predictors of femoral neck BMD, while age was a significant negative predictor (50.3% of variance), even after adjustment for confounders. Discussion The present work confirmed that sex is a powerful predictor of BMD in older adults, pointing towards the greater bone mass associated with male gender. Expectedly, our data revealed that age is a significant predictor of BMD in older adults, which was previously demonstrated by others (Bass, Ford et al. 2006). Our observation that BMI was a significant positive predictor of femoral neck BMD is in agreement with previous studies (Tang, Sheu et al. 2007). In conclusion, our data highlight that older adults, particularly female with low BMI are important target population for interventions to prevent osteoporosis. References Bass M, Ford MA, Brown B, Mauro-moustakos A, Keathley RS (2006). *South Med J*, 99(2), 115-22. Cummings SR, Bates D, Black DM (2002). *Jama*, 288: 1889-97. Kung AW, Huang QY (2007). *J Musculoskelet Neuronal Interact*, 7(1), 26-32. Tang YJ, Sheu WH, Liu PH, Lee WJ, Chen YT (2007). *J Bone Miner Metab*, 25(1), 54-9. Acknowledgement This research was funded by the Portuguese Foundation of Science and Technology (FCT), grant FCOMP-01-0124-FEDER-009587 - PTDC/DES/102094/2008. E. A. Marques, F. Wanderley and J. Mota are supported by grants from Portuguese FCT (SFRH/BD/36319/2007, SFRH/BD/ 33124/2007, and SFRH/BSAB/1025/2010 respectively).

**EFFECTIVENESS OF A 6-MONTH WATER-BASED EXERCISE IN PREVENTING PHYSICAL DECLINE IN ELDERLY SUBJECTS.**

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The development and progression of sarcopenia is a complex and multi-factorial process. A growing body of evidence indicates that physical activity in elderly can slow the loss of skeletal muscle and function. Among exercise modalities, water-based protocols are suggested for subjects in whom a lower joint stress is recommended, however, limited data are available about their actual effects in maintaining muscle mass and physical fitness. **PURPOSE:** To determine the effect in body composition, strength and flexibility of a physical activity program performed in thermal water respect to a similar land-based protocol. **METHODS:** 40 subjects (N=20 Male, N=20 Female) were recruited (age = 71.7 yrs, BMI = 26.2 kg/m<sup>2</sup>), and randomly allocated to two groups: Aquatic Group (AG) and Land Group (LG). During the 6 months, subjects followed a twice-a-week exercise intervention. Exercise intensity was monitored using Borg's Scale and heart rate. Functional evaluation was performed before and after the exercise protocols. Body composition was assessed by bioimpedance analysis, strength by handgrip dynamometry, as well as isotonic knee extension. Physical performance was also assessed using the Senior Fitness Test. Statistical analysis was made using ANOVA for repeated measures. Because of healthy reasons or lack of interest in participation, 6 subjects dropped out from the study (2 in AG vs 4 in LG). **RESULTS:** AG showed a significant reduction in body weight (69.7±13.3 to 68.8±13.6 kg,  $p<0.05$ ) and fat mass (21.9±5.8 to 20.9±5.6 kg,  $p<0.05$ ), while LG did not. AG and LG improved both in 8-foot up & go (5.6±1.2 to 4.9±0.7,  $p<0.05$  and 6.1±2.1 to 5.3±2.1 seconds,  $p<0.05$ ) and modified sit & reach tests (AG 2.8±6.7 to 12.8±6.7 cm in right leg,  $p<0.05$ ; AG 3.5±8.0 to 13.33±7 cm left leg,  $p<0.05$ ; LG 5.0±12.6 to 13.4±11.5 cm in right leg,  $p<0.05$ ; LG 5.6±12.1 to 13.7±11.7 cm in left leg,  $p<0.05$ ). Handgrip strength proved a significant increase only in LG (18.7±8.4 to 23.5±9.1 kg,  $p<0.05$ ). The other tests demonstrated a similar, not significant, positive trend. **CONCLUSIONS:** Both land and water-based activities seem beneficial in improving dynamic balance and flexibility. Strength values appear maintained. Further analysis will allow evaluation of muscle mass by peripheral quantitative computed tomography and the comparison with a control group.

**EFFECTS OF HIGH-RESISTANCE CIRCUIT VS. TRADITIONAL STRENGTH TRAINING ON BODY COMPOSITION AND STRENGTH IN OLDER WOMEN**

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**Introduction:** Traditional strength training (TS) has been used in several populations, including children, young adults, and older adults (Brentano et al., 2008). However, there is no information about high-resistance circuit training (HRC) (Alcaraz et al., 2008) in healthy older women. The purpose of the present study was to compare the effects of 12 weeks of HRC vs. TS on upper and lower limb isokinetic strength, lean mass, fat mass and bone mineral density (BMD). **Methods:** Thirty-seven women (55-75 years old) were randomly assigned to a TS (n = 15, 6RM, 1-3 sets) or to a HRC (n = 15, 6RM, 1-3 sets), and a control group (CG, n = 7, no exercise). Training consisted of weight lifting 2 times a week during 12 weeks. Prior to and at the end of the training program, maximum isokinetic strength (90°•s<sup>-1</sup> and 270°•s<sup>-1</sup>) and body composition (DXA) were determined. Main and interaction effects resulting from the intervention were analyzed using single or multivariate analyses of variance (ANOVA) with repeated measures ( $p \leq 0.05$ ). **Results:** After training, total fat free mass was increased in the HRC group (4.5%) and total fat mass was decreased in the HRC group (3.3%). There were no changes in the BMD for TS and HRC. A significant increase of isokinetic strength was observed in both experimental groups for the angular speeds of 90°•s<sup>-1</sup> and 270°•s<sup>-1</sup> in upper and lower limbs, being established statistically significant differences among TS and CG, and among HRC and CG. In the CG, there were no changes in the variables analyzed. **Conclusion:** The results seem to indicate that there is an improvement in the upper and lower limbs strength with both training methods. However, only a significant decrease in fat mass was found in HRC group. There were no changes in the BMD for TS and HRC, probably a long-term training should be applied for improving bone adaptations. **References:** Alcaraz, P.E., Sánchez-Lorente, J., & Blazevič, A.J. (2008). Physical performance and cardiovascular responses to an acute bout of heavy resistance circuit training vs. traditional strength training. *J. Strength Cond. Res.*, 22, 667-671; Alcaraz, P.E., Pérez-Gómez, J., Chavarrias, M., & Blazevič, A.J. (2011). Similarity in adaptations to high-resistance circuit vs. Traditional strength training in resistance-trained men. *J. Strength Cond. Res.*; Brentano M, Cadore E, Da Silva E, Ambrosini A, Coertjens M, Petkowicz R, Viero I, Kruel L. (2008). *J Strength Cond. Res.*, 22, 1816-1825.

**OSTEOPOROSIS AND LIFESTYLE IN ELDERLY PEOPLE**

GOMEZ CABELLO, A., GONZÁLEZ-AGÜERO, A., CASAJÚS, J.A., ARA, I., VICENTE-RODRÍGUEZ, G.

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**Osteoporosis and lifestyle in elderly people** Gómez-Cabello A1, González-Agüero A1, Casajús JA1, Ara I1,2, Vicente-Rodríguez G1 1 GENUD Research Group, University of Zaragoza, Zaragoza, Spain 2 University of Castilla-La Mancha, Toledo, Spain **Introduction:** osteoporosis constitutes a growing problem worldwide that has a deep impact on quality of life and mortality (1). In younger populations, physical activity has been associated with increased bone mass whereas a sedentary lifestyle has been linked to a reduced bone mass (2). This study aimed to test whether the self-reported lifestyle (active/sedentary behaviours) could have a relationship with the risk of osteoporosis among elderly. **Material and methods:** 218 subjects (63 men and 155 women) aged 73.04±5.8 were evaluated in Aragón (Spain) within the framework of the elderly EXERNET multi-centre study. Bone mineral density was assessed at lumbar spine and hip sites by dual-energy X-ray absorptiometry. Sample was classified into three different groups according WHO guidelines (3) taking into account T-Score values at lumbar spine and hip sites. Self-reported physical activity, hours of walking and hours spent sitting per day were recorded by a questionnaire. Logistic regression was applied to study the association of the self-reported lifestyle with the risk of osteoporosis after controlling for age, height, lean and fat masses as confounders. **Results:** those women who spent sitting less than 4 hours per day showed 81.6% lower risk of suffering osteoporosis compared with those spending more time sitting (95% CI [0.045-0.749]). No association between sedentary lifestyle and risk of osteoporosis in men was found. Neither hours walking per day nor regular physical activity were independently associated with lower risk of osteoporosis in men or in women. **Discussion:** the absence of objective measures of active behaviours and the lack of information regarding the intensity of the activity could mask a positive association between active lifestyle and risk of osteoporosis. **Conclusion:** a sedentary lifestyle has a great impact on bone health among elderly, and therefore, reducing the hours sitting per day among seniors could reduce the risk of suffering osteoporosis, especially in elderly women. Refer-

ences: 1. Center JR et al. Mortality after all major types of osteoporotic fracture in men and women: an observational study. *Lancet*. 1999  
 2. Vicente-Rodriguez G et al. Extracurricular physical activity participation modifies the association between high TV watching and low bone mass. *Bone*. 2009 3. World Health Organization. Assessment of osteoporosis at the primary health care level. Summary Report of a WHO Scientific Group. WHO, Geneva. 2007 Acknowledgments: supported by Ministerio de Trabajo y Asuntos Sociales (104/07), and University of Zaragoza (UZ 2008-BIO-01). AGC has received a PhD grant from Gobierno de Aragón (B059/09).

## **METABOLIC RESPONSE TO HYPERGLYCAEMIA DURING EXERCISE IN ELDERLY AND YOUNG MALES**

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Metabolic response to hyperglycaemia during exercise in elderly and young males JM Malone<sup>1</sup>, SC Waldron<sup>2</sup>, IT Campbell<sup>2</sup>, A Hulton<sup>1</sup>, D Doran<sup>1</sup>, DPM MacLaren<sup>1</sup> <sup>1</sup> Department of Sport and Exercise Science, Liverpool John Moores University, Tom Reilly Building, Liverpool, L3 5AF and <sup>2</sup> Department of Anaesthesia, University Hospital of South Manchester, Manchester, M23 9LT Ageing is associated with an increased incidence of insulin resistance and body composition changes. We evaluated the physiological responses to maintained hyperglycaemia during exercise between young and elderly males. Eight endurance trained elderly (69.1 ± 5.2 y) and young (22.4 ± 2.9 y) males were studied during 40-min cycling exercise (60%) under both hyperglycaemic (10mM glucose) and control (0.9% saline) infusion conditions. Baseline anthropometric and physiological data revealed that participants were matched for body mass (76.3 ± 10 v 78.6 ± 4.3 kg) and % body fat (20.8 ± 4.3 v 18.9 ± 3.9%) whereas the elderly had significantly lower VO<sub>2</sub>max (41.1 ± 12.2 v 55.8 ± 5.1 ml.kg<sup>-1</sup>.min<sup>-1</sup>) and HOMA-2%B (63.6 ± 22.4 v 125.3 ± 78.2; P < 0.05). Venous blood samples were collected at baseline, post prime infusion, and at 20 and 40-min during exercise for insulin, glucose, NEFA, glycerol, lactate and 3-hydroxybutyrate. Carbohydrate and fat oxidation rates were determined using indirect calorimetry, and the hyperglycaemic clamp enabled calculation of glucose utilisation. The young displayed higher rates of carbohydrate oxidation (2.19 ± 0.51 g.min<sup>-1</sup>) compared to the elderly (1.51 ± 0.58 g.min<sup>-1</sup>; P < 0.01) with no differences in fat oxidation evident. Higher glucose utilisation rates were also observed in the young compared to the elderly at both 0 – 20 minutes (85.76 ± 23.95 and 56.67 ± 15.09 μM.kg<sup>-1</sup>.min<sup>-1</sup>, respectively) and at 20 – 40 minutes (104.87 ± 17.79 and 57.60 ± 29.30 μM.kg<sup>-1</sup>.min<sup>-1</sup>, respectively) Despite a blunted insulin response in the elderly (p = 0.01), no differences were observed for NEFA, glycerol, lactate and 3-OHB between groups. These data suggest that elderly males have a reduced ability to oxidise carbohydrate and dispose of glucose during exercise under conditions of maintained hyperglycaemia. In part this may be due to diminished beta-cell function resulting in lower levels of insulin despite no differences in insulin sensitivity.

## **EFFECT OF EXERCISE TRAINING TO HEALTH RELATED QUALITY-OF-LIFE IN MIDDLE-AGE AND OLDER ADULTS**

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**PURPOSE** To compare the direct effects of exercise training to the health related Quality-of-life (HRQOL) and the indirect effects of exercise training to HRQOL through the changes of physical fitness and physical activity. **METHODS** Fifteen females (54+/-3.6 years) and five males (66+/-7.6 years) participated in a 12-week exercise-training program. The program consisted of 12 training sessions; contents of the session were 20-min of warm-up, 20-min of walking, 40-min of resistance training with an elastic band and a balance ball, and 10-min cool-down. The frequency of training was once a week. Before and after the program, HRQOL, physical fitness, and physical activity of the participants were measured. The HRQOL was assessed using 4 domains of the WHOQOL-BREF (Physical, Psychological, Social, and Environmental QOL). Physical fitness was measured by grip strength, sit-ups, sit-and-reach, single-leg balance with eyes open, 10-m hurdle walk, and 6-min walk. Physical activity (METs•h) was measured by an accelerometer for before and last 1 week in the training program. The direct effects of training to HRQOL were estimated by the main effect of the two-way ANOVA with repeated measurements (factors were gender 2 levels and training 2 levels). The indirect effects of training to HRQOL were correlation coefficients between the changes of HRQOL and the changes of physical fitness components and physical activity. **RESULTS** The results of ANOVA model showed significant improvements of Physical (F (1, 18) = 6.8, p = 0.018), Psychological (F (1, 18) = 14.7, p = 0.001), Social (F (1, 18) = 9.2, p = 0.007), and Environmental QOL (F (1, 18) = 15.6, p = 0.001). In physical fitness components, sit-and-reach (F (1, 18) = 8.8, p = 0.008) and 6-min walk (F (1, 18) = 27.4, p < 0.001). Physical activity also significantly increased F (1, 18) = 23.8, p < 0.001). While the direct effects of training to HRQOL was significant, there were no significant correlation coefficients between the changes of HRQOL and the changes of physical fitness and physical activity (absolute value of r < 0.36, p > 0.12). **CONCLUSIONS** These results showed that exercise training directly effected improvement of the HRQOL in middle and older Japanese adults.

## **LONG-TERM EFFECTS OF TRAINING ON MUSCLE STRENGTH IN OLDER ADULTS**

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**Introduction** Several studies have shown beneficial training effects on health and physical function in older adults. To further investigate the effects of these studies a long term follow up is needed, to see whether the effects of the intervention persist over time. Previous studies have shown that muscle strength was preserved 6 months after a traditional heavy strength training program over 6 months (Beyer et al., 2007), but not after 12 weeks of functional training (Giné-Garriga et al. 2010). The aim of this study was to evaluate the long term effect of different training programs on muscle strength in elderly. **Methods** This study was a 12 months follow-up of subjects participating in a 13-week training study. The participants (70-92 years) had been randomly divided into a strength training group (STG), a functional strength training group (FTG) and an endurance training group (ETG). Muscle strength was measured as 1RM in four different exercises (chest press, seated row, shoulder press and knee extension) before intervention (T1), after the intervention (T2), and 12 months later (T3). All data were analyzed with linear mixed modeling, and results are given in effect sizes with 95% confidence limit. An effect of 0.2 of the baseline SD is regarded small, 0.6 moderate and 1.2 large (Hopkins et al., 2009). **Results** Out of the 85 elderly who completed the training intervention, 62 completed the T3 data collection. The increases observed during the intervention period were largest for STG, followed by FTG. At T3, strength was slightly reversed, and more in the two strength groups compared to ETG. For STG, a reduction was observed in chest press (ES=-0.25; ±0.17), shoulder press (ES=-0.47; ±0.19) and knee extension (ES=-0.97; ±0.29), while decreases were observed in shoulder press (ES=-0.30; ±0.21) and knee extension (ES=-0.90; ±0.35) for FTG. The only substantial decrease in ETG was in knee extension (ES=-0.44; ±0.30). From T1 to T3, small positive effects were observed in chest press for STG (ES=0.31; ±0.13) and FTG (ES=0.25; ±0.17), in seated row for STG (ES=0.34; ±0.18), and in knee extension for STG (ES=0.36; ±0.34), FTG (ES=0.30; ±0.35) and ETG

(ES=0.47;  $\pm 0.27$ ). The increase observed in STG was substantially different from ETG (ES=0.20;  $\pm 0.25$ ) for seated row. Discussion The most important finding of this study was that 12 months after the initial intervention period, strength was generally higher than before the intervention start. The two strength training groups tended to decrease more than ETG from post intervention to 12 months. This was most likely due to larger gains in strength during the intervention, and thus it may have been more demanding to sustain the increased strength during the follow up period. References Beyer N et al (2007). Aging Clin Exp Res, 19, 300-309. Giné-Garriga M et al. (2010). JAPA, 18, 401-424. Hopkins WG et al. (2009). Med Sci Sports Exerc, 41, 3-12.

### EFFECTS OF NON-PHARMACOLOGICAL INTERVENTIONS ON HEALTH RELEVANT PARAMETERS IN CONGESTIVE HEART FAILURE PATIENTS

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Objectives: The objective of this study was to examine the physiological effects that various exercise training methods have on CHF patients. Methods: 100 patients were randomised and divided in to an Endurance group (ETG, n=25), High intensity strength training group (STG, n=25), Circuit training group (CTG, n=25) and a Dietary comparison group referred to as non-training group (NTG, n=25). The interventions took place over a period of six months with three testing points. 78 patients (ETG: n=21; STG: n=20; CTG: n=20; NTG: n=17) completed the study. Results: The EF increased significantly in all training groups at all test points (ETG: pre  $31 \pm 6\%$  post  $46 \pm 8\%$ ; CTG: pre  $29\% \pm 7\%$  post  $45\% \pm 11\%$ ; STG: pre  $30\% \pm 7\%$  post  $45\% \pm 7\%$ ), but no significant change in the NTG was found. All groups showed a significant improvement in the NYHA classification (by one class). The NT-pro-BNP showed a significant decrease from  $1495 \pm 1555$  pg ml<sup>-1</sup> to  $934 \pm 702$  in the ETG (post vs. pre,  $p < 0.01$ ) and the NTG of  $1557 \pm 907$  to  $1105$  pg ml<sup>-1</sup> (interim vs. pre,  $p < 0.05$ ). Finally the peak VO<sub>2</sub> showed no significant changes in the NTG, but again significant changes in all the training groups. No training-related adverse effects were reported in any intervention group. Conclusion: Supervised outpatient exercise training is safe and beneficial in CHF patients with NYHA class II and III. All exercise interventions have a positive effect on cardiovascular and exercise specific parameters, but there is no significant difference between the various exercise interventions. Looking at the changes expressed in percentage the high intensity strength training group produced the greatest effects. This should be further examined.

### THE EXAMINATION OF THE RELATION BETWEEN THE BACK PAIN AND PHYSICAL STRUCTURE, AND SPORT HABITS ON PEOPLE WHO HAVE SOME BACK PAIN PROBLEMS

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Introduction The painful deformity of the musculoskeletal system is cause of work-related disability. So the purpose of this study was to examine of the relationship between physical structure and back pain. The study was designed for people who have some compliments about back pain problems. It was evaluated if there were some correlation between sport and other habits, diseases and risk factors and back pains. Methods In total, 176 people participated to this study. 89 of them (age  $34.72 \pm 5.33$ , height  $171.97 \pm 9.1$ , weight  $75 \pm 15.5$ ) were chosen as a control group and 87 of them (age  $32.9 \pm 7.9$ , height  $171.9 \pm 9$ , weight  $6 \pm 15.5$ ) were chosen who had back pain problems. The study group was chosen from a private sport and health centre members who have been there for 5 years. For anthropometric measurements, Anthropometric Standardization Manual was taken as reference. After all subjects' risk factors searched, physical parameters were measured and BMI, waist hip ratio, fat percent, LBW body surface area were calculated. Risk factors like diseases, life style and sports habits were asked. For statistical analysis, Par Q test was applied. All data was analyzed by SPSS statistical software. Results As a result of this study, 58% of the participants who had back pains did some exercises regularly in the past; 23 % of them did not do any exercises and 6% of them had a licence in some sports branches. There were no any significant correlation between sum of trunk skinfold and sum of extremity skinfold, BMI, BSA, waist hip ratio and body fat. Also there were no correlation between waist hip ratio, sum of trunk and BMI. Discussion According to the literature, in Leboeuf-Yde and Charlotte DC's review, 32% different studies reported a statistically significant positive weak association between body weight and back pain, also Anderson et al found the prevalence of significant knee, hip, and back pain increases with increased levels of BMI in their study. After all, in present study, there was no any relation between back pain and physical structure especially in some fat parameters. Because of sport habits and histories of the participants might be the reason of this unallied. References 1. Mirtz TA, Greene L. Is obesity a risk factor for low back pain? An example of using the evidence to answer a clinical question. Chiropr Osteopat. 2005 Apr 11;13(1):2. 2. Rodacki AL, Fowler NE, Provensi CL, Rodacki Cde L, Dezan VH. Body mass as a factor in stature change. Clinical Biomechanics. 2005 Oct;20(8):799-805.

### RELATION BETWEEN LOW BACK PAIN AND PHYSICAL ACTIVITY AT ADMINISTRATIVE AND FACTORY WORKERS

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FADEUP

Introduction: Low back pain (LBP) is the leading cause of disability in adults and the third leading cause of disability after that age. Several studies have studied the relation between LBP and Physical Activity (PA), suggesting that an increase in PA decreased LBP. However, some controversy exists because the PA related to repetitive movements in work context can contribute significantly to the increase in LBP. The aim of this research was to study the relation between PA and LBP. Methodology: It was studied a sample of  $n = 175$  individuals in the employment context. PA was assessed by the International Physical Activity Questionnaire and pain in the lumbar area using the Standardized Nordic Musculoskeletal Questionnaire. Results: There are no statistically significant differences ( $p > 0.05$ ) among subjects with pain and without pain with regard to the average time of daily moderate or vigorous PA. It was found that subjects without LBP, spent significantly ( $p < 0.05$ ) more time sitting than in pain. Discussion: The absence of statistically significant differences between groups of individuals with pain and without pain may be due to the fact that assessments of this variable were done by questionnaire and did not differentiate monitored PA and labour PA. Considering that this sample comes from a workplace in serial production and its administrative, we believe that the significant differences in time between the groups in pain and without pain, is related to the fact that the administrative workers (who are most of the day sitting) do not lift loads, while factory workers (who spend their workday standing) have a large part of their work activities lifting loads. It is thus evident the importance of planning monitored PA programs mainly for workers who lift loads. It was suggested the importance of evaluating PA by methodologies that distinguish between monitored PA and labour PA and are controlled by professionals. References: • Burton AK et al. (2005). Best Pract Res Clin Rheumatol, 19, 541-555. •Van Der Hulst M

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## Poster presentations

### PP-PM05 Sports Physiology and Testing

#### ANALYSIS OF DUATHLON AND TRIATHLON COMPETITIONS IN YOUNG ATHLETES

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Analysis of Duathlon and Triathlon competitions in young athletes Comotto S, Capranica L, Piacentini M.F. DiSMUS University "Foro Italico", Rome, Italy Introduction The aim of the present study was to investigate the pacing strategy (PS) and the rating of perceived exertion (RPE) during triathlon (TR) and duathlon (D) competitions in 13-year old athletes, which include swimming (S), cycling (C) and running (R) and R, C, R phases, respectively. For both races it has been hypothesized a positive PS with higher RPE scores after the last phase of the competition with respect to previous ones, and a correlation between PS and RPE changes during the race. Methods Four (M=2; F=2) 13-year old athletes participating in both D (R:800m, C:4000m, R:400m) and TR (S:150m, C:4000m, R:800m) Italian championships, took part in the present study. A wearable GPS (SPY Pro X, GPS Sport System, 15hrz) was used to record individual velocities and distance covered. To evaluate PS, 25m, 100m, and 500m mean distance was considered for S, R and C, respectively. RPE scale (Borg, 1998) was administered before, during the 2 transitions (T1 and T2), at the end of the race (E), and at 30-min of recovery (REC). A student paired T-test ( $p < 0.05$ ) was used to verify differences in PS. A 2 (TR and D)  $\times$  4 (T1, T2, E, and REC) ANOVA for repeated measures was applied ( $p < 0.05$ ) to RPE values. Pearson's correlation was applied to RPE and PS. Results For both races, PS resulted positive (TR:-51%; D:-47%), negative (TR:+18%; D:+20%) and even, for the three phases of the race. For RPE, differences ( $p < 0.05$ ) emerged during TR, with higher E values ( $8.3 \pm 1.5$ ) with respect to T1 ( $5.5 \pm 1.3$ ) and T2 ( $7.0 \pm 1.4$ ), whereas similar values were recorded during D (T1: $7.3 \pm 0.9$ ; T2: $7.5 \pm 0.6$ ; E: $7.8 \pm 1.0$ ). PS and RPE showed a significant ( $p < 0.05$ ) correlation only for the first ( $r = 0.98$ ) and last ( $r = 0.97$ ) R phases of D. Discussion To our knowledge, this is the first study to evaluate the PS and RPE during competition in very young athletes. Independently from competition, a positive PS what observed, in line with what reported for elite athletes (Le Meur et al., 2009). In particular, children started with fast velocities and decreased the pace during the race, probably because it is crucial to be included the first group after T1 (Comotto et al., 2011; Vleck et al., 2006). During TR, the highest RPE observed at the end of the competition could due to the effect of the first S phase, which is critical for determining the final ranking (Vleck et al., 2008). However, further research is needed to verify tactical parameters influencing PS. References Borg (1998) Campaing IL: Human Kinetics Comotto et al (2011) 1<sup>o</sup> World Congress of Science in Triathlon Le Meur et al (2009) Eur J Appl Physiol, 106: 535-545 Vleck et al (2006) Int J Sports Med, 27: 43-48

#### PROFILING YOUNG BASKETBALL PLAYERS - THE CONTRIBUTION OF ANTHROPOMETRIC AND TECHNICAL CHARACTERISTICS

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Introduction Basketball players need to perform according to the demands of their playing position, which require different characteristics. Anthropometric, physiological and technical characteristics have been found to differ between athletes as a function of playing position (Delaxtrat & Cohen, 2009; Hoare, 2000). Identifying these characteristics could help to profile players at an early age, and to provide insights into benefits of position-specific training. Therefore, we examined whether anthropometric, physiological and technical characteristics could discriminate between guards, centers and forwards, and consequently could be useful for profiling basketball players. Methods 60 Talent-identified basketball players aged 13-19 yrs (16 guards, 32 forwards, 12 centers) from the Dutch Premier League were assessed for anthropometric, technical and physiological characteristics. A test battery consisting of basketball-specific field tests was applied. Test scores were compared across playing position. Players from the three positions were similar in age, cumulative years of basketball, cumulative hours of practice per week, and number of games per week ( $p < 0.05$ ). Results One-way ANOVA and Kruskal-Wallis tests revealed differences across playing positions on anthropometric and technical but not on physiological characteristics ( $p < 0.05$ ). Independent t-tests and Mann-Whitney tests revealed centers scoring highest on the anthropometrics height, sitting height, reach height, wingspan, and weight followed by forwards and guards ( $p < 0.05$ ). On the technical characteristics slalom dribble, time difference between slalom dribble and slalom sprint, as well as on star dribble guards performed best followed by forwards. Centers were slower in dribbling and worse in ball handling ( $p < 0.05$ ). Moderate to large effect sizes were found ( $r = .44-.82$ ). Discriminant function analysis revealed that 'height' and 'star dribbling' classified 76% of talented players correctly. Discussion Anthropometric, in particular height, and technical characteristics, in particular dribbling and ball handling, differ between talent-identified basketball players according to playing position. Although selection procedures in youth basketball should be focused on multi-dimensional characteristics, profiling anthropometric and technical characteristics can contribute significantly to positioning basketball players at an early age. A next step is to investigate whether young players benefit from position-specific training. References Hoare DG (2000). J Sci Med Sport, 3, 391-405 Delextat A, Cohen D (2009). J Strength Cond Res, 23, 1974-81

#### COMPARISON OF PHYSIOLOGICAL DIFFERENCES BETWEEN THREE OLYMPIC RACE DISTANCES IN SHORT-TRACK SPEED SKATING

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TITLE: Comparison of Physiological Differences between Three Olympic Race Distances in Short-Track Speed Skating AUTHORS: Hesford, CM.1,2, Laing SJ.1, Cooper CE.2, Cardinale, MC.1. INSTITUTIONS: 1British Olympic Medical Institute (London, UK), 2University of Essex, (Colchester, UK). PURPOSE: To compare the physiological effects at global and local muscle level of undertaking short-track speed skating race simulations over the 3 Olympic race distances. METHODS Subjects were 6 male elite short track speed skaters, all members of the Great Britain Olympic squad (age:  $22 \pm 3$  years, height:  $172.6 \pm 11.79$  cm, mass:  $70.75 \pm 12.43$  kg, mid-thigh skin fold thickness:  $6.97 \pm 1.3$

mm). Subjects performed race simulation over each Olympic distance (500m; 1000m; and 1500m) in randomized order separated by at least 24h. In addition to measurements of global oxygen consumption (VO<sub>2</sub>) and blood lactate concentration, two spatially resolved near-infrared oximeters were used to non-invasively measure the changes in both muscle tissue oxygen saturation (TSI%) and hemoglobin concentration (tHb) in the right and left vastus lateralis muscles. RESULTS Simulations were completed in  $44.82 \pm 0.41$  s (500m),  $94.95 \pm 2.08$  s (1000m) and  $151.03 \pm 4.04$  s (1500m). Post-1000m blood lactate was significantly higher than post-500m blood lactate ( $9.76 \pm 0.54$  mmol•l<sup>-1</sup> v  $6.77 \pm 0.61$  mmol•l<sup>-1</sup>,  $P=0.005$ ). Peak VO<sub>2</sub> was significantly higher during lap 1 of 500m than lap 1 of 1500m ( $49.04 \pm 5.35$  ml•kg<sup>-1</sup>•min<sup>-1</sup> v  $31.56 \pm 5.24$  ml•kg<sup>-1</sup>•min<sup>-1</sup>,  $P<0.05$ ). Race distance did not affect magnitude of maximal TSI reduction, but linear regression analysis of TSI% change during race start showed that race distance affected the speed of initial desaturation (slope values =  $-2.99 \pm 0.07$  in 500m,  $-2.42 \pm 0.09$  in 1000m, and  $-1.91 \pm 0.08$  in 1500m). Following initial desaturation, asymmetry between legs was observed in the 500m and 1000m: left leg TSI values increased throughout the race, indicating gradual muscle restoration, whereas right leg values remained stable. Single lap analysis showed consistent differences in the patterns of right and left leg tHb changes caused by specific demands of each section of lap. Greatest difference between the legs is seen during cornering, when the skater 'hangs' on the right leg. TSI asymmetry is not observed in the 1500m, during which the 'hang' phase is not generally employed. CONCLUSION: The study has highlighted the differences in right and left leg muscle saturation during the 3 race distances. The use of the portable tool to acquire local muscle measurements in vivo, in combination with the global measures which were taken, builds a more comprehensive understanding of the metabolic demands of undertaking the three different race distances. This information may have implications for athletes and coaches in terms of specificity of training, with regard to both leg asymmetry and race distance.

## ADAPTATION OF THE LÉGER'S FITNESS TEST TO JUDO

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ADAPTATION OF THE LÉGER'S FITNESS TEST TO JUDO Kirbschus, K., Kirbschus, M., Ferrauti, A. Ruhr-University Bochum, Department of Coaching Science (Bochum, Germany) Introduction The multistage 20 m shuttle run test for aerobic fitness (Léger et al. 1982) is worldwide used for endurance testing in different sports and several modifications of the test design had been published in the last two decades. The aim of the present study was to use the original beep protocol for a specific endurance test in judo by adapting the motoric demands. Methods In order to validate a maximal multistage judo shuttle run test 14 well trained judoka (age  $22.0 \pm 4.3$  yrs, BMI  $23.4 \pm 1.6$ ) and 13 4th division soccer players (age  $23.6 \pm 3.0$  yrs, BMI  $23.5 \pm 1.8$ ) completed the regular shuttle run test (SRT) and the judo adapted version (JSRT) on two occasions at least one week apart in a cross over designed order. To test the repeatability 16 Judoka repeated the JSRT twice. Adaptation of the JSRT consisted in the following criteria: The distance covered between the beeps corresponded to 8m on a judo mat. Simultaneous to the beeps the athletes have to push-up behind the line. Between two beeps one judo role should be done in a target zone between two lines. Results No differences were found between the maximum test level performance during the SRT between judoka ( $11.6 \pm 1.3$ ) and soccer players ( $11.1 \pm 1.5$ ). During JSRT judoka reached significantly higher test levels ( $9.2 \pm 1.8$ ) than soccer players ( $5.6 \pm 1.4$ ). Blood lactate concentration after exhaustion tended to be higher in judoka ( $9.1 \pm 3.3$  mmol/l) than in soccer players ( $7.1 \pm 2.0$  mmol/l). Test retest correlation of the JSRT was significant ( $r=0.900$ ) and differences in mean maximum test levels were found. Discussion The JSRT seems to be sufficient valid and reliable. We recommend this test for judoka coaches because of its practical value when using the available Test CD and the usual training surroundings. References Léger, LA & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO<sub>2</sub> max. Eur J Appl Physiol Occup Physiol 49:1-12.

## MANIPULATION OF PACING PROFILES DURING SIMULATED 400M RACES IN HIGH-LEVEL JUNIOR SWIMMERS: EFFECTS ON PERFORMANCE

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Introduction Recent research suggested that athletes develop a stable pacing profile (PP) during their career, which is recalled for similar trials (Mauger et al., 2010). However, there is only little data available whether such PP are optimal and in which way slight manipulations may have an impact on performance. Therefore, the aim of this study was to manipulate self-selected PP (PPSS) during simulated 400 m competitions in high-level junior swimmers and analyze the effects on performance. Methods 13 competitive front-crawl swimmers (4♀, 9♂, age:  $18.4 \pm 2.6$  yrs, training history:  $6.5 \pm 1.6$  yrs) performed 3 simulated 400m races. The first test was swum with a PPSS. The first 100m section of the following tests was manipulated in a randomised order: slower (PPslow:  $+2.9 \pm 1.4$ s,  $4.2 \pm 2.0\%$ ) or faster (PPfast:  $-1.9 \pm 0.8$ s,  $3.0 \pm 1.4\%$ ). 15m start time was determined by video analysis. All 100m split times were determined during each trial. Maximal blood lactate concentrations [bLa]max and heart rates [HR]max were measured for all tests. Results There was a tendency for faster average 400m times for the self-selected trials (PPSS =  $272.5 \pm 15.9$  s, PPslow =  $275.7 \pm 16.0$  s, PPfast =  $276.9 \pm 17.7$  s,  $p=0.07$ , partial eta square =  $0.20$ ). Neither [bLa]max ( $10.3$  to  $10.8$  mmol/L,  $p=0.68$ ) nor HRmax ( $177$  to  $178$ /min,  $p=0.71$ ) were significantly different between conditions. While the initial 100m was significantly slower in PPslow compared to PPSS, no differences for all further sections were observed ( $p>0.9$ ). In contrast, the faster first 100m section in PPfast resulted in slower times during the second half of the race ( $\sim 2$ s per 100m,  $p<0.02$ ). 2 subjects showed their best performance in PPfast ( $-2.9$ s) and 4 in PPslow ( $-0.2$  to  $-1.3$ s). When corrected for start time ( $7.1 \pm 0.7$ s) no difference was observed between sections in PPSS ( $p>0.18$ , even pacing). Furthermore, the first section was faster than all others in PPfast ( $p<0.001$ , fast-slow) as well as slower than the last one in PPslow ( $p=0.03$ , slow-fast). Discussion It is concluded that a PP manipulation with slower or faster first sections does not result in better performance time compared to PPSS during a 400m race in most swimmers. On average, starting slower did not enable swimmers to speed up towards the end of the race, whereas starting faster resulted in considerable performance decrements during the later sections of the race. However, single subjects showed better performance during the manipulated races, hence in some cases the PPSS might not be optimal. Future research should focus on the identification of subject characteristics that indicate which PP should be chosen to swim as fast as possible. References Mauger AR, Jones AM, Williams CA. (2010). Eur J Appl Physiol, 2010; 108 (5), 1015-23



## CARDIORESPIRATORY AND METABOLIC RESPONSES DURING MAXIMAL AND SUBMAXIMAL EGGBEATER KICKING BY WATER POLO PLAYERS

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**Introduction** During a water polo match, players float in the water and perform the eggbeater kick (EK) for about 1 h. The intensity of the EK depends on the situation and is especially high during contact play. The purpose of this study was to investigate the cardiorespiratory and metabolic responses during maximal and submaximal EK exercises in water polo players. **Methods** Thirteen male college-age competitive water polo players performed incremental cycling (C) and EK exercises in random order. Both exercises consisted of n•3-min exercises with 60-s recoveries until exhaustion. During EK, subjects were not allowed to use arm sculling. **Results** We found that  $\dot{V}O_{2peak}$  was significantly lower during EK than C ( $48.9 \pm 6.8$  vs.  $53.6 \pm 4.9$  ml/kg/min,  $p < 0.05$ ), as was  $\dot{V}E_{peak}$  ( $102.3 \pm 16.5$  vs.  $135.8 \pm 15.2$  l/min,  $p < 0.05$ ). We also compared heart rate (HR), minute ventilation ( $\dot{V}E$ ), tidal volume (TVE), and respiratory rate (RR) between EK and C at three levels of  $\dot{V}O_2$  (24, 36 and 48 ml/kg/min). Although HRs at all three  $\dot{V}O_2$  levels did not significantly differ between the exercises,  $\dot{V}E$ s at all three  $\dot{V}O_2$  levels were significantly lower during EK than C. In addition, TVEs were significantly greater during EK than C at the two lower  $\dot{V}O_2$  levels, while RRs were significantly lower. **Discussion** We found  $\dot{V}O_{2peak}$  during EK to be 91% of that during C in water polo players. It may be that active leg muscle mass during EK was smaller than during C. Additionally, because  $\dot{V}E_{peak}$  was lower during EK, arterial  $O_2$  content also may have been lower, contributing to the lower  $\dot{V}O_{2peak}$ .  $\dot{V}E$ s at three levels of  $\dot{V}O_2$  were lower during EK than C. Given that the thermal conductivity of water is greater than that of air, and that  $\dot{V}E$  increases with increases in core temperature during exercise (Hayashi et al. 2006), the lower  $\dot{V}E$  during EK may reflect a lower core temperature. We also found that TVEs at the two lower  $\dot{V}O_2$  levels were significantly greater during EK than C, while RRs were lower. Because buoyancy in a resting vertical position increases with increases in TVE (Von Döbeln et al. 1974), the subjects may have increased their buoyancy during EK by increasing TVE. If so, not only their leg movement (Sanders, 1999) but also their breathing is important for keeping their upper body above the water surface during EK. **References** Sanders R H. (1999). J Appl Biomech. 15, 284-291. Hayashi K, Honda Y, Ogawa T, Kondo N, Nishiyasu T. (2006). J Appl Physiol. 100, 414-20. Von Döbeln W, Holmér I. (1974). J Appl Physiol 37, 55-59.

## ANALYSIS OF PERFORMANCE INDICATORS' VARIATION DURING BEACH VOLLEYBALL MATCHES.

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**Introduction** Physiologic, functional and tactical demands of team sports have been studied, in an attempt to better understand the critical determinants of performance (Bangsbo, Mohr & Krstrup, 2006). Therefore, the purpose of this study was to analyse the variability of the acute physiologic responses, muscular power, and tactical performance in Beach Volleyball matches. **Methods** Sixteen male Brazilian beach volleyball players (aged  $28.1 \pm 6.0$  years) were analyzed in eight matches. Heart rate was measured at rest (before match) and continuously during the match. Blood lactate concentrations and vertical jump measurements were made at rest, and at the end of the 1st, 2nd and 3rd sets. Tactical performance was assessed during the match sets using the following indicators: coefficient of efficiency of performance on service, reception, distribution, spike, block and defence. The Wilcoxon matched-pairs ranks tests were used to determine differences between paired data. **Results** Blood lactate concentrations increased significantly from rest to the final of each set, (1st  $1.8 \pm 0.5$  p=0.01; 2nd  $3.5 \pm 2.3$  p<0.001; 3rd  $3.5 \pm 1.5$  p<0.001). Average heart rate increased significantly (p=0.036) from the end of the 1st set ( $146 \pm 12$ ) to the end of the 2nd set ( $150 \pm 9$ ). Moreover, an improvement in vertical jump was observed from rest ( $53.2 \pm 7.6$ ) to the end of the 1st set ( $53.8 \pm 7.5$ ; p=0.017), and between the 1st set and the 3rd set ( $55.0 \pm 7.8$ ; p=0.016). No significant differences were found for tactical performance. **Conclusions** Blood lactate concentrations does not seem to reflect the match intensity. Although heart rate values showed high variability, the set average values were stable during the match, but lower when compared to other intermittent sports, including indoor volleyball. Vertical jump and tactical performance were stable during the match. Possibly, the work-to-rest ratio during the match afforded enough time for recovery, which might explain the observed stability. **References** Bangsbo, J.; Mohr, M.; Krstrup, P. Physical and metabolic demands of training and match-play in the elite football player. Journal of Sports Sciences [S.l.], v. 24, n. 7, p. 665-674, 2006.

## THE EFFECTS OF THE DIFFERENCES OF CYCLING TIME ON ENERGY DYNAMICS AND BIOCHEMICAL MARKERS OF HEART DAMAGE FOR JAPANESE RECREATIONAL CYCLISTS

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**THE EFFECTS OF THE DIFFERENCES OF CYCLING TIME ON ENERGY DYNAMICS AND BIOCHEMICAL MARKERS OF HEART DAMAGE FOR JAPANESE RECREATIONAL CYCLISTS** Hayao Ozaki, Shinichiro Murade, Ryo Kakigi, Takashi Nakagata, Toshinori Yoshihara, Shizuo Katamoto, Hisashi Naito Juntendo University **Introduction** Prolonged cycling and running impact energy dynamics and cardiac function (Costill, 1970; Neumayr et al., 2005). However, the effects of the differences of cycling time on energy dynamics and biochemical markers of heart damage have not yet been explored. Therefore the aim of this study was to investigate them for Japanese recreational cyclists. **Methods** A total of 28 recreational cyclists, aged 18-63 years, participated in the same local enduro and were divided into 3 groups by the race time: within 1-hour group (1H, n=7), 1-2 hour group (2H, n=14), more than 4-hour group (4H, n=7). Venous blood samples were obtained from an antecubital vein before the start of the race (Pre) and immediately after the race (Post). Then insulin, non-esterified fatty acid (NEFA), heart type fatty acid-binding protein, N-terminal pro-brain natriuretic peptide (NT-proBNP), cardiac troponin T (cTnT), creatine kinase, creatine kinase MB (CK-MB), myoglobin, lactate dehydrogenase, aspartate aminotransferase, alanine aminotransferase (ALT) and  $\gamma$ -glutamyl transpeptidase ( $\gamma$ -GTP) were measured at commercially available laboratories. Blood lactate (LA) and glucose levels were evaluated with blood from a fingertip, respectively. **Results** There were not differences in all value-Pre and was a time effect in all value except ALT and  $\gamma$ -GTP. LA-Post in the 2H group ( $7.1 \pm 0.8$  mmol/l) was significantly higher than that in the 1H ( $4.8 \pm 0.8$  mmol/l) and 4H ( $2.3 \pm 0.2$  mmol/l) group. There was a significant increase in NEFA-Post for the 4H ( $1433 \pm 94$   $\mu$ Eq/L) group compared to the 1H ( $243 \pm 35$   $\mu$ Eq/L) and 2H ( $590 \pm 76$   $\mu$ Eq/L) group. cTnT-Post and CPK-MB-Post in the 4H ( $0.073 \pm 0.027$ ,  $9.2 \pm 1.9$  ng/mL) group were significantly higher than that in the 1H ( $0.005 \pm 0.002$ ,  $4.3 \pm 1.2$  ng/mL) and 2H ( $0.013 \pm 0.002$ ,  $5.4 \pm 0.5$  ng/mL) group and NT-proBNP-Post in 4H ( $99 \pm 27$  pg/mL) group was higher than that in the 2H ( $51 \pm 16$  pg/mL) group. **Discussion** LA after the race increased until 2-hour but was lower in the 4H group than 1H and 2H group. Costill (1970) has also shown the same results in running. Meanwhile, NEFA significantly increased in the 4H group after the race compared to the 1H and 2H group. Thus the differences of cycling time influenced energy dynamics in enduro.

Additionally, although there are not different in the value associated with hepatic function after the race among three groups, cTnT, CPK-MB and NT-proBNP as clinical indicators of cardiac damage significantly increased in the 4H group compared to the 1H and 2H group. Therefore, such a race over 4-hour may put great stress on cardiac system for Japanese recreational cyclists. References Costill DL (1970). *J Appl Physiol*, 28(3), 251-255. Neumayr G et al (2005). *Am J Cardiol*. 96(5), 732-735.

### BODY MASS AND SKINFOLDS IN ELITE FEMALE ROAD CYCLISTS: NORMATIVE VALUES AND TYPICAL CHANGES

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**Introduction** Anthropometric characteristics of a relatively small sample of elite female cyclists have previously been described (Martin et al., 2001). However, typical changes in body mass and sum of seven skinfolds over a year of training and racing in this weight conscious population are not well documented. This study reports body mass and sum of seven skinfolds in elite female cyclists and describes the relationship between changes in these commonly monitored variables. **Methods** Anthropometric profiles were assessed in elite female cyclists from 1996 - 2010. Body mass was recorded using a calibrated scale and sum of seven skinfolds were measured in duplicate using calibrated callipers (Harpenden) as described by Norton & Olds (1996). Descriptive statistics were calculated for mass and skinfolds. Change scores for mass and skinfolds that occurred from two weeks to six months were calculated. Change scores were analysed using linear regression analysis. The percentage of change scores that deviated from the expected relationship was documented. **Results** Data from 22 female cyclists met the inclusion criteria for this study. Five scientists completed 9.6 ( $\pm 4.9$ ) anthropometric profiles. Cyclists were of a high calibre and included a former UCI number one ranked cyclist, World Cup winners, and Olympians. Mean ( $\pm$  SD) body mass was 58.91kg ( $\pm 3.86$ ) [range 56.76 ( $\pm 3.84$ ) to 61.46kg ( $\pm 3.93$ )]. Mean sum of seven skinfolds was 61.0mm ( $\pm 14.1$ ) [Range 51.0mm ( $\pm 14.1$ ) to 73.8mm ( $\pm 14.8$ )]. Change scores were examined in 17 cyclists where there was a high frequency of monitoring. Change scores were distributed as follows: 22% inc mass – inc skinfold; 42% dec mass – dec skinfolds; 19% inc mass – dec skinfolds; 16% dec mass – inc skinfold. On average, the greatest reduction in body mass was -2.4kg ( $\pm 1.0$ ) while the greatest weight gain was 2.0kg ( $\pm 1.0$ ). On average, the greatest reduction in skinfolds was -13mm ( $\pm 7$ ) and the greatest gain was 10mm ( $\pm 7$ ). Only 14% of the variance in change in mass could be explained by change in skinfolds. **Discussion** Our results indicate that ~2.0-2.5kg fluctuations in body mass and ~10-13mm fluctuations in skinfold are realistic seasonal changes in elite female cyclists. Due to our methodology, these estimates are likely conservative. Approximately one third of the change scores indicate that elite female cyclists manipulate fat free mass and fat mass independently. **References** Martin, D. T., et al. (2001). *Sports Med*, 31(7), 469–477. Norton, K., & Olds, T. (1996). *Anthropometrica: a textbook of body measurement for sports and health courses*. University of New South Wales Press.

### THE CLASSIFICATION OF CYCLISTS: A SYSTEMATIC LITERATURE REVIEW

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**Introduction** There already exists a classification of 'professional' cyclists (Jeukendrup et al, 2000), however it seems that many different classifications and criteria are used to describe a group of cyclists. The aim of this systematic literature review is to present an overview of physiological values per classification. **Methods** A systematic literature review. **Inclusion criteria:** healthy, male subjects, sufficient described group of subjects, and cycling related research. **Exclusion criteria:** articles published before 2000, n<6 subjects, age < 18 yrs, no detailed subject descriptions and groups of subjects including females or mixed groups. In literature, various definitions describe the group of subjects. We used the following most common classifications: 'untrained', 'recreationally trained', 'trained', 'well trained' and 'professional' for further analysis. **Results** Based on the above mentioned criteria 135 articles were included. The most cited parameters for subject descriptions are gender (n=81), age (n=125), body mass (n=125), height (n=101), relative and/or absolute VO2max or VO2peak (n=95), and absolute and/or relative peak power output (PPO) (n=51). 35 articles gave information concerning history and current training/competition data. According to the database, groups of subjects categorized as 'untrained', 'recreationally trained', 'trained', 'well trained' and 'professional' presented VO2max values of respectively 42.9  $\pm$  4.2, 49.2  $\pm$  5.2, 64.3  $\pm$  6.3, 65.5  $\pm$  6.1 and 74.8  $\pm$  3.6 mL/kg/min. For the absolute VO2max values of respectively 3.4  $\pm$  0.1, 3.8  $\pm$  0.3, 4.4  $\pm$  0.3, 5  $\pm$  0.3 and 5.1  $\pm$  0.2 L/min were observed. The absolute PPO values for the five categories were respectively 284  $\pm$  23, 308  $\pm$  13, 359  $\pm$  28, 406  $\pm$  52 and 456  $\pm$  47 W. For the relative VO2max significant differences between the classifications were found, except between 'trained' – 'well trained' cyclists (p=0.289). For the absolute VO2max and PPO values significant differences were observed between 'recreationally trained' – 'trained' (p=0.007; p=0.009), and 'trained' – 'well trained' subjects (p=0.005; p=0.006). **Conclusion** This systematic literature review clearly shows several overlap zones from the physiological parameters between the different classifications. A definition of a unified terminology and criteria for classification are needed. **Reference** Jeukendrup AE, Craig NP, Hawley JA. The bioenergetics of world class cycling. *J Sci Med Sport* 2000 Dec; 3(4): 414-33.

### COMPARISON BETWEEN SPECIFIC AND UNSPECIFIC TESTING IN SWIMMING

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**Introduction** Physiological parameters measurement is a valid tool to assess exercise capacity of athletes engaged in different types of sport activities providing that, when testing, subjects perform an exercise similar to that of their specific discipline. This concept is particularly true for sport such as swimming, since it is not simple to reproduce in the laboratory setting the specificity of swimming movements. This study was set to compare results from three unspecific exercise testing procedures [arm-cranking (AC), cycling (CY), and running (RU)] with those obtained from one specific swimming (SW) test in a swimming pool. **Methods** 12 athletes at Italian national level (age 19.2  $\pm$  2.8 years, weight 68.9  $\pm$  5.7 Kg, and height 177.3  $\pm$  6.1 cm) agreed to participate in this investigation. They underwent three laboratory standard incremental exercise tests up to exhaustion using three different protocols and ergometers: AC, CY, and RU. During all tests data of maximal oxygen uptake (VO2max), maximal heart rate (HRmax), and anaerobic threshold (AT) were gathered. These data were then compared to those obtained from an incremental SW test while subjects wore a portable metabolic device (VO2000, MedicGraphics, USA) and exercised against an elastic rope which was tied at one extremity. The workload was controlled by a dynamometer. **Results** Statistics revealed that SW testing provided higher values of VO2max and VO2 at AT with respect to AC and CY testing while no difference was found between SW and RU. Moreover, HRmax was lower during SW than during all the other exercise testing. **Discussion** Results from the present study reveal that, among the various testing procedures employed, only RU testing provides VO2 values which

are similar to those obtained from specific SW testing. However, none of the unspecific testing protocols provide data that can be interchangeably used instead of SW testing. Thus, it is strongly recommended the use of specific SW testing to assess swimmers exercise capacity. References Holmér I, (1992) *Ann Physiol Anthropol*, 11(3); 269-76. Di Prampero, (1985) *La locomozione umana su terra, in acqua, in aria*. edi-ermes. Zamparo P, Bonifazi M, Faina M, Milan A, Sardella F, Schena F, Capelli C. (2005) *Eur. J. Appl. Physiol.* 94: 697-704. Barbosa TM et al. (2006) *Int J Sports Med.*; 27(11):894-9. Zamparo P, Capelli C, Cautero M, Di Nino A. (2000) *Eur. J. Appl. Physiol.* 83: 487-491. Capelli C, Pendergast DR, Termin B. (1998) *Eur. J. Appl. Physiol.* 78: 385-393. Barbosa TM et al. (2006) *Int J Sports Med.* 27(11):894-9.

## ASSESSMENT, MONITORING AND CONTROL OF HIGH LEVEL ROLLER SPEED SKATERS

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INDEPORTES ANTIOQUIA

Introduction Roller Speed Skating has gained great popularity in our country due to many results in world championships and other competitions where Colombia has been winner. This involves several factors: Organization of regional tournaments by National Federation, big volumes of training loads and many competitions, Sports Medicine and Applied Science's evaluations, all this has guaranteed an adequate preparation to competition. Methods We want to show some results of monitoring, evaluation and control we usually do to Colombian's skaters which show the reasons they are better of the world currently. Anthropometric characteristics and evaluation of aerobic and anaerobic power show a well-trained athlete's group for achievement of their objectives. The evaluations have been made in Physiology Laboratories of Indeportes Antioquia in Medellin and High-performance Center of Coldeportes Nacional in Bogotá, Colombia. Results The average and standard deviation for men and women's group were: Size:  $172,9 \pm 4,1$  cm;  $160,8 \pm 4,3$ . Weight:  $67,9 \pm 7,6$  kg;  $57,9 \pm 3,0$  kg. %Fat:  $7,3 \pm 0,9$ ;  $14,3 \pm 2,6$ %. %Lean Body Mass:  $92,8 \pm 0,9$ %;  $85,7 \pm 2,6$ %. Somatotype X: 0,7; -1,3. Y: 5,0; 2,8. Wingate Test:  $14,7 \pm 2,7$  watt;  $9,5 \pm 0,6$  watt. VO2max.  $63,8 \pm 9,3$  ml/kg.min;  $55,6 \pm 2,8$  ml/kg.min. Bosco Test:  $29,0 \pm 7,5$  watt/kg;  $22,5 \pm 4,4$  watt/kg. Discussion These results demonstrate great preparation of Colombian's skaters to World Championship. Also, these results added to a great volume in training loads and very good sports technique, allow skating is claimed as an option to show our country like sports potency in this modality. References 1. Marino, F, Dominguez, C, Correa, JG. Quinchía, A. Ojeda, N. Descripción de las características cineantropométricas de los patinadores de carreras en línea, campeonato mundial, Barrancabermeja, Colombia, 2000. *Rev. Ant. De Med. Dep. y Cien. Apl. a la Act. Fis.*, vol.3, número 2, 2000. 2. Marino F., Gámez R., Camacho J., Correa JG., Cineantropometría del patinaje de carreras, I copa del mundo – Santafé de Bogotá 1997, *Rev. Ant. De Med. Dep. y Cien. Apl. a la Act. Fis.*, vol.3, número 2, 2000. 3. Rodríguez, C., Perfil antropométrico del patinador panamericano, Documentos, Instituto de Medicina del Deporte, La Habana, 1991. 4. Stuto A, Corrada A, Basile G, Monti M, La Rosa R, Martignon G. Parametri antropometrici e fisiologici in pattinatrici di altissimo livello, Federazione Italiana de Hockey y Patinaje, Documentos, 1999.

## Poster presentations

### PP-PM06 Environmental Challenge

#### UNIQUE EFFECTS OF INTERMITTENT EXERCISE AND TIME OF DAY ON RECOVERY BLOOD PRESSURE "KINETICS"

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Introduction Exercise is an important intervention in blood pressure (BP) control. Previously, we reported that intermittent exercise mediates a greater overall reduction in recovery blood pressure (BP) than continuous exercise, irrespective of time of day (Jones et al., 2009). However, the exact minute-by-minute time-course in BP reduction was not described and the amount of sleep prior to the morning and afternoon exercise times was not controlled in this previous study. Therefore, we investigated the effects of intermittent exercise on minute-by-minute BP recovery at two times of day while controlling for prior sleep and posture. We hypothesised that BP falls in a cumulative manner during the recovery phases of intermittent exercise. Methods Following an estimation of required statistical power based on previous research, a sleep- and posture-controlled protocol (Jones et al., 2008) was completed at 06:30 and 16:30 h by 9 men, aged (mean $\pm$ SE)  $27\pm 9$  years. At each time of day, participants completed 3x10 min bouts of semi-supine cycling (60% peak power output) with each bout separated with 10 min of passive recovery. Recovery period 3 was followed by 10 min of supine rest. Systolic and diastolic BP and mean arterial pressure (MAP) were measured continuously from the middle finger (Finometer). Data were analysed using repeated-measures linear mixed models and are described as mean $\pm$ SE. Results Baseline BP was unaffected by time of day ( $P>0.05$ ). Recovery MAP differed between times of day ( $P=0.003$ ) and recovery periods ( $P=0.002$ ). MAP did not differ significantly ( $P=0.57$ ) between recovery periods 1 ( $88\pm 3$  mmHg) and 2 ( $88\pm 3$  mmHg) but was significantly ( $P<0.0005$ ) lower in recovery period 3 ( $82\pm 3$  mmHg). For the first min of recovery period 1, MAP was  $20\pm 6$  mmHg higher in the morning ( $P<0.005$ ), but declined more rapidly than in the afternoon. The time-course of MAP was much less variable in recovery periods 2 and 3. Discussion These data provide the first evidence that BP reduces during the recovery periods of intermittent exercise in a non-linear cumulative fashion. Even when prior sleep is controlled through a novel protocol, BP is highest during the first min of the first recovery period in the morning, but this 'shock effect' dissipates during subsequent recovery periods. Given the strong relationship between changes in BP in the morning and risk of stroke and cardiovascular events (Kario, 2010), our results have important implications for the prescription of exercise in the control of BP. Jones H, et al., (2009). *Chronobiol Int*, 26, 293-306. Jones H, et al., (2008). *Chronobiol Int*, 25, 987-998. Kario K. (2010). *Hypertension*, 56, 765-773.

#### EFFECT OF TIME OF DAY ON UPPER AND LOWER BODY HIGH INTENSITY EXERCISE PERFORMANCE

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Introduction Circadian rhythms influence many physiological functions of the human body, however their impact on high intensity exercise remains inconclusive. Previous studies which have investigated high intensity leg cycle ergometry include Reilly & Down (1992) who reported no time of day effect on performance when subjects were tested at 6 time points in a 24hr period. However a similar study by Hill & Smith (1991) found power output (PO) to be higher in the afternoon than in the morning. In addition there is recent evidence which demonstrates that the upper body plays a significant role in the production of PO during high intensity leg cycle ergometry (Baker et al 2001). Therefore the objective of this study was to assess peak power of the upper and lower body over a 12hr period and to establish if

they follow similar patterns of diurnal variation. A secondary aim was to assess the impact of the subject's motivation on performance. Methods 11 male subjects ( $22.9 \pm 2.6$  yrs;  $182 \pm 0.06$  cm;  $80.43 \pm 14.39$  kg) were tested over a 12hr period (0800-2000h). Every hour, on the hour, subjects performed a 10s maximal leg cycle ergometry test; every hour, on the half hour, they performed a standing broad jump (SBJ), maximal hand grip test (HG) and vertical jump (VJ). Tympanic temperature, blood pressure, heart rate (HR) and EFI scores (Exercise-Induced Feeling Inventory) were recorded at regular intervals. Results The main results show that there were no significant differences across the 12hr period for peak power produced by the upper or lower body ( $P > 0.05$ ). However PO of the lower body (SBJ, VJ) and PO during high intensity cycling along with positive engagement all peaked at 1900h. HR immediately following the 10s maximal cycling was found to be significantly higher at 1900h ( $P < 0.05$ ) compared to all other time points (except 1700, 1800h). Discussion-Conclusion The results show that PO is not significantly affected by the time of day therefore indicating that there is no circadian rhythm in high intensity exercise. However there is a suggestion that lower body PO is somewhat affected by motivational levels of subjects as evidenced by peak values for positive engagement coinciding with peaks observed for PO. It is likely subjects were highly motivated at 1900 as this was the last trial of the day. These findings suggest that to ensure true peak performance during high intensity exercise, individuals must be highly motivated. References Baker J et al (2000). Power output of legs during high intensity cycle ergometry: Influence of handgrip. *J Sci Med Sport* 4(1): 10-18. Hill D & Smith J (1991). Circadian rhythm in anaerobic power & capacity. *Can J Sport Sci* 16: 30-32. Reilly T & Down A (1992). Investigation of circadian rhythms in anaerobic power and capacity of the legs. *J Sports Med Phys Fit* 32: 343-347.

### CIRCADIAN VARIATION IN HYPERTHERMIC HYPERVENTILATION DURING PROLONGED EXERCISE IN THE HEAT

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Introduction Hyperthermia during exercise causes skin vasodilation and sweating (two thermoregulatory responses), as well as hyperventilation (Fujii et al. 2008). Notably, these thermoregulatory responses during exercise are influenced by circadian variation in resting core temperature. It is unclear, however, whether the same is true of hyperthermic hyperventilation. We therefore examined whether hyperthermic hyperventilation during prolonged exercise is altered by circadian variation in body temperature. Methods Ten male subjects performed a cycle exercise at 50% of peak oxygen uptake in the heat ( $37^{\circ}\text{C}$  and 50% RH) at 6:00 (AM) and 18:00 (PM). Before each exercise, the subjects were immersed for 25 min in water at  $18^{\circ}\text{C}$  to detect the esophageal temperature (Tes) threshold for hyperventilation (Tsuji et al. 2009). Results The Tes thresholds for increases in the sweat rate (SR) and forearm vascular conductance (FVC) were higher at PM than AM ( $P < 0.05$ ), but there was no difference in the respective slopes of the SR-Tes and FVC-Tes relations at the two times. The Tes threshold for hyperventilation was higher at PM than AM ( $37.2 \pm 0.7$  vs.  $36.6 \pm 0.6^{\circ}\text{C}$ ,  $P < 0.05$ ), and the slope of the minute ventilation (VE)-Tes relation at Tes above the threshold was greater at PM than AM ( $16.5 \pm 5.0$  vs.  $10.8 \pm 5.5$  L/min/ $^{\circ}\text{C}$ ,  $P < 0.05$ ). The Tes threshold for increases in respiratory frequency (f) was also higher at PM than AM ( $37.4 \pm 0.6$  vs.  $36.7 \pm 0.7^{\circ}\text{C}$ ,  $P < 0.05$ ), and the slope of f-Tes relation tended to be greater at PM than AM. Tidal volume declined steadily without a threshold in response to increasing Tes at both AM and PM. Discussion Our observation of circadian rhythm-related changes in two thermoregulatory responses is consistent with previous findings. Like those thermoregulatory responses, the Tes threshold for hyperventilation shifted to a higher temperature from AM to PM. However, the slope of VE-Tes relation was greater at PM than AM, which is different from the thermoregulatory responses. Furthermore, the Tes threshold for increases in f was nearly identical to that for increases in VE, and the slopes of the f-Tes and VE-Tes relations were both greater at PM, suggesting changes in hyperthermic hyperventilation are mainly attributable to changes in f. In conclusion, those results suggest that humans exhibit circadian variation in hyperthermic hyperventilation during prolonged exercise in the heat. References Fujii N, Honda Y, Hayashi K, Soya H, Kondo N, Nishiyasu T. (2008). *J Appl Physiol*, 104, 998-1005. Tsuji B, Honda Y, Fujii N, Kondo N, Nishiyasu T. (2009). PPT conference, Japan.

### GENDER INFLUENCE ON SKIN TEMPERATURE AT REST AND DURING EXERCISE IN THE COLD : THE ROLE OF SUBCUTANEOUS FAT

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Introduction Subcutaneous fat affects skin temperature (Tsk) through the conductive heat transfer between the body core and the skin. Vasoconstriction induced by cold exposure maximises the insulatory benefits provided by subcutaneous fat (Rennie, 1988). Higher amounts of body fat are commonly found in females and this has been suggested to impact thermoregulatory responses at rest and during exercise (Wagner and Horvath, 1985). Gender differences in fat patterning may also explain patterns of Tsk distribution. The aim of the study was therefore to investigate the role of subcutaneous fat on overall and local Tsk responses. Methods Nine males and females of similar fitness ( $53.7$  vs  $50.3$  mL/min/kg, NS) participated in the experiment. Skinfold thickness at 24 body sites was measured to assess local fat distribution and predict overall body fat percentage (%BF). Participants were asked to rest for a 5 min period followed by 40 min of running at 70%  $\text{VO}_{2\text{max}}$  in a semi nude condition at  $10^{\circ}\text{C}$ . Whole-body skin temperature was recorded by infrared thermography before (PRE) and immediately after running (POST). Body maps of Tsk patterns for both genders were obtained using an image processing technique under MATLAB. A specific segmentation of local Tsk was also performed to match the location of local skinfold values. Results Females had a significantly higher %BF than males and exhibited a lower overall mean Tsk ( $-2^{\circ}\text{C}$  at PRE,  $p < 0.01$  and  $-1.5^{\circ}\text{C}$  at POST,  $p < 0.05$ ). Mean Tsk was correlated to %BF at PRE ( $r = -0.7$ ,  $p < 0.01$ ) but the absolute metabolic rate of exercise was the main predictor at POST ( $r = 0.7$ ,  $p < 0.01$ ). Although absolute Tsk decreased during exercise, patterns of Tsk distribution were relatively constant and similar for males and females. Many local Tsk differences were significant between genders, especially in the legs and arms. Within participants distribution of Tsk was not correlated to local skinfold thickness. Only for the anterior torso in males at POST such a relation was found. ( $r = -0.7$ ,  $p < 0.05$ ). Discussion Subcutaneous fat only partly influenced overall and local Tsk responses in the groups studied. Metabolic response associated to cold and exercise (Havenith, 2001) may largely produce the overall gender difference in mean Tsk. Locally, it can be hypothesized that the insulation provided by poorly perfused muscles at rest and during exercise (Rennie, 1988) also contribute to the Tsk distribution together with local skin blood flow and morphological factors. Similarities in body maps of Tsk patterns for both genders represent a novel finding. References Havenith G (2001) *J Thermal Biol* 26(4-5) 387-393 Rennie (1988) *Med Sci Sports Exerc* 20: S177-S184 Wagner JA, Horvath SM (1985) *J Appl Physiol* 58(1) 180-186

**EXERCISE IN COLD AIR INCREASED THE H<sub>2</sub>O<sub>2</sub> RELEASE IN EXHALED BREATH CONDENSATE**

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**Introduction:** Many publications indicated that winter athletes have hypersensitive bronchial systems and symptoms like bronchoconstriction and changes in the epithelial cells caused by the inhalation of cold and dry air. Therefore exhaled breath condensate (EBC) is interesting because it contains a number of mediators which arise from the bronchial system. The aim of this study was to determine the influence of constant exercise combined with cold air on the H<sub>2</sub>O<sub>2</sub> release as a marker of airway inflammation in exhaled breath. **Method:** Twelve healthy males (23.1±1.5 years) were randomly assigned at 2 different days (with 1 day rest) to perform one 50 min run (75–80% of their maximum heart rate) under normal (N) laboratory (18.1±1.1°C) and one under cold (C) field conditions (-15.2±3.1°C) Before and immediately after each run EBC was collected from 100L of exhaled air under laboratory conditions. Hydrogen peroxide concentration was analyzed using a EcoCheck amperometer (FILT, Berlin). In further analysis release per minute and theoretical release for the total amount of water from 100L exhaled breath were calculated. **Results:** Prior to the two runs H<sub>2</sub>O<sub>2</sub> concentrations were 145.0±31.1 (N); 160.0±49.1nmol/L (C) and theoretical release 70.3±37.1 (N); 82.6±27.1pmol/min (C) (p>0.05). After both conditions a significant increase of H<sub>2</sub>O<sub>2</sub> concentration from 243.0±43.8nmol/L (N) and 420.3±49.1nmol/L (C) (p<0.001) together with an increase in the theoretical release from 178.9±38.1pmol/min (N) and 318.3±35.2pmol/min (C) (p<0.001) was detected. **Conclusion:** The release of H<sub>2</sub>O<sub>2</sub> into the EBC has been shown under resting conditions and after exercise. Concentration and release sig. increased after exercise in cold air compared to resting and laboratory conditions and indicates an increase of inflammatory and oxidative stress. A association between H<sub>2</sub>O<sub>2</sub> and bronchial hypersensitivity should be investigated in further studies.

**HYPOXIA AUGMENTS THE OSCILLATORY BLOOD FLOW PATTERN IN THE NONWORKING LIMB DURING INCREMENTAL EXERCISE**

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**Introduction** Regular aerobic exercise augments conduit vessel function. Interestingly, exercise-induced increases in vascular function have been observed in nonactive limbs, e.g., the forearm in response to cycling. A recent study revealed that an increase in mean blood flow and a marked oscillatory blood flow pattern appeared in nonworking limb during normoxic exercise, and these are thought to augment vascular function (Green et al. 2005). Exercise in hypoxic condition is associated with large changes in central hemodynamics and peripheral vascular resistance in nonactive limbs, and thus it is hypothesized that blood flow pattern would change, i.e., greater antegrade and retrograde blood flows, during hypoxic exercise. The aim of present study was to elucidate the change in the oscillatory blood flow in nonworking limb during incremental exercise in hypoxia. **Methods** Eight males participated in this study. Two maximal incremental exercise tests were conducted on a semi-recumbent cycle ergometer while breathing normoxic (inspired oxygen fraction (FIO<sub>2</sub>) = 0.21) or hypoxic gas mixture (FIO<sub>2</sub> = 0.12). The exercise began at an initial power output of 30 W, and workload was increased by 30 W every 2 min until exhaustion. Brachial blood velocity and arterial diameter were recorded simultaneously using Doppler ultrasonography, and the blood flows were calculated. **Results** Exercise induced progressive increases in antegrade and retrograde blood flows during incremental exercise in normoxia and hypoxia. The magnitude of changes in antegrade and retrograde blood flows during exercise in hypoxia were significantly (P<0.05) greater than normoxia (normoxia vs. hypoxia, antegrade blood flow at 150 W: 171.1±12.5 vs. 193.5±15.4 ml/min and retrograde blood flow at 150 W: -90.2±7.7 vs. -130.9±10.7 ml/min, mean±SE). **Discussion** It has been supposed that an increase in antegrade flow may be an important modulator of the acute effect of exercise on endothelial function (Green et al. 2011). Therefore, it is assumed that hypoxic exercise may present a more potent stimulus to endothelium in conduit arteries in nonactive limbs. On the other hand, there is also some evidence that retrograde flow may decrease the beneficial effect (Thijssen et al. 2009), and thus further studies are needed to test the assumption. Our results suggest that hypoxia has a significant impact on the oscillatory antegrade and retrograde blood flow pattern in the nonworking limbs during incremental exercise. **References** Green DJ et al. (2005) J Physiol, 562:617–628. Green DJ et al. (2011) Exp Physiol, 96:57–70. Thijssen DHJ et al. (2009) Hypertension, 53:986–992.

**SUPRASPINAL FATIGUE AFTER HYPOXIC AND NORMOXIC EXERCISE IN HUMANS**

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Cerebral O<sub>2</sub> delivery has been proposed to limit exercise tolerance (Rasmussen et al. 2010), but the role of supraspinal processes to fatigue in hypoxia is unknown. We tested the hypothesis that the contribution of supraspinal fatigue to task failure would be exacerbated after locomotor exercise in acute severe hypoxia compared to normoxia and that any such change would be related to a reduction in cerebral O<sub>2</sub> delivery. Nine competitive male cyclists (mean ± S.D. maximum O<sub>2</sub> uptake 61.1 ± 4.6 ml•kg<sup>-1</sup>•min<sup>-1</sup>) completed three exercise trials on a cycle ergometer at 77% of peak workload: 1) to the limit of tolerance in acute hypoxia (HYPOX-TLM; inspired O<sub>2</sub> fraction = 0.13, arterial O<sub>2</sub> saturation = 78%); 2) for the same duration as HYPOX-TLM but in normoxia (NORM-ISO; 0.21, 98%); and 3) to the limit of tolerance in normoxia (NORM-TLM; 0.21, 96%). Before and immediately after each trial, twitch responses to supramaximal femoral nerve stimulation and transcranial magnetic stimulation were obtained to assess neuromuscular and cortical function, respectively. Throughout each trial, cerebral oxygenation (frontal cortex) and cerebral blood flow velocity in the middle cerebral artery (CBFV) were assessed using near-infrared spectroscopy and transcranial Doppler sonography, respectively. Cerebral O<sub>2</sub> delivery was calculated as the product of arterial O<sub>2</sub> content and CBFV. Exercise time declined by 54% in HYPOX-TLM compared to NORM-TLM (3.6 ± 1.3 vs. 8.1 ± 2.9 min; p < 0.001). Maximum voluntary force and potentiated quadriceps twitch force were decreased below baseline after exercise in each condition; the decreases were greater in HYPOX-TLM compared to NORM-ISO (p < 0.001), but were similar in HYPOX-TLM compared to NORM-TLM (p > 0.05). Cortical voluntary activation also decreased after exercise in each condition; however, the decline in HYPOX-TLM (-17%) was greater (p < 0.05) compared to both NORM-ISO and NORM-TLM (-5 and -8%, respectively). The reductions in cortical voluntary activation occurred in parallel with reductions in cerebral oxygenation and O<sub>2</sub> delivery. The results indicate that the decrease in exercise tolerance in acute hypoxia is due, in part, to supraspinal fatigue, possibly as a consequence of inadequate O<sub>2</sub> delivery to the brain. **References** Rasmussen, P., Nielsen, J., Overgaard, M., Krogh-Madsen, R., Gjedde, A., Secher, N.H. and Petersen, N.C. (2010). Reduced muscle activation during exercise related to brain oxygenation and metabolism in humans. Journal of Physiology 588, 1985–1995.

## INFLUENCE OF EXERCISE DURATION ON O<sub>2</sub> SATURATION AND ITS HETEROGENEITY AMONG THE LEG MUSCLES

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**Introduction** In general, blood flow increases in relation to local metabolic rate, and the O<sub>2</sub> balance is distributed heterogeneously between and within skeletal muscles during exercise (Kalliokoski et al., 2001). Exercise intensity is an important factor to determine heterogeneity of O<sub>2</sub> saturation in skeletal muscles (SmO<sub>2</sub>) during incremental cycling (Kime et al., 2001). However, it is unknown whether exercise duration, especially during steady state exercise, influences SmO<sub>2</sub> and its heterogeneity. **Methods** Ten healthy young males performed bicycle exercise at 30%, 50%, and 70%VO<sub>2peak</sub> for 30 min. Pulmonary O<sub>2</sub> uptake (pVO<sub>2</sub>) was monitored continuously during the experiments. The SmO<sub>2</sub> was monitored at the belly of vastus lateralis (VL), rectus femoris (RF), and vastus medialis (VM) muscle by near infrared spatial resolved spectroscopy (NIRSRS). To examine heterogeneity of the SmO<sub>2</sub> saturation in a single muscle, an additional NIRSRS probe was placed on a proximal point of 30% of the length between the patella and the greater trochanter, from the belly of VL muscle. Fat layer thickness on each measurement site was measured to evaluate the accurate SmO<sub>2</sub> values using an ultrasound device. As an index of SmO<sub>2</sub> heterogeneity within and between muscles, coefficients of variation (CV) of values of each muscle were calculated for 3-6 min and 27-30 min. **Results** As exercise continued, the mean SmO<sub>2</sub> of the three muscles significantly increased at 30%VO<sub>2peak</sub>, decreased at 70%VO<sub>2peak</sub> (P<0.05), and maintained at 50%VO<sub>2peak</sub> (P=0.5). Although significant differences were observed for the mean SmO<sub>2</sub> at the end of exercise, the CV of SmO<sub>2</sub> between muscles did not change over the trial at all intensities. Conversely, in a single muscle, significant main effect over time was observed by ANOVA analysis and the CV significantly increased at 70%VO<sub>2peak</sub>. Changes of CV within muscle were positively correlated with changes of pVO<sub>2</sub> at 30% (r=0.8), 50% (r=0.4), and 70%VO<sub>2peak</sub> (r=0.5). **Discussion** The SmO<sub>2</sub> heterogeneity between the leg muscles was relatively maintained during steady state exercise at mild- to severe-intensity although exercise duration impacted the mean SmO<sub>2</sub> itself according to exercise intensity. These results may be attributed predominantly to compensation by surrounding muscles. In addition, time effects were observed for regional difference of SmO<sub>2</sub> within VL muscle. These results suggest that the disparities in the O<sub>2</sub> balance are associated with increased muscle O<sub>2</sub> consumption and the marked disparities may be due to the recruitment of additional muscle fibers. **References** Kalliokoski et al. (2001). *Am J Physiol Endocrinol Metab*, 280(6), 1015-21. Kime et al. (2006). *Jpn. J. Phys. Fitness Sports Med*, 55(Supl.), S19-S21.

## THE EFFECT OF PRE-COOLING AND PASSIVE HEATING ON PACING STRATEGIES AND INTERMITTENT-SPRINT PERFORMANCE IN TEAM SPORT ATHLETES

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**Introduction** Team sport athletes often engage in pre-cooling prior to exercise in the heat to reduce thermoregulatory strain and improve performance. Conversely, warm-up practices are used amongst athletes to increase endogenous temperature and improve subsequent high-intensity exercise performance. This paradox in pre-exercise interventions raises questions concerning which thermal state is optimal for subsequent intermittent-sprint performance. Therefore, this study examined the effects of pre-exercise cooling and heating on pacing and intermittent-sprint performance in the heat. **Methods** Ten male, team-sport athletes completed three randomized conditions including, a thermo-neutral environment (CONT); whole body submersion in an ice-bath (ICE) and passive-heating in a hot environment (HEAT) prior to 50min intermittent-sprint exercise (ISE) in the heat (31 ± 1°C). Exercise involved repeated 15 m maximal sprints and self-paced exercise of varying intensities (hard running, jogging, walking, and bounding). Performance was measured by sprint times and total distances covered (TDC), and pacing strategies were assessed via distance covered during 10min phases of the ISE. 15 maximal contractions were performed to determine maximal voluntary torque (MVT), activation (VA), and twitch contractile properties (TCP). Physiological measures included heart rate (HR), core (Tcore) and skin (Tskin) temperatures, physiological strain index (PSI), capillary blood, and perceptual ratings. **Results** Mean sprint times, especially during the initial 10min, were slower during ICE compared to HEAT (P<0.05). TDC was not different between conditions but less distance was covered during HEAT in the final 10min compared to ICE and during 31-40min compared to CONT (P<0.05). Post-ex MVT was reduced within CONT and HEAT, and VA was higher post-intervention and post-ex during ICE. Peak torque and relaxation rates were improved post-intervention during HEAT compared to ICE. Finally, HR, Tcore, Tskin and PSI during exercise were lower in ICE compared to CONT and HEAT (P<0.05). **Conclusion** Initial sprint performance was faster following HEAT and slowed by ICE, possibly due to altered contractile properties at the start of exercise. Conversely, pre-cooling maintained endurance performance later in the protocol, while HEAT resulted in greater performance declines. ICE maintained MVT and VA post-exercise compared to HEAT, suggesting improved skeletal recruitment. Accordingly, passive heating augmented initial sprint times yet reduced pacing strategies later in the protocol, while pre-cooling reduced cardiovascular and thermoregulatory strain and allowed for selection of higher exercise intensities throughout the protocol.

## HEAT LOSS RESPONSES DURING PASSIVE HEATING WITH DIFFERENT TYPES OF PHYSICAL TRAINING

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1: Kobe University (Kobe, Japan), 2: Kobe Design University (Kobe, Japan), 3: Osaka International University (Osaka, Japan) **Introduction** Endurance training improves heat loss responses, as demonstrated by the lower core temperature threshold and the higher slope of heat loss responses (Nadel et al., 1974). In addition, it has been observed that the sweating rate during cycling in the heat is greater in the order of endurance runners, sprinters, and untrained individuals (Irion, 1987). However, it is unknown whether the core temperature threshold and slope of the heat loss responses differ between types of physical training. Thus, we conducted passive heating to investigate heat loss responses in distance runners, sprinters, and untrained men. **Methods** Nine distance runners, 11 sprinters and eight untrained men rested in the supine position with water perfusion suits in a climatic chamber that was regulated at an ambient temperature of 27°C and relative humidity of 50%. After thermoneutral conditions for 50 min, hot water was perfused into the suits for 50 min to increase oral temperature by 1°C. The sweating rate and skin blood flow on the chest, forearm, thigh and palm were measured continuously during the passive heating, and the mean values of sweating and skin blood flow from non-glabrous skin sites were calculated. **Results** The oral temperature threshold for onset of the mean sweating response in distance runners was significantly lower than that of sprinters and untrained men (P<0.05), and the slope for sweating was significantly higher in distance runners than in untrained men (P<0.05). The oral temperature threshold for onset of mean cutaneous vasodilation in distance runners was only significantly lower than that of sprinters and untrained men (P<0.05). **Discussion** The results in this study suggest that the training of distance runners lowers the

oral temperature threshold for the onset of sweating and cutaneous vasodilation, and increases the slope of sweating during passive heating. In contrast, training of sprinters does not affect the oral temperature threshold and the slope of the heat loss responses during passive heating. Increases in core temperature during exercise are important for improvement of the heat loss responses (Pandolf, 1979); therefore, we consider that the different levels of increase in core temperature during daily training sessions between distance runners and sprinters may affect the improvement of heat loss responses during passive heating. References Irion GL. (1987). *Aviat Space Environ Med*, 58, 948-53. Nadel ER, Pandolf KB, Roberts MF, Stolwijk JAJ. (1974). *J Appl Physiol*, 37, 515-520. Pandolf KB. (1979). *Med Sci Sports*, 11(1), 60-65.

## THE EFFECT OF POST-EXERCISE COLD WATER IMMERSION ON CONSECUTIVE DAYS CYCLING PERFORMANCE AND HEART RATE VARIABILITY

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1: The University of Queensland, School of Human Movement Studies (Brisbane, Australia), 2: Centre of Excellence for Applied Sport Science Research, Queensland Academy of Sport (Brisbane, Australia), 3: ASPIRE, Academy of Sports Excellence (Doha, Qatar) Introduction We investigated the effect of daily post-exercise cold water immersion (CWI) during three consecutive days of intensive training on cycling performance and heart rate variability (HRV). Methods Five trained cyclists randomly completed 3 d of intensive training including either a 5-min post-training CWI recovery or not (PAS), and performed recovery based training for the following 2 d. On each day of intensive training, cyclists completed a training session lasting 114 min that included 66 maximal effort sprints and a total of 9 min of sustained effort (time trial; TT). Performance (mean power for sprints; total work for TT), heart rate (HR), and rating of perceived exertion (RPE) were assessed during each session. HRV (natural logarithm of the square-root of mean squared differences of successive R-R intervals; Ln rMSSD) was monitored (1) on waking each day of intensive training and for the following 3 d, and (2) 5 min post-recovery intervention during the intensive training period. Perceptions of recovery were assessed in the morning before training, and prior to sleep on each day of intensive training. Effects were examined using magnitude-based inferences. Results CWI resulted in very likely higher post-recovery intervention Ln rMSSD on day 1 (difference [90% confidence limits]; 29.2% [8.4;54.1]) and 2 (27.3% [11.8;45.1]), and almost certainly higher Ln rMSSD on day 3 (23.7% [18.5;29.1]). CWI was associated with almost certainly lower tiredness prior sleeping on day 2 (-26.0% [-32.3;-19.1]) and likely lower on day 3 (-20.5% [-34.9;-2.8]). Compared with PAS, CWI had unclear effects on changes from day 1 on sprint and TT performance, mean session HR, mean session RPE, and waking Ln rMSSD. A moderate negative relationship was observed between changes compared with day 1 in waking Ln rMSSD and changes in TT performance ( $r = -0.47$  [-0.72;-0.12]). Unclear relationships were observed between the changes compared with day 1 in waking Ln rMSSD and changes in sprint performance, post-recovery intervention Ln rMSSD and perceived tiredness, next day waking Ln rMSSD and perceived tiredness. Conclusion CWI enhanced cardiac vagal reactivation and reduced perceived tiredness post-exercise, however, the effect of CWI on performance and waking cardiac vagal activity during and following a period of intensive training remains unclear. The implication of waking cardiac vagal activity on exercise performance warrants further investigation.

## CARDIORESPIRATORY AND THERMAL RESPONSES TO COMBINED HYPOXIC AND THERMAL CHALLENGE

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Cardiorespiratory and thermal responses to exercise in the heat are elevated compared to exercise in the cold (Galloway & Maughan, 1997), and exercise in hypoxic conditions also causes an exaggerated cardiorespiratory response compared with sea level (Reeves et al. 1992). As athletes, are often exposed to the combined challenge of exercise in hypoxic and hot conditions, the aim of this study was therefore to investigate the combined effect of these challenges on the cardiorespiratory and thermal response to exercise. Nine healthy well trained males participated in the ethically approved study. Following assessment of VO<sub>2</sub> peak on a recumbent cycle ergometer, subjects attended the laboratory on 3 separate occasions and exercised for 15 mins at 70% VO<sub>2</sub> peak in 3 climatic conditions; SL at 32°C, 2300m at 18°C and 2300m at 32°C. Respiratory data (VE, Bf, Tv) were calculated from expired gas collection. HR and SaO<sub>2</sub> were measured using Dynamap. Rectal temperature (RT) was measured using a grant thermometer and skin temperature measured at 4 sites using squirrel thermistors and data logger. Sweat production rate was measured by changes in nude body mass and urinary osmolality assessed by osmometry. Statistical differences were assessed by two way ANOVA with repeated measures. There was no significant difference ( $p > 0.05$ ) in RT between the conditions, although there was a significant effect of time ( $p < 0.05$ ). There was no significant ( $p > 0.05$ ) effect of time of skin temperature, but there was a significant condition effect ( $p < 0.05$ ) and interaction ( $p < 0.05$ ). Mean ( $\pm$ SD) skin temperature values before exercise for SL at 32°C, 2300m at 18°C and 2300m at 32°C, were  $32.88 \pm 0.88$ ,  $32.87 \pm 0.70$  and  $30.06 \pm 1.26$  respectively alternating to levels of  $34.22 \pm 0.80$ ,  $33.91 \pm 0.98$  and  $28.04 \pm 1.31$  after the 15 minute exercise protocol. There was no significant difference in sweat production rate between the three conditions as ( $p > 0.05$ ). There was significant main effect of VE between conditions ( $p < 0.05$ ) and across time ( $p < 0.05$ ). SaO<sub>2</sub> showed significant main effects across time ( $p < 0.05$ ) and between conditions ( $p < 0.05$ ) with mean ( $\pm$  SD) values of  $97.33 \pm 0.57$  (SL at 32°C),  $93.25 \pm 2.83$  (2300m at 18°C) and  $93.17 \pm 3.01$  (2300m at 32°C). There was also a significant interaction ( $p > 0.05$ ). HR showed a significant effect over time ( $p < 0.05$ ). This data suggests that the combined influence of exercise at altitude and in the heat causes an altered respiratory response but no difference in thermal strain, compared with either heat or altitude alone. It would be intriguing to examine these responses in exercise bouts of extended duration. Galloway S. & Maughan, R. (1997). Effects of ambient temperature on the ability to perform prolonged cycle exercise in man. *Med Sci Sports Exerc*. 29: 1240-1249. Reeves, J. et al. (1992) Oxygen transport during exercise at altitude and the lactate paradox: Lessons from operation Everest II and Pikes Peak. *Am Coll Sports Med*. 20: 275-296.

## RELATIONSHIP BETWEEN SLEEP HABITS AND MENTAL HEALTH IN SPORT CLUB MEMBERS OF ELDERLY

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Introduction: The QOL for elderly people has two aspects; physical health and mental health. Exercise and sleep habits maintain and promote physical and mental function (Weinstein et al., 2007, King AC et al., 2008). The person who feels no sound sleep when getting up in the morning was 24.2% in Japan (Japanese Health and Welfare Trend Survey, 2003). Comfortable sleep is one of the important

problems in the health care. The purpose of this study was to clarify the sleep and mental problem for health care of comprehensive community sports club members in Japan northern area. Subject & Method: Subjects in this study were 81 middle and elderly people with a mean age of  $61.0 \pm 7.3$  (SD). They were members of comprehensive community sport club, which is called SPOR club, participated in a fitness class. Life-style, including sleep habits, and psychological measurements were taken. The life-style measurements were smoking, exercise and sleep habits. Sleep habits were measured by time of getting to bed, sleep-onset latency, time of getting up, sleep duration, nap habits, subjective symptom of lack of sleep and Japanese version of Pittsburgh Sleep Quality Index (PSQI-J). The psychological measurement used a 30-item General Health Questionnaire (GHQ30). Statistical analysis used SPSS. Result: Subjects who have no habit of smoking were 97.5%. Duration of exercise habit was  $64.6 \pm 73.1$  (SD) months. In sleep duration, classification of over 6 hours and under 7 hours was significantly longer than other classification. Total point of PSQI-J was  $8.9 \pm 4.1$  (SD) and total point of GHQ30 was  $GHQ30\ 3.5 \pm 3.9$  (SD). There was a significantly positive correlation between PSQI-J and GHQ30. In each factor on the GHQ30, the ratio of the persons with a high score (3-5 point) of sleep disturbance was about 25 percent. It was higher than in the other factors of GHQ30. Discussion: From these results, it was suggested that there were the relationships with exercise habit, sleep habits and a level of mental health. According to results of PSQI-J and GHQ30, there were a relationships between sleep quality, sleep-onset latency, sleep disturbances, use of sleep medication, daytime dysfunction and mental health. From the ratio of the persons with the highest scores in the factor of the GHQ30, it was suggested that one in four persons experienced a sleeping disorder. It was supposed that sleep habit changed better with duration of exercise habit. Continuous measurement is necessary to assess the change of these indexes. Acknowledgments: This study was financially supported by a grant from Hokusho University Northern Regions Lifelong Sports Research Center (SPOR). References: King AC et al., (2008) J. Gerontology, 63, 9, 997-1004 Weinstein et al., (2007) Med. Sci. Sports Exerc, 39, 4, 735-741

### PREVENTION MEASURES FOR HYPOTHERMIA USING A RESCUE SHEET DURING A SHORT TIME STAY IN A SNOW HOLE

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1:KUMW(Okayama, Japan), 2:KUPH(Kagawa, Japan), 3:GSKUMW(Okayama, Japan), 4:HIT(Hiroshima, Japan), 5:UMDS(Kobe, Hyogo) Introduction Humans have typical responses for exposure to coldness. Hypothermia is a serious medical condition caused by extreme cold. Prompt action is needed in the case of exposure to coldness. Therefore, the aim of this study was to examine the usefulness of prevention measures for hypothermia using a rescue sheet during a short time stay in a snow hole. Methods Six healthy young men participated in this study. Each of them gave informed consent. Each one put on a rescue sheet as if in an emergency, and stayed for one hour in the snow hole; one subject per hole. Heart rate (LRR-3: Nihonkohden), rectal temperature (YSI Precision 4000 A Thermometer), the scale of subjective thermal sensation and the activity of the parasympathetic nervous system (MemCalc/Tarawa) were measured during each stay in the snow hole. Two snow holes were prepared: A: 105cm height, 110cm width and 110cm interior, B: 116cm height, 109cm width and 116cm interior. Temperature in the snow holes were  $A: 3.7 \pm 0.7$  and  $B: 3.3 \pm 0.8$  degrees centigrade. Results The starting and closing heart rates for the experiment were  $70 \pm 7.4$  bpm and  $75 \pm 9.0$  bpm respectively. The differences in starting and closing rectal temperatures were  $-0.03$  degrees centigrade. Starting and closing LogHF were  $2.7 \pm 0.8$  and  $2.6 \pm 0.9$ . The starting and closing scores of subjective thermal sensations were  $1.3 \pm 0.8$  and  $3.3 \pm 0.9$  respectively. There were statistically no changes in each measurement of heart rate, score of subjective thermal sensation, activity of the parasympathetic nervous system and rectal temperature (ANOVA). Discussion Heart rate when exposed to cold temperatures, significantly decreases with time passage. According to a previous study, the decreasing tendency of the heart rate is controlled by measures against cold. The result of this study suggests that the rescue sheet controlled this decreasing tendency of the heart rate. Spectral analysis of cardiovascular signals, such as the heart rate R-R interval, systolic and diastolic blood pressure, provides useful indices of short and long-term changes in neural autonomic control. The RR HF component reflects mostly vagal modulation (Pagani et al., 1986). According to the previous study, a score of subjective thermal sensation was significantly increased, and the activity of the parasympathetic nervous system was significantly decreased during a stay in a snow hole (Onodera et al. 2009). The increased tendency to the score of the subjective thermal sensation is controlled by the activity of the parasympathetic nervous system. Consequently, it was not conceivable that there appeared to be typical responses. These data suggest that using the rescue sheet (or tarpaulin) for an emergency is effective to inhibit a decrease of the physiological indexes during a short stay in a snow hole. References Pagani M et al (1986). Eur J Appl Physiol 87:174-181 Onodera S et al (2009). J Jof Mountain Medicine 29:173-176

## Poster presentations

### PP-PM13 Soccer 2

#### ANTHROPOMETRIC AND PHYSIOLOGICAL CHARACTERISTICS OF CLUB AND VARSITY LEVEL HURLING PLAYERS.

KIERAN, C., QUINN, C., DORAN, D.A.

ITT DUBLIN

ANTHROPOMETRIC AND PHYSIOLOGICAL CHARACTERISTICS OF CLUB AND VARSITY LEVEL HURLING PLAYERS. Collins, K. 1, Quinn. C. 2, Doran, D.A. 2. 1: ITTD (Dublin, Ireland), 2: LJMU (Liverpool, England) Introduction An understanding of position-specific demands within hurling may be useful in training protocol development and performance monitoring. The aim of this study was to examine the anthropometric and physiological characteristics of club and varsity level hurling players in relation to playing position. Methods Twenty-nine male competitive hurlers (age  $21 \pm 2.07$  yrs; height  $179.3 \pm 0.6$  cm and body mass  $80.5 \pm 9.4$  kg) underwent anthropometric and physiological assessment at the midpoint of the competitive season. The anthropometric variables of height and body mass were determined. Percentage body fat (BF%) and lean muscle mass (LM) were assessed by Dual X-ray absorptiometry (DXA) (Hologic QDR, USA). Physiological characteristics of countermovement jump (CMJ), linear sprint speed over 10, and 20 m; repeated 35 m sprint performance and fatigue index (RAST), agility (AGT) and estimated  $VO_{2max}$  were determined. Players were classified as defenders (DF), midfielders (MF), or forwards (FW) for the purpose of positional data analysis. Results Significant positional differences were evident in height and body mass ( $P < 0.01$ ) but not in BF% or LM ( $P > 0.05$ ). Generally, MF were taller, heavier, leaner and more muscular ( $186.4 \pm 8.4$  cm;  $86.9 \pm 4.6$  kg;  $14.6 \pm 1.0$  %;  $68.6 \pm 2.2$  kg) than DF ( $186.4 \pm 8.4$  cm;  $86.8 \pm 1.3$  kg;  $20.3 \pm 5.7$  %;  $60.3 \pm 6.0$  kg) or FW ( $177.2 \pm 8.4$  cm;  $76.2 \pm 4.0$  kg;  $18.6 \pm 3.8$  %;  $58.2 \pm 6.8$  kg). No positional differences were detected for CMJ height ( $P > 0.05$ ), with FW ( $50.0 \pm 7.5$  cm) and MF ( $49.1 \pm 7.1$  cm)



performance exceeding that of the DF ( $44.8 \pm 2.3$  cm). No positional differences in 10 and 20 m linear sprints were detected ( $P > 0.05$ ). Forwards were faster ( $1.9 \pm 0.1$ s;  $3.1 \pm 0.2$ s) than DF ( $2.0 \pm 0.4$ s;  $3.4 \pm 0.5$ s) with MF slowest ( $2.1 \pm 0.3$ s;  $3.5 \pm 0.1$ s). Fatigue index during RAST performance was higher in FW ( $26.6 \pm 10.8\%$ ) relative to DF ( $18.0 \pm 9.3\%$ ) and MF ( $22.0 \pm 5.4\%$ ) ( $P > 0.05$ ). Agility was higher in MF relative to DF ( $6.9 \pm 0.2$ s vs.  $7.7 \pm 1.3$ s;  $P = 0.04$ ) but not FW ( $7.1 \pm 0.4$ s;  $P > 0.05$ ). Estimated  $\text{VO}_{2\text{max}}$  differed between positions ( $P = 0.047$ ). Midfielders exhibited significantly higher  $\text{VO}_{2\text{max}}$  ( $50.2 \pm 2.4$  mL·kg<sup>-1</sup>·min<sup>-1</sup>) than DF ( $44.4 \pm 8.5$  mL·kg<sup>-1</sup>·min<sup>-1</sup>) and FW ( $44.6 \pm 6.9$  mL·kg<sup>-1</sup>·min<sup>-1</sup>). No differences were noted between DF and FW ( $P > 0.05$ ). Discussion Positional differences in the anthropometric and physiological characteristics of club and varsity hurling players show little significant variance across playing positions. Despite the statistical homogeneity a physiological and anthropometric hierarchy is apparent. The general performance level across most parameter falls short of that apparent at higher levels of the game. Future research should consider if this positional homogeneity is characteristic of performer at a more elite level. References

## **EFFECT OF BODY HEIGHT DIFFERENCE ON THE BALL KICKING PERFORMANCES DURING ADOLESCENCE MALE SOCCER PLAYERS.**

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**Introduction** The purpose of this study was to investigate the effect of body height difference on the ball kicking performances during adolescence male soccer players. **Methods** The study participants included 149 Japanese male soccer players aged from 12 to 15 years. The participants were classified into 2 factors on the basis of their chronological age (age difference) and average body height (body height difference: higher and lower to the average body height group). Body compositional parameters for body height (BH), body weight (BW) and fat free mass (FFM) of the whole body were measured using the body impedance analysis method. Muscle thickness of thigh anterior (MTA: including rectus femoris and vastus intermedius) was measured by Ultrasonography method (SSD-900, Aloka). Cross-sectional planes were imaged at 50% of femur length from trochanter major to lateral condyle of femur, starting at the trochanter major. The ball distance (BD) was measured by the tape measure. The ball velocity (BV) was measured using a Rader gun. By using a custom-made speed meter, we measured the maximal swing velocity of the lower limb (SV) while the players were kicking the ball. **Results** With respect to BH, FFM, BD, BV and SV, there were significantly differences from 12 to 15 years old. However, MTA was significantly increased from 14 to 15 years old. BH and FFM were significantly body height differences from 12 to 15 years old. But also, MTA was showed significantly body height difference in 13 years old. There were showed significantly body height differences from 12 to 13 years old in BD. With respect to BV, there was significantly body height difference from 13 to 15 years old. However, SV was showed significantly body height difference in only 13 years old. Moreover, in the relationship between FFM and BD, BV and SV, higher body height group plotted higher performances than lower body height group. **Discussion** Body height difference during adolescent was affected on development of ball kicking performances. Moreover, higher body height group showed heavier FFM than lower body height group. Therefore, it was considered that body height difference was affected to FFM (muscle volume) during adolescence. From these results, it was suggested that body height growth may be affected on ball kicking performances during adolescence. **Reference** Malina RM, Peña Reyes ME, Eisenmann JC, Horta L, Rodrigues J, Miller R. (2000) J Sports Sci 18 (9) 685-93. Malina RM, Eisenmann JC, Cumming SP, Ribeiro B, Aroso J. (2004) Eur J Appl Physiol 91 (5) 555-562.

## **REPRESENTATION OF FOOTBALL PLAYERS' TRAJECTORIES USING SURFACE MAPS.**

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CAMPINAS STATE UNIVERSITY

**Representation of football players' trajectories using surface maps.** Felipe Arruda Moura, Juliana Exel Santana, Ricardo Machado Leite de Barros and Sergio Augusto Cunha. Laboratory of Instrumentation for Biomechanics, University of Campinas, Campinas, Brazil. **Introduction** The development of automatic tracking systems has allowed analysing football players' physical, technical and tactical performances. However, there is a lack of studies related to analysis of players' trajectories as tactical information. Therefore, the aim of this study was to propose a representation of football players' trajectories using surface maps. **Methods** The 2D players' positions as function of time during a Brazilian First Division Championship match were obtained using DVideo software, by its specific interface developed to track football players (Figueroa et al., 2006a; Figueroa et al., 2006b). For the representation of each player trajectory, we created a 3D shaded surface (the surface maps). Thus, we divided the football field in small squares and then we quantified the total number of frames that the player stayed inside each square. This information was stored in a matrix F that was used as the high of the 3D surface, associated to the x and y coordinates of each square centre. Squares with greater high values were coloured red and the minor values were coloured blue. Finally, the colour shading of surface was interpolated across the square faces. **Results** The surface maps to each player trajectory were created, for the first and second halves. With these data, it is possible to analyse team organization on the field and how it changes from the first to second half. **Discussion** A previous study proposed a representation of players' positions where they touched the ball using Principal Components Analysis (Barros et al., 2006). According to the authors, this kind of representation, for all players in a same figure, can be associated to tactical organization of the team. On the other hand, the analysis proposed in the present study has the advantage of representing, during the entire match, the field positions where player frequented most, although it is not possible to visualise all team in a same figure. **Results** allowed concluding that surface maps are efficient in to provide additional tactical insights for coaches. **References** Barros, R. M. L., Cunha, S. A., Magalhães Jr., W. J. & Guimarães, M. F. (2006). Representation and analysis of soccer players' actions using principal components. Journal of Human Movement Studies, 51, 103-116. Figueroa, P. J., Leite, N. J. & Barros, R. M. L. (2006a). Background recovering in outdoor image sequences: An example of soccer players segmentation. Image and Vision Computing, 24(4), 363-374. Figueroa, P. J., Leite, N. J. & Barros, R. M. L. (2006b). Tracking soccer players aiming their kinematical motion analysis. Computer Vision and Image Understanding, 101(2), 122-135.

## **CHANGES IN HOMOCYSTEINE AFTER AN OFFICIAL SOCCER MATCH IN PROFESSIONAL MALE SOCCER PLAYERS**

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1: Department of Physical Education and Sports Science, National and Kapodistrian University of Athens, (Athens Greece). 2: Department of Medicine, National and Kapodistrian University of Athens, (Athens Greece 3: Department of Sports Organization and Management, University of Peloponnese, (Sparta - Laconias, Greece) **Introduction** Soccer is the most popular sport in the world and played by men,

women and children. It is one of the major types of exercise modifying significantly homeostasis of human body. However, it is still unclear whether a soccer game can modify the basal levels of inflammatory markers. The aim of this study was to examine changes caused by an official soccer match on inflammation markers, such as homocysteine (Hcy) in the plasma of professional male soccer players. **Methods** The study consisted of 22 professional male soccer players defining the experimental group ( $23.14 \pm 2.97$  yrs;  $180.91 \pm 6.12$  cm;  $75.96 \pm 5.77$  Kg;  $10.60 \pm 0.62\%$ ;  $12.59 \pm 2.89$  yrs; for age, height, body mass, % body fat, and training experience, respectively; mean  $\pm$  SD) and a control group of 20 participants with similar characteristics (age, weight, height, body mass fat). In both groups, blood was taken before the match, immediately after the match, as well as 24 and 48h after the match. **Results** Groups by Measures (2 x 4) ANOVA with repeated measures on the last factor for homocysteine ( $\mu\text{mol/l}$ ) showed statistical significant differences for Groups ( $F_{1,40} = 4.26$ ,  $p < 0.05$ ), Measures ( $F_{3,120} = 264.21$ ,  $p < 0.0001$ ), and Groups by Measures interaction ( $F_{3,120} = 264.21$ ,  $p < 0.0001$ ). Bonferroni post hoc analyses of the significant interaction indicated that soccer players had significantly lower concentration of homocysteine (a) before the game ( $M = 6.80 \pm 1.46$ ) compared to concentrations immediately ( $M = 8.06 \pm 1.67$ ), 24 hours ( $M = 12.86 \pm 2.75$ ) and 48 hours after the game ( $M = 7.76 \pm 1.74$ ), (b) immediately after the game compared to concentrations 24 hours after the game, and (c) significantly higher concentration of homocysteine immediately and 24 hours after the game compared to concentrations 48 hours after the game. The rest of paired comparisons did not reach statistical significance. Also, no statistically significance was observed among the 4 measurements of the control group. **Conclusions** Our results show that an official soccer match is a quite demanding type of exercise related with significant changes in plasma levels of inflammatory markers, such as homocysteine. These findings suggest that soccer players should enter a recovery period after a single soccer game in order to regain their homeostasis before exposing themselves to a new acute bout of exercise.

### INFLUENCE OF A SOCCER MATCH ON THE CARDIAC AUTONOMIC CONTROL OF REFEREES

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UNIVERSIDADE CATÓLICA DE BRASÍLIA

The aim of this study was to: assess the impact of soccer refereeing on the cardiac autonomic control as determined by heart rate variability (HRV); and examine the potential relationships between HRV and cardiovascular stress (time spent at an exercise intensity relevant to maximum heart rate, HRmax) during matches. Sixteen referees of both sexes volunteered for this study and completed 24-hr beat-by-beat heart rate recordings during a match and a rest day. Compared to the rest day, referees exhibited significantly lower 24-hr HRV and parasympathetic modulations during the match day. Similarly, night-time (00:00-05:00) HRV was significantly lower on match day compared to the rest day indicating an impaired HRV after the match. Greater resting HRV was significantly associated with greater match time spent at an intensity  $>85\%$  HRmax during the match ( $p=0.524-0.728$ ,  $p<0.05$ ). The current results confirm that soccer referees exhibit significant physiological stress during matches that continues for at least 10 hours post-match (i.e. lower post-match HRV). Resting HRV may provide a simple and prognostic tool for the monitoring of soccer referees' cardiovascular function prior to, during, and following matches irrespective of fitness characteristics.

### RELIABILITY OF ANAEROBIC PERFORMANCE TESTS IN SOCCER

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**RELIABILITY OF ANAEROBIC PERFORMANCE TESTS IN FOOTBALL** Sekulic, Z.I., Lepir, D.I., Markovic, S.I. 1: Faculty of physical education and sport (Banja Luka, Bosnia and Herzegovina) **Introduction** The aim of this study was to examine the reliability of measurement tests of anaerobic performance in sprint and jump ability in football. The main aim is to establish the reliability of tests of muscular power through the four tests commonly used in testing players. **Methods** Twenty-six senior players from the Premier League Bosnia & Herzegovina participated in this study. They performed three consecutive trials for the four tests of muscular power (5 and 10 meters sprint, squat jump and countermovement jump). Testing was conducted using the Globus Ergo Tester. Reliability of measurement is expressed by coefficient of variation (CV). **Results** Coefficient of variation was 3.42 % for 5 meter sprint test and 2.77 % for 10 meter sprint test. For the squat jump test CV was 10.58 %, and countermovement jump test CV was 10.40 %. **Discussion** Sprint tests have better reliability than the vertical jump tests. Players must be more familiar with the protocol for the reduction of variation found in repeated trials when conducting SJ and CMJ. **References** Carling, C.; Reilly, T.; Williams, A. M. (2009). Performance Assessment for Field Sports, 133 -170. Taylor & Francis Routledge Stølen, T., Chamari, K., Castagna, C., Wisløff, U. (2005). Sports Med 2005; 35 (6): 501-536.

### REPEATED SPRINT ABILITY AND SKILLS IN ADOLESCENT SOCCER PLAYERS

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**INTRODUCTION** The development of sprinting and dribbling were investigated among youth soccer players aged 12–19 (Huijgen et al., 2010). Dribbling appeared to improve further after late adolescence, while sprinting after that age hardly improved. The present study identified the predictors of repeated sprint ability and skills in adolescent soccer players. **METHODS** The sample included 159 Portuguese players aged 11–12 ( $n=75$ ) and 13–14 ( $n=68$ ) years. Measurements included chronological age (CA), skeletal age (SA: Roche et al., 1988), pubic hair (PH: Tanner, 1962), anthropometry (height, sitting height, weight and sum of four skinfolds), repeated sprint ability (RSA: 7x35-m sprints with a 25-s recovery interval), composed soccer skill score derived from four tests (Figueiredo et al., 2009), and experience. Multiple linear regression analysis was used to examine the independent effects of age, maturity, body size and proportions, adiposity and experience on RSA, skills and the composite skill scores. **RESULTS** Explained variances differed among the functional capacity (best sprint: 27–48%) and skills ( $<25\%$ ). Training experience and body size were the predictors of best sprint in both groups. Age and adiposity were primary predictors in players aged 11–12 years, while experience and a proportionally longer trunk appeared among predictors in players aged 13–14 years. Stage of PH did not contribute to explained variances in any indicators of functional capacity and soccer skill in both age groups. **DISCUSSION** Adolescent players somewhat delayed in SA for CA (lower SACA ratio) tended to have a higher soccer skill composite score. Experience in soccer and CA had a positive influence while adiposity in younger players and body weight in older players had a negative influence on dribbling. Future studies should include skeletal age as the best indicator of biological maturation. Additional research is needed to examine longitudinal changes of functional and skill scores (using multilevel) separately for early puber-

tal players contrasting in biological maturation at the baseline. ACKNOWLEDGMENTS Partially supported by FCT (SFRH/BD/64648/2009; PTDC/DES/2011) REFERENCES Figueiredo AJ, et al. (2009). *Ann Hum Biol*, 36 (1), 60-73. Huijgen BCH, et al. (2010). *J Sports Sci*, 28 (7), 689-698. Roche AF, et al. (1988). *Assessing the skeletal maturity of the hand-wrist*. Illinois. Springfield. Tanner JM (1962). *Growth at adolescence*. Oxford. Blackwell Scientific.

## STRENGTH, SPEED AND JUMPING ABILITIES OF TALENTED MALE AND FEMALE HANDBALL PLAYERS

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**Introduction** In team handball a variety of skills and fitness components is required to perform at a top level, and the sport is hallmarked by intermittent high speed and explosive activities, interspersed by low intensity activities (Ziv and Lidor 2009). Therefore, this study first aimed to examine strength, speed and jumping abilities in talented youth handball players, and secondly to compare Under-18 and Under-16 players in the selected parameters. **Methods** Male (n=29) and female (n=29) youth handball players chosen by the Norwegian Handball Federation (NHF) were tested in strength (squat and bench press), speed (10m, 30m and repeated sprint ability of 6\*30m) and jumping abilities (CMJ and SJ), and also had their anthropometrics measured. To reveal possible differences in mean between the U-18 and U-16 within both male and female handball players we applied independent t-tests. Differences were considered significant at  $p < 0.05$  and results are presently expressed as means  $\pm$  standard deviations (SD). **Results** No significant differences in anthropometry were observed between U18 and U16 in male or female players. Further, within male players we did not observe any between group differences ( $p \leq 0.05$ ) in any of the tested performance parameters. However, the U16 male (n=14) players on average perform slightly better in all tests, than the U18 (n=15) male players. Moreover, we did not find any significant ( $p \leq 0.05$ ) differences in test performances between U18 female players and U16 female players either. A few trends ( $p \leq 0.1$ ) were however observed. First, in both 10m sprint ( $2.04 \pm 0.10$  vs.  $2.11 \pm 0.10$  s) and 30m sprint ( $4.87 \pm 0.22$  vs.  $5.03 \pm 0.22$  time, a trend ( $p \leq 0.1$ ) towards female U18 (n=14) players running on average faster than female U16 (n=15) players were found. Secondly, findings indicated a trend ( $p \leq 0.1$ ) towards female U18 players jumping higher ( $25.80 \pm 4.27$  vs.  $23.25 \pm 3.42$  cm) in SJ than female U16 players. **Discussion** We examined anthropometry and strength, speed and jumping abilities in talented U18 and U16 male and female handball players. The hypothesis of taller and heavier U18 players, due to pubertal development and muscle growth, were not verified, as no anthropometric differences were revealed between age classes in any of the sexes. Further, due to the assumption that U18 players train more hours and harder, we expected U18 players to perform better in all tests than U16 players, but this were not observed either. However, within female players a trend towards U18 performing better than U16 was seen within 0-10m sprint, 0-30 sprint and SJ. As we don't know the contents of the current training plan for any of the players, findings cannot be further explained. **References** Ziv, G. and R. Lidor (2009). *Eur Journ Sport Sci*, 9(6): 375-386.

## SQUAT AND BALANCE ABILITY IN YOUNG FOOTBALL PLAYER

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**Introduction** Squat is one of the most important training exercises used to improve strength efficiency. This basic exercise needs muscular coordination, joints flexibility, stability and postural control (Krintz M et al., 2009). Therefore, balance ability could affect the correct exercise execution. Aim of this research is to check a factual correlation between a correct squat execution and balance ability in young amateur football players. **Methods** 42 male young amateur football players ( $16.3 \pm 1.3$ ) have been evaluated. Dynamic functional postural analysis of squat exercise, tested with simplified squat test (Alberti G., Milan, 1980), and balance ability (LPF), evaluated with Libra (Easytech, Prato, Italy), have been assessed. Subjects were split in groups based on both types of exercise performed: full (FS), deep (DS) and half squat (90°); and on factors limiting the performance: ankle (A) range of motion and lumbar (L) flexibility. LPF results of different groups were correlated together and analysed with ANOVA for repeated measures on SPSS v.15 software.  $P < 0.05$  was chosen as the significant rate. **Results and Discussion** Average values show no statistical diversity in balance ability between FS, DS and 90°, while best results present a significantly greater balance performance in DS than 90° ( $p < 0.01$ ). Finally, FS-L group best results show balance performances significantly higher than FS-A ( $p < 0.005$ ). **Conclusions** The study indicates that the best DS and FS exercise execution seems related to the balance ability improvements. FS executions also pointed out balance performances rising in subjects with greater ankle ROM and lumbar flexibility. **References** Kritz M., Cronin J., Hume P. The bodyweight squat: a movement screen for the squat pattern. Institute of Sport & Recreation Research New Zealand, AUT University, Auckland, New Zealand and School of Biomedical and Health Science, Edith Cowan University, Perth, Western Australia, 2009, p. 76-85. Gulatieri D, Annoni M, Alberti G. Comparison between strength training with overloads and balance training. In: Roi GS, Tencone F: *The Rehabilitation of Winter and Mountain Sport Injuries*. Calzetti Mariucci Editore, Torgiano, 2006, pp 204-207

## PEAK POWER IN FULL SQUAT RELATED TO DECREASED KICK SPEED AFTER FATIGUE INDUCED BY REPEATED SPRINTS IN SOCCER PLAYERS

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FEDERACIÓN DE FÚTBOL DE LA REGIÓN DE MURCIA

**PEAK POWER IN FULL SQUAT RELATED TO DECREASED KICK SPEED AFTER FATIGUE INDUCED BY REPEATED SPRINTS IN SOCCER PLAYERS** López-Segovia, M.1, Palao, J.M.2, González-Badillo, J.J.3 1: Research Center of Murcia Soccer Federation (Murcia, Spain), 2: University of Murcia (Murcia, Spain), 3: University of Pablo de Olavide (Seville, Spain). **Introduction** Kick execution in soccer is influenced by the fatigue produced by the repeated sprints (RS) that are characteristic of the game. Various studies have demonstrated the effect of fatigue on kick speed (KS) (Amiri-Khorasani et al, 2010; Kellis et al, 2006). However, in the bibliography review done, no studies have been found that analyze the loss in kick speed due to RS in relation to the player's lower-body power. The objective of the present study was to assess the relationship between RS ability and KS in function of the lower-body power of the soccer player. **Methods** Eighteen field players from a soccer team from the Spanish Third Division were analyzed. The RS protocol consisted of executing 40m series (with photoelectric cells placed at 0m and 40m to register time) with 2' of recovery between series, until 3% of the speed from the best series of each player is lost. Before and after those sprints (pre-post RS), each player took two instep kicks with each leg after running approximately 3m, with a minute of recovery between each kick. The speed of the best kick with each leg was recorded (Stalker Sport radar) for posterior analysis. A week later, each player completed a progressive full squat test with loads (FSL) (López-Segovia et al, 2010). The maximum power generated in the concentric phase with 20, 30, 40, 50, and 60 kg was recorded as an indicator of the profile of FS20-60 power for each player.

For data analysis, Pearson correlation and t-test were used. The alpha level was set at  $p < 0.05$ . Results Significant reductions in the SK for the dominant (3.3%) and non-dominant legs (6.6%) ( $p \leq 0.001$  and  $p \leq 0.000$ , respectively) were found. A significant relationship was found between the percentage of kick speed loss with the non-dominant leg and peak power in the F520-60 ( $r = 0.517$ ,  $p \leq 0.05$ ). This relationship was not found for the dominant leg. Discussion The lesser speed loss found with the dominant leg could be due to the greater stability and/or inter- and intramuscular coordination. These data seem to corroborate the absence of relationship between power and the speed loss for the dominant leg. Future studies should assess the level of loss of RS under game-like conditions and which workout protocols help to reduce the levels of loss of RS brought about by RS ability. References Amiri-Khorasani, M., Osman, N.A.A., and Yusof, A. (2010). J Strength Con Res, in press. Kellis, E., Katis, A., and Vrabas, I.S. (2006) Scand J Med Sports. López-Segovia, M., Palao, J.M., González-Badillo, J.J. (2010). J Strength Con Res.

## Poster presentations

### PP-PM20 Molecular Biology

#### STRENGTH TRAINING ELEVATES HSP27, HSP70 AND ACRYSTALLIN LEVELS IN MUSCULI VASTU LATERALIS AND TRAPEZIUS

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Introduction: Increased levels of Heat Shock Proteins (HSPs) have been found both after single bouts of high-force and endurance exercises, as well as after short periods of training. In this study we aimed at investigating changes in the HSPs levels after 2 (6 sessions) and 11 weeks of strength training. Methods: Fifteen young men ( $27 \pm 6$  yr,  $182 \pm 8$  cm and  $82 \pm 13$ ) were recruited and randomized to training either three sets in lower-body exercises and one set in upper-body exercises (3L-1UB), or one set in lower-body exercises and three sets in upper-body exercises (1L-3UB). Biopsies were obtained from m. vastus lateralis and m. trapezius before, during (after 2 weeks) and after 11 weeks of strength training (3 bouts per week). The biopsies were analyzed for HSP27, HSP70 and  $\alpha$ crystallin levels in the cytosolic and the cytoskeletal compartments. Results: For all subjects combined, a HSP response was observed as the cytosolic levels of HSP27 ( $186 \pm 69\%$ ) HSP70 ( $146 \pm 51\%$ ) and  $\alpha$ crystallin ( $184 \pm 82\%$ ) increased in vastus lateralis after 11 weeks of training. In trapezius the only observed increase was for HSP27 in the cytosolic fraction after 2 weeks of training ( $149 \pm 59\%$ ). However, trapezius contained higher levels of HSP70 and  $\alpha$ crystallin than vastus lateralis at baseline. HSP27 was measured in both the cytosolic and cytoskeletal cellular compartment, but changes were merely found in the cytosolic compartment. We found no evidence for an effect of training volume (1 vs. 3 sets) on the HSP response. Discussion: Without effect of training volume, strength training resulted in elevated levels of HSP27, HSP70 and  $\alpha$ crystallin in vastus lateralis. In trapezius, which contained higher levels of HSP70 and  $\alpha$ crystallin than vastus lateralis at baseline, only the HSP27 levels were increased (after 2 weeks) with training. References: 1) Feasson et al., 2002 2) Febraio & Koukoulas, 2000 3) Liu et al., 2000

#### A PRELIMINARY STUDY OF THE IMPACT OF EXERCISE ON PLASMA MUSCLE SPECIFIC MIRNAS

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A PRELIMINARY STUDY OF THE IMPACT OF EXERCISE ON PLASMA MUSCLE SPECIFIC MIRNAS Gomes, C.P.C1, Farias, L.R.2, Pereira, R.W.1 1: UCB (Brasília, Brazil), 2: UnB (Brasília, Brazil) Introduction There is much to learn about the muscular molecular adaptations to exercise and increasing evidence points to the importance of miRNAs in such processes. Since muscle specific miRNAs (myomiRs), have been vastly studied in skeletal muscle tissue but not as circulating miRNAs, here we investigated them in plasma. The main goal of this pilot experiment was to identify the levels of three myomiRs in plasma of high aerobically adapted individuals and whether their expression was significantly altered due to training. Methods Plasma was obtained from two high aerobically adapted individuals at rest and immediately after running. The miRNAs were isolated and then quantified in triplicates by real-time PCR using TaqMan miRNA Assays to miR-1, -133a and -206, and RNU48 as endogenous control. The relative changes in expression were calculated using the delta delta Ct method, where the mean delta Ct of each group was used for comparison. Statistical t-test was run for all data and results were considered significant at  $P < 0.05$ . Results miR-1, -133a and -206 on high aerobically adapted individuals were significantly higher after running compared to the levels at rest, where the increase was of 2, 2.68 and 5.63 times respectively ( $P < 0.02$ ). Discussion Since research on circulating miRNAs has focused in disease, it is unknown how exercise training changes myomiR expression. Two different studies, Nielsen et al (2010) and McCarthy and Esser (2010), showed a decrease in miR-1 and -133a levels in muscle biopsies after aerobic training. However the latter also observed an increase in the levels of the corresponding primary-miRNAs, including pri-miR-206. Meanwhile, Laterza et al (2009) reported an increase of the circulating muscle specific miR-133a after chemically induced muscle tissue injury in mice. In our findings, miR-133a was increased 168% after exercise, which might indicate muscle injury. We are aware of the limitations of our work regarding the number of subjects and the necessary aerobic parameters. Nevertheless, this was a first attempt to verify if it was relevant pursuing studies with myomiRs in plasma. Indeed, our results raise several questions including a very relevant one: is there any biological relevance of the increase of these myomiRs in plasma after exercise? References Laterza OF, Lim L, Garrett-Engle PW, Vlasakova K, Muniappa N, Tanaka WK, Johnson JM, Sina JF, Fare TL, Sistare FD, Glaab WE (2009). Clin Chem, 55: 1977-83. McCarthy JJ, Esser KA (2007). J Appl Physiol, 102: 306-13. Nielsen S, Scheele C, Yfanti C, Akerstrom, TC, Nielsen, AR, Pedersen, BK, Laye, MJ (2010). J Physiol, 588: 4029-37.

#### LIVER NESFATIN GENE EXPRESSION AND ITS CONCENTRATION RESPONSES TO AN ENDURANCE TRAINING IN MALE RAT

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LIVER NESFATIN GENE EXPRESSION AND ITS CONCENTRATION RESPONSES TO AN ENDURANCE TRAINING IN MALE RAT Ghanbari-Niaki, A.1, Hosseinpour, F.1, Fathi, R.1 1: FPESS (Mazandaran, Iran) Introduction Nesfatin-1 is a novel anorexigenic protein that derived from Nucleo-

bindin-2 (NUCB2) gene (Oh et al., 2006; Goebel et al., 2009), expressed in adipose tissue and also is found in plasma (Li et al., 2010; Shimizu et al., 2008). The purpose of this study was to examine the effect of an eight week endurance training regimen on nesfatin gene expression and concentration in the male rat liver. Methods Eleven adult wistar male rats were used. Animals were randomly divided into Training (ES, n=6) and control (CS, n=5) groups. Training group was exercised on a motor-driven treadmill at 0% grade, 60 min, 5 days/week for 8 weeks (Katsuhiko and Jian, 2008), and 50-55%vo2max (Brooks and White, 1978). Excised liver samples were frozen in liquid nitrogen for determination of nesfatin-1 mRNA and liver concentration by RT-PCR & ELISA, respectively. Results Although liver nesfatin mRNA expression and its concentration were increased, changes were not significant. Also liver glycogen concentration was significantly higher in trained rats compared to control rats. Discussion The results of this research show for the first time that nesfatin-1 expressed in the liver and that it responded to endurance training. Insignificant variations of nesfatin-1 expression and concentration in liver might be attributed to the role of its in energy balance. References Oh S, Shimizu H, Satoh T, Okada S, Adachi S, Inoue K, Eguchi H, Yamamoto M, Imaki T, Hashimoto K, Tsuchiya T, Monden T, Horiguchi K, Yamada M, Mori M. (2006). *Nature*, 443(7112), 709-712. Goebel M, Stengel A, Tache Y, Sachs G, Lambrecht NW. (2009). *Gastroenterology*, 452, 241-246. Li Q, Wang H, Chen X, Guan H, Jiang Z. (2010). *Regulatory Peptides*, 72-77. Shimizu H, Ohsaki A, Mori M. (2008). *Peptides*, 30(5), 995-998. Brooks GA, White TP. (1978). *J Appl Physiol*, 45(6), 1009-1015. Katsuhiko O, Jian W. (2008). *Nutr Sci Vitaminal*, 239, 0832.

### **SIRNA-INDUCED SILENCING OF HYPOXIA-INDUCIBLE FACTOR 3A INCREASE OF EXERCISE ENDURANCE IN RATS**

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siRNA-INDUCED SILENCING OF HYPOXIA-INDUCIBLE FACTOR 3A (HIF3A) INCREASE OF EXERCISE ENDURANCE IN RATS Drozdovska S.1, Gavenauskas B.2, Drevitska T.2, Dosenko V.2 1: NUPESU (Kiev, Ukraine), 2: BIPH (Kiev, Ukraine) Introduction Exercise endurance depends on adequate adaptation of an organism to exercise-induced hypoxia. One of the crucial factors in this process is hypoxia-inducible factor that regulates transcription of many target genes encoding proteins that are involved in molecular adaptation to hypoxia (Mason S. et al., 2004; Lundby C. et al., 2009). The new data about antagonistic effects of different isoforms of HIF has been obtained recently – some splice variants of HIF3A can prevent transcription of target genes by HIF1A and HIF2A (Hara S. et al., 2001; Murphy B.J., 2004; Maynard M. et al., 2005). The aim of this study is to research exercise endurance of rats after knockdown of HIF3A using of siRNA. Methods The research was carried out on Fisher male rats (n=14). After a five-week swimming course with weight (O<sub>2</sub> consumption was on the level of 70-75% of peak intake) animals were injected into a tail vein with siRNA in dose of (80x1000) ng. In a week there was a second injection in the same quantity. The functional swimming test on exercise endurance was carried out before the first and second injections and 3 days after them. The effectiveness of RNA-interfering was estimated using Real-time PCR in muscles with preference of slow-twitch fibers (m. gastrocnemius) and fast-twitch fibers (m. soleus). Results Performing time of swimming test by HIF3A-knockdown rats after first and second injection of siRNA was 33% higher compared to control rats (injection of scrambled siRNA). Level of HIF3A mRNA expression was 2,6 fold (P<0.05) lower in m. gastrocnemius and 1.65 fold (P<0.05) in m. soleus compared to control. Discussion Obtained data indicate beneficial effect of HIF3A silencing on exercise endurance in rats and also proved previous results concerning negative effect of HIF3A in adaptation to hypoxia. siRNA-induced knockdown of this gene can be used for further researching of ways of exercise endurance increase and treatment of hypoxic conditions. References Hara S., Hamada J., Kobayashi C., Kondo Y., Imura N. *Bioch Bioph Res Comm* (2001) 287: 808–813. Lundby C., Calbet J.A.L., Robach P. *Cellular and Molecular Life Sciences*. Volume 66, № 22, 2009. Mason S., Howlett R., Kim M., Olfert I., Hogan M., Mc Nulty W., Hickey R., Wagner P., et al. *Plos Biology* (2004). Issue10, V.2, 1540-1547. Maynard M.A., Evans A.J., Hosomi T., Hara S., Jewett M.A., Ohh M. *FASEB J* (2005) 19: 1396-1406. Murphy B.J. *Comp Biochem Physiol B Biochem Mol Biol*. (2004)139: 495-507.

### **COLLAGEN V EXPRESSION IN CAPSULE OF ATHLETIC POPULATION UNDERGOING OPEN SHOULDER STABILIZATION**

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Introduction: Shoulder dislocations are often caused by trauma, but predisposing intrinsic factors might also influence the risk. Collagen type V is widely distributed in tissues and helps regulate the diameters of fibrils of the abundant collagen type I. Mutations in its genes have been identified which can result in connective tissue fragility, particularly in skin and joints. The aim of this study was to assess if there is a correlation in the distribution of collagen V in capsule and Beighton score. Methods: Localization of Collagen V was studied by immunohistochemical staining of paraffin embedded sections of capsule from patients attending for open shoulder stabilization between Nov 2008 and July 2009. Grading of the stain was done on a 0-4 scale (0=no staining and 4=strong staining >50% of the slide) by three observers. Clinical examination was used to assess generalized ligament laxity using the Beighton score. Laxity is scored on a 0-9 scale. Scores of 4 or above are indicative of generalized ligament laxity. Results: 15 patients were studied undergoing open shoulder stabilization for recurrent instability. The mean age of patients was 24 years with a range from 16-31 years. 14 patients were male and 1 female. Most common sport played was rugby in 7 patients (47%) and football in 5 patients (33%). The average Beighton score for these patients was 2.4 with a range from 0-8. 4 patients (27%) had a Beighton score of 4 or above indicating generalized ligament laxity. Synovial surface of the capsule, blood vessels and extracellular matrix stained positive to varying degrees for collagen V. There was no correlation between Beighton score and collagen V expressions in the extracellular matrix of the capsule. Discussion: We studied the expression and distribution of Collagen V in capsule of patients undergoing open shoulder stabilization and found no correlation with Beighton score. This study highlights the complex role of different genes involving Collagen V which are responsible for extracellular matrix organization and strength of the shoulder capsule.

### **SMALL LEUCINE RICH PROTEOGLYCAN EXPRESSION IN SHOULDER CAPSULES OF ATHLETIC POPULATION UNDERGOING SHOULDER STABILIZATION**

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Introduction: Shoulder dislocations are often caused by trauma, but predisposing intrinsic factors might also influence the risk. Decorin and biglycan are members of the SLRP's family which are important constituents of interstitial extracellular matrices (ECM) and play important roles in the regulation of collagen fibrillogenesis. Their deficiency could influence wound healing and integrity of skin and muscle. The aim of this study was to assess if there is a correlation in the distributions of SLRP's in capsule and Beighton score. Methods: Localiza-

tion of decorin and biglycan was studied by immunohistochemical staining of paraffin embedded sections of shoulder capsule from patients attending for shoulder stabilization between Nov 2008 and July 2009. Grading of the stain was done on a 0-4 scale (0=no staining and 4=strong staining >50% of the slide) by three observers. Clinical examination was used to assess ligament laxity using the Beighton score. Laxity is scored on a 0-9 scale. Scores of 4 or above are indicative of generalized ligament laxity. Results: 15 patients were studied undergoing open shoulder stabilization for recurrent instability. The mean age of patients was 24 years with a range from 16-31 years. 14 patients were male and 1 female. Most common sport played was rugby in 7 patients (47%) and football in 5 patients (33%). The average Beighton score for these patients was 2.4 with a range from 0-8. 4 patients (27%) had a Beighton score of 4 or above indicating generalized ligament laxity. Synovial surface of the capsule, blood vessels and skeletal muscles stained negative but ECM was positive to varying degrees for decorin. There was no correlation between Beighton score and Decorin expressions in extracellular matrix of the capsule. Synovial surface of the capsule, blood vessels and ECM stained positive to varying degrees for Biglycan. There was no correlation between Beighton score and Biglycan expressions in the extracellular matrix of the capsule. Conclusions: We studied the expression and distribution of SLRP's (Decorin and Biglycan) and found no correlation between the Beighton score and SLRP's distribution in the extracellular matrix of the shoulder capsule. This study highlights the complex role of different genes including the SLRP's which are responsible for extracellular matrix organization and strength of the shoulder capsule.

### **TGF- $\beta$ ISOFORMS INHIBIT IGF-1-INDUCED MIGRATION AND REGULATE TERMINAL DIFFERENTIATION IN A CELL-SPECIFIC MANNER**

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**Introduction** Following muscle injury, the damaged tissue and influx of inflammatory cells stimulate the secretion of growth factors and cytokines to initiate repair processes. This release of chemotactic signaling factors activates resident precursor cells and stimulates their mobilization and migration to the site of injury where regeneration can occur. In terminally differentiated adult skeletal myofibers, repair is carried out by a small population of stem cells called satellite cells, which are activated in response to disease or trauma, forming myoblasts which aids regenerative processes. Similarly, endogenous cardiac stem cells have also been identified, although they seem to have limited effect in functional repair (Collins and Russell 2009). Furthermore, although the transplantation of exogenous stem cells has shown promising results, consistent and functional cardiac repair has not been demonstrated. To be of greater therapeutic use, insight is required into the regulatory mechanism(s) of growth factors in the cytoplasmic milieu of progenitor cells which could optimize regeneration processes (Nadal-Ginard and Fuster, 2007). The three Transforming Growth Factor- $\beta$  (TGF- $\beta$ ) isoforms, and Insulin-like Growth Factor-1 (IGF-1) are among the known regulatory factors released following muscle damage. To determine the effect of these growth factors of muscle regeneration, we investigated the effect of TGF- $\beta$ 1, - $\beta$ 2, - $\beta$ 3 and IGF-1 on muscle progenitor cell migration and the effect of TGF- $\beta$  isoforms on myoblast fusion. **Methods** Recombinant active TGF- $\beta$ 1, - $\beta$ 2, - $\beta$ 3 (5 ng/ml) and IGF-1 (10 ng/ml) were used to determine their effect on C2C12 skeletal muscle satellite cell and P19 embryonal carcinoma cell differentiation and migration. C2C12 myoblast fusion, and P19 embryoid body formation and terminal differentiation were assessed following 72 hr TGF- $\beta$  treatment, whereas the effect of TGF- $\beta$  isoforms and IGF-1 on migration was determined following 7 hr incubation. **Results** Our results showed that TGF- $\beta$  decreases C2C12 myoblast fusion in an isoform-independent manner. In the P19 cell lineage, results demonstrate that TGF- $\beta$ 1 specifically and significantly increased P19 embryoid body formation, but not expression of connexin-43 or myosin heavy chain. IGF-1 significantly increased cell migration compared to TGF- $\beta$  isoforms, which, on their own, had no significant effect on the mobilization of either C2C12 or P19 cells. **Discussion** These results emphasize the importance of evaluating progenitor cell migration and fusion in context of the cellular and cytokine environment. A greater understanding of stem and progenitor cell activation, signaling and involvement in growth and repair, as well as the profile of growth factor expression during these processes, is essential in establishing more effective cell-based therapies. **References** Nadal-Ginard B, Fuster V. (2007) Myocardial cell therapy at the crossroads. *Nat Clin Pract Cardiovasc Med* 4(1):1. Collins JM, Russell B. (2009) Stem cell therapy for cardiac repair. *J Cardiovasc Nurs* 24: 93-97.

### **EFFECT OF ECCENTRIC EXERCISE VELOCITY ON MYOSTATIN AND FOLLISTATIN GENE EXPRESSION IN HUMAN SKELETAL MUSCLE**

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**Introduction** It has been suggested that eccentric exercise (EE) velocity seems to affect the magnitude of muscle mass increment. However, intracellular mechanisms that regulate acute increments in protein synthesis after each training session, which eventually lead to muscle hypertrophy, after fast EE training remains to be elucidated. Growth and differentiation factor-8 (GDF), also known as Myostatin (MSTN), is a transforming growth factor- $\beta$  family member that acts as an inhibitor of skeletal muscle hypertrophy. MSTN-deficiency has been associated to significant increases in muscle mass. MSTN activity is regulated by a protein known as Follistatin (FLST). FLST over-expression has been shown to promote muscle hypertrophy. Since EE produces muscle hypertrophy, it is reasonable to assume that this kind of physical training will induce down-regulation of MSTN signaling. The aim of this study was to compare the effect of fast and slow EE on MSTN and FLST gene expression. **Methods** Twenty four healthy male were randomly assigned to either a slow (20°s<sup>-1</sup>, n= 8) or fast (210°s<sup>-1</sup>, n=8) eccentric group. The acute exercise bout consisted of 5 sets of 8 reps of EE knee extensions (0 to 90°) at either slow or fast velocity on the isokinetic dynamometer, interspersed by 3 min rest interval. Peak torque, work, and impulse were calculated for each repetition throughout the sets of eccentric exercise. Muscle biopsy samples were taken before, immediately, and 2 h after the exercise bout. MSTN, FLST, follistatin related protein 3 (FLL-3) and GASP-1 gene expression were quantified by real time PCR. **Results** There were no differences in peak torque values between sets and velocities (p>0.05). Similarly, total work was similar between velocities (p>0.05). On the other hand, the total impulse and the impulse per set (main velocity effect) were significantly higher for the slow EE group (p<0.05). No changes were observed for MSTN mRNA content (p>0.05). A main time effect was observed for FLST, FLL-3 and GASP-1 (pre vs. 2h; p<0.05). No differences were found at any time point between velocities. **Discussion** The findings of the present study indicated that a acute bout performing EE activates similar gene expression responses related to components of MSTN signaling pathway. However, despite the previous data available reporting greater muscle hypertrophy responses after higher velocity EE, no difference were observed between high and low velocity EE in this study. It is possible that other intracellular pathways might be activated in response to EE training protocol.

## VALIDATION OF ISOLATION AND CHARACTERISATION OF CARDIAC STEM CELLS FROM THE FOUR CHAMBERS OF THE MOUSE HEART

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**Introduction** c-kitpos CD45neg Cardiac Stem Cells (CSCs) are a small subpopulation of cells with stem cell properties and regenerative potential within the embryonic and adult heart. We have previously shown that CSCs become activated and differentiate into new myocardial cell following exercise training, contributing to improved cardiac functional adaptation. Here, we show that CSCs are present in all four chambers of the adult heart and show similar phenotypic and functional characteristics. Furthermore, they can be routinely and efficiently isolated using several methods. **Methods** Whole mouse hearts from 6-week male C57BL6 mice (n=18) were dissected into the 4 chambers (right and left ventricle, right and left atrium). Small cardiac cells were isolated from each chamber using three different techniques: Enzymatic digestion, enzymatic digestion using GentleMACS® technology or explant culture technique. The percent number of c-kit positive (c-kitpos) CSCs were analysed for each chamber by flow cytometry. c-kitpos CSCs were enriched through magnetic activated cell sorting (MACS, Miltenyi) and characterised for chamber-specificity, surface markers by flow cytometry analysis, clonogenicity, multipotency and self-renewal. **Results** The efficiency of c-kitpos CSC isolation from each chamber using the 3 isolation techniques was similar, with ranges from 4 to 8% of the small cell population. Thus far, c-kitpos CSCs have been successfully enriched and lines cultured for the left atria (LA) and right ventricle (RV). These CSC lines are clonogenic (19±4%) and self-renewing. For two LA and two RV CSC lines at passage 5, flow cytometry analysis revealed maintenance of positivity for stem cell markers, c-kit and Sca-1, and negativity for CD45 (haematopoietic) and CD34 (endothelial). qRT-PCR analysis of the CSC clonal cell lines from the different chambers revealed expression of the multipotency genes. **Conclusion** c-kitpos CSCs are present in all 4 chambers of the adult mouse heart and can be successfully identified and routinely isolated using either enzymatic digestion or explant culture. c-kitpos CSCs enriched from the LA and RV express similar stem cell surface markers and multi-potency genes, indicative of an indistinct population of CSCs throughout the mouse heart.

## GROWTH FACTORS IN SKELETAL MUSCLE REGENERATION OF ELITE GRECO-ROMAN WRESTLERS

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**Introduction** Skeletal muscles are able to regenerate after injury. This process is due to the activation of muscle precursor cells, called satellite cells, which proliferate and differentiate to form new myotubes. In this regeneration process, hydrogen peroxide, nitric oxide, cytokines and growth factors which come from the muscle and/or from motor nerve and inflammatory cells have been shown to play key roles. During recovery, most of these molecules have been released to circulation and could be useful in assessment of muscle regeneration in athletes (Kuang et al., 2008; Wilborn et al., 2009). The purpose of the study was to estimate the extracellular signals of satellite cells activity in elite Greco-Roman wrestlers in four training periods. **Methods** Twenty athletes, members of national team, were observed during two preparatory periods (January, December), pre-start period (April) and start period (June) differed in type and intensity exercise. In blood, concentrations of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), nitric oxide (NO), pro-inflammatory cytokines (IL-1 $\beta$  and TNF $\alpha$ ), hepatocyte growth factor (HGF), insulin-like growth factor (IGF-1), platelet-derived growth factor (PDGF-BB) and brain-derived neurotrophic factor (BDNF) were measured. Total creatine kinase (CK) activity was a marker of muscle damage. **Results** The levels of H<sub>2</sub>O<sub>2</sub>, TNF $\alpha$  and growth factors HGF, IGF-1, PDGF-BB and BDNF were significantly elevated during the second part of preparatory period and pre-start period where dominated the endurance exercises and technical training elements. NO increased during the mountain training in December. The changes in CK activity were not associated with growth factors levels and pro-inflammatory cytokines. Individual analysis of growth factors revealed that HGF, IGF-1 and PDGF-BB were most increased in top-athletes. **Discussion/Conclusion** We have concluded that wrestling training of high intensity has significant influence on growth factors accompanied by increase hydrogen peroxide and cytokine TNF $\alpha$ . However, the degree of release of HGF, IGF-1, PDGF-BB and BDNF and pro-inflammatory cytokines might be related to several factors that include the athlete's fitness level, exercise intensity, and exposure to environmental conditions. **References** Kuang S, Gillespie MA, Rudnicki MA. (2008). Cell Stem Cell, 2, 22-31. Wilborn CD, Taylor LW, Greenwood M, Kreider RB, Willoughby DS. (2009). J Strength Cond Res, 23, 2179-2186.

## OBSERVATION OF A WAVE-LIKE STRUCTURE IN ATROPHIED SKELETAL MOUSE MUSCLE USING SCANNING ELECTRON MICROSCOPY AND IMMUNOHISTOCHEMISTRY.

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**Introduction** Skeletal muscle shows structural and functional changes and high plasticity, depending on stimulation levels. It has previously been reported that the soleus muscle immobilized in a shortened position forms a wave-like structure (Oka K et al. 2003). Reported structural changes associated with disuse muscle atrophy include a wavy contour and myofibrillar disruptions (Anzil AP et al. 1991). However, the relationship between the appearance of a wave-like structure and myofibrillar disruption is unclear. The purpose of the present study was to analyze the ultrastructural changes of muscle fibers in the wave-like structure using scanning electron microscopy (SEM). **The present experiment** was performed with a SEM method using paraffin sections that has been previously reported (Oka K et al. 2006). **Materials and Methods** The soleus muscles of 5-week-old female ICR mice were used in this study. These mice were divided into a control group and an immobilized group. In the immobilized group, the left hindlimb was immobilized at the ankle joint in maximum planter flexion. After 10 days of immobilization, the excised soleus muscle was fixed with acetone and embedded in paraffin in the usual manner. Longitudinal serial paraffin sections of 8 micrometer were made: 1 section was observed with SEM and 1 neighboring section in the series was stained with anti-collagen type IV antibody (a marker for endomysium). **Results** The muscle fiber showed a linear contour in the control group and myofibrils were visible. In muscle fibers of the immobilization group, wave-like structure was observed: it appeared as a groove, and was thought to be endomysium inserted into the cytoplasm of the muscle fiber. The wave-like structure was positive for anti collagen IV antibody. Based on these results, the structure which inserted into the cytoplasm and formed a groove was confirmed to be endomysium. Moreover, myofibrillar disruption was not observed at region of the wave-like structure. **Discussion** Atrophied muscle induced by tenotomy has been previously observed using SEM, and it has been reported that grooves appear in tenotomized muscle on the fiber surface (Abou Salem EA et al. 2001). The structural changes observed in the present study were speculated to be morphological changes similar to those that have been described as a groove in previous studies. Additionally, the myofibrils were

observed distinctly at a specific region of the wave-like structure, and it was suggested that myofibrillar disruption did not occur in the atrophied skeletal mouse muscle.

### CHANGES IN SALIVARY ANTIMICROBIAL PEPTIDES, IMMUNOGLOBULIN A AND CORTISOL AFTER PROLONGED STRENUOUS EXERCISE

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The aim of the present study was to examine whether amount of oral antimicrobial components, human  $\beta$ -defensin-2 (HBD-2), cathelicidin (LL-37) and immunoglobulin A (IgA), might be affected by prolonged strenuous exercise. Ten young male volunteers either exercised on recumbent ergometer at 75 % VO<sub>2</sub> max for 60 min (exercise session) or sat quietly (resting session). Saliva samples were obtained at 60 min intervals during sessions for measurements of saliva antimicrobial components (HBD-2, LL-37 and IgA), saliva cortisol and osmolality. Saliva flow rate was decreased and saliva osmolality was increased during the 60-min exercise. Saliva HBD-2 and LL-37 concentrations and secretion rates were increased during and after the exercise, whereas saliva IgA concentration and secretion rates were decreased after the exercise. Saliva cortisol was increased during and after the exercise. The areas under the curve (AUC) of the time courses of saliva levels of HBD-2 and LL-37 were negatively correlated with those of cortisol levels in saliva. The present findings suggested a single bout of prolonged strenuous exercise caused a transient increase in the saliva HBD-2 and LL-37 levels. In addition, the transient rises in these antimicrobial peptide levels might be affected by increase in cortisol levels by the exercise.

### RELATIONSHIP BETWEEN CHANGE RATES OF SALIVARY CHROMOGRANIN A AND FATIGUE COMPLAINTS OF LANGUID BODY AND THIRST IN JUDO TRAINING AND LECTURE IN STUDENTS

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Relationship between change rates of salivary chromogranin A and fatigue complaints of languid body and thirst in judo training and lecture in students. Naomasa Sakamoto, Kunihiro Sakamoto Preventive Medicine, Hyogo College of Medicine, Japan Introduction: The relationships between the change rates of salivary chromogranin A (CgA) and physical fatigue complaints after judo training and lecture were examined. CgA was considered as one of the index of sympathetic system. In this study the fatigue complaints were considered the items of languid body and thirst feeding using enquete method authorized by the Japanese industrial hygienists association. The relationship was analyzed by multiple regression analyses using the dummy number for transition pattern of fatigue complaints. Methods: Subjects were eight healthy male students, nonsmoker, average age 24.75 years old and standard deviation 7.94 years old. Salivary collection and fatigue survey were down three times at the attend school, after the first lesson and after the second lesson. The fatigue complaints by judo and lecture lesson were examined using the descriptive enquete method of fatigue survey. The items of fatigue complaint category were considered the languid body as physical fatigue complaints and thirst feeling as neurosensitive fatigue complaints. CgA was measured by Yanaihara institute. The change rate of CgA by the load was measured as the base of data at the attending school. The transition patterns of fatigue complain were shown by dummy number as following; 100 of the incidence case, 010 of the continuous case and 001 of the disappearance case of fatigue complaint. Correlation coefficient and multiple regression analysis were down by Excel. Results: The change rates of CgA level were 0.715 of median value for judo and 0.603 of median value for lecture. The analysis was down using the all these data. Correlation coefficients( r ) between the change rate of CgA and the transition pattern of fatigue complaint were analyzed as following,  $r = -0.145$  for the disappearance of languid body and  $r = 0.291$  for the continuous of thirst feeling. The effects of the fatigue complaint on the change rate of CgA were analyzed by multiple regression method using dummy number of the transition pattern. The standard partial regression coefficients of the change rates of CgA to the fatigue complaint cases were  $-0.377$  for the disappearance case and  $0.476$  for the continuous thirst feeling case. Discussion. The disappearance of languid body complaint was showed to decrease tendency corresponding to increase the CgA level. It seemed that the languid body complaint might be disappeared by decrease of sympathetic condition. The continuous thirsty feeling was related to increase corresponding to CgA level. Thus, it seemed that the change rate of salivary CgA level was showed the relation between the sympathetic status and the thirst complaint.

## Poster presentations

### PP-PM21 Adaptive Physical Activity

#### OBJECTIVE QUANTIFICATION OF PHYSICAL ACTIVITY IN DOWN'S SYNDROME ADOLESCENTS. A PILOT STUDY

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OBJECTIVE QUANTIFICATION OF PHYSICAL ACTIVITY IN DOWN'S SYNDROME ADOLESCENTS. A PILOT STUDY Viuda-Serrano, A., Ruiz-Vicente, D., Theirs Rodríguez, C.I., Salinero, J.J., Pérez, B. Universidad Camilo José Cela INTRODUCTION Knowing the degree of physical activity in a population group becomes the first step to address sport promotion policies to encourage a healthy lifestyle that may have impact on better living conditions. Traditionally, we have used questionnaires and log books to ascertain the practice of physical activities and sports. Present times determine the use of technology, such as accelerometers, which have been shown to be a valid tool to objectively quantify physical activity levels in different populations. An accelerometer is an electronic device that collects accelerations produced by the body over a period of time. Through this instrument, we are able to know the fulfilment of official recommendations for physical activity and also the activity patterns followed by different groups. OBJECTIVE The aim of this study is to carry out a first approach to the objective quantification of physical activity in young people with Down syndrome in Spain. We also seek to know if they meet official recommendations of physical activity for health and patterns of physical activity. METHOD Five adolescents with Down syndrome aged  $17.8 \pm 1.2$  were analyzed for a week using GT3X tri-axial accelerometers. All recorded days were valid, except for two single days in one of the participants due to an illness. RESULTS Most of their physical activity was limited to sedentary or light activity. They performed about 30 minutes of moderate or vigorous activity, so did not meet physical activity recommendations. Subjects carried out an average over



8.000 steps a day, far away from the recommended 10.000 steps, although two of the participants reach more than 9.700 steps a day. Both in quantity and intensity, physical activity made on working days significantly exceeds that held on weekends. On average, half of physical activity (also in quantity and intensity) performed throughout the day is made within the school, which emphasizes the importance of school as a promoting or facilitating means for physical activity. CONCLUSION Accelerometers have been proved to be a valid tool to assess physical activity in special groups of population with specific characteristics, such as Down's syndrome adolescents. In the future, it would be interesting to extend the study sample, in order to draw meaningful conclusions about the physical practice of this collective. REFERENCES Fredriksen, P. M. et al. (2000). Physical activity in children and adolescents with congenital heart disease. Aspects of measurements with an activity monitor. *Cardiology in the Young*, 10, 98-106. Grace, C. et al. (2003). Energy metabolism in Bardet-Biedl syndrome. *International Journal of Obesity*, 27(11), 1319-1324. Ward, D. et al. (2005). Accelerometer use in physical activity: best practices and research recommendations. *Medicine and Science in Sport and Exercise*, 37(11 Sup.), S582-588.

## INTERDEPENDENCE OF PHYSICAL PERFORMANCE, FATIGUE AND DISABILITY IN FEMALE PATIENTS WITH RELAPSING REMITTING MULTIPLE SCLEROSIS

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**Introduction** Fatigue is a frequent and often disabling symptom in patients with multiple sclerosis (MS) (Stuke et al., 2008) significantly affecting quality of life. In the present study we investigate the interdependence of physical performance, fatigue and disability in female patients with relapsing remitting multiple sclerosis (RR-MS). **Methods** Untrained female patients with RR-MS participated in this study (n=56, age 37 +/-8.3 years). The mean disability according to the expanded disability status scale (EDSS) was 1.9 +/-0.6. At the beginning of the examination all participants completed the fatigue severity scale questionnaire (FSS) (Krupp et al., 1989). Patients were then divided into a non-fatigue group (NF) with a FSS score value (FSS-sv) below 4.0 and a fatigue group (FG) with a FSS-sv of 4.0 and higher. Subsequently, all subjects completed a treadmill testing according to the modified Naughton protocol (Patterson et al., 1972). Gas exchange was measured continuously to determine the peak oxygen uptake during the treadmill test (VO<sub>2</sub>peak). Blood lactate concentration and heart rate were measured after each incremental. **Results** There were no significant differences between NF and FG with regard to the mean blood lactate concentration, heart rate and VO<sub>2</sub>peaks. The correlation between VO<sub>2</sub>peak and FSS-sv was also not significant (p>0.05). The EDSS correlated negatively with the VO<sub>2</sub>peak (p<0.001). **Discussion** We conclude that based on this cross-sectional approach, severity of fatigue in untrained MS patients had obviously no effect on physical performance. The significant correlation between EDSS and VO<sub>2</sub>peak can most likely be explained by the superior motoric skills in patients with lower EDSS scores. Other studies came to similar results (Motl RW & Goldman M, 2011). Further studies are needed to investigate the impact of specific physical exercise on fatigue and disability in patient with MS. **References** Krupp, L. B.; LaRocca, N. G.; Muir-Nash, J.; Steinberg, A. D. (1989): The fatigue severity scale. Application to patients with multiple sclerosis and systemic lupus erythematosus. In: *Arch. Neurol* 46 (10), S. 1121-1123. Motl RW; Goldman M (2011): Physical inactivity, neurological disability, and cardiorespiratory fitness in multiple sclerosis. In: *Acta Neurol Scand* 123 (2), S. 98-104. Patterson, J. A.; Naughton, J.; Pietras, R. J.; Gunnar, R. M. (1972): Treadmill exercise in assessment of the functional capacity of patients with cardiac disease. In: *Am. J. Cardiol* 30 (7), S. 757-762. Stuke, K.; Flachenecker, P.; Zettl, U.K.; Elias, W.; Freidel, M.; Haas, J. et al. (2008): MS-Register in Deutschland 2008: Symptomatik der MS. In: *Akt Neurol* 35 (S 01).

## THE LEVEL OF CHANGES UNDER THE IMPACT OF WATER GAMES AND EXERCISES UPON MOTORIC STATUS OF THE CHILDREN WITH DOWN SYNDROME

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**BACKGROUND:** Many researches have shown that the development of motoric abilities with children with Down syndrome (DS) is significantly limited (Lauteslager, 1991). It's obvious that their motoric develops relatively slowly and it is accompanied by significantly reduced moving abilities (Jobling, 1994; Ulrich, 1992). The aim of this research was to establish the level of changes of motoric status under the impact of programme activities of water games and exercises of children with DS. **METHODS** The research has been conducted with the sample comprising of 12 children with DS, 8 male (n=8, mean age=9.7±3. yrs; mean height= 1.32±0.16m, mean weight= 41.9±15.5 kg) as well as 4 female examinees (n=4, mean age=9.1±3.6 yrs; mean height=1.29±0.13m; mean weight= 30.5±7.5 kg). The programme was carried out within the period of 12 weeks at the pool for non-swimmers training (average water temperature 28,6 C), twice a week per 60 minutes. Both prior and after the carried out programme, a testing of a part of motoric status was performed in order to establish the effects of the programme itself. For the analysis of initial and final testing, T-test for dependant samples has been used / marked differences are significant at p <, 0500) **RESULTS** The analyses of results for balance assessment „one leg standing“ (p=, 0012), the speed of alternative movements „hand tapping“ (p=, 0006), explosive force „ 20 meters sprint“ (p=,0000), coordination „slalom –ball rolling“ (p=,0034), flexibility „spread legs sitting bend“ (p=,0010) and coordination in water „ 12 meters shallow water running „ (p=,0001) show high level of statistic significance with all examinees. **CONCLUSIONS** Final results' testing shows statistically significant level of shanges in relation to the initial testing. Similar results were obtained by other authors proving that with the application of adequate physical exercise programme, motoric status is able to be improved, especially strength and balance at children with DS (Gupta, 2010). On the basis of this, it could be concluded that with appropriate impulse under the impact of various water games and exercises, significant improvement of the level of motoric status at children with DS is notable. **REFERENCES** Gupta, S., BK. Rao, SD. Kumaran (2010). Effect of strength and balance training in children with Down's syndrome. *US National Library of Medicine. PubMed.gov* Jobling, A. (1994). Physical education for the person with Down syndrome: More than playing games? *DS Research and Practice*. 2(1):31-35. Lauteslager, P.E.M. (1991). Motor development in young Down's syndrome children. *Nederlands Tijdschrift voor Fysiotherapie*, 101: 260-269. Ulrich, B.D., Ulrich, D.A. & Collier, D.H. (1992). Alternating stepping patterns: hidden abilities of 11-month-old infants with DS. *Developmental Medicine and Child Neurology*, 34.

## THE ANALYSIS OF BODY BALANCE IN A PARALYMPIC SPRINTER: A CASE REPORT

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**Introduction** Trans-tibial amputation is responsible for biomechanical changes (i.e. absence of muscles, bones and joints) and modifications in both afferent and efferent projections. Because of these impairments, body balance is difficult to control and falls are a significant

problem for trans-tibial amputees (Curtze et al., 2010). The aim of our study was to evaluate whether specific exercises can improve body balance in a paralympic sprinter (category: T-44) after 7 weeks of training. Methods The athlete was a healthy and active female subject (age: 37 years; weight: 58.2 Kg; height: 161cm; BMI: 22.45) with an unilateral transtibial amputation to 1/3 of the right lower limb since the age of 2 years and 6 months. The athlete was tested during the 6th and 7th mesocycle of training macrocycle prior XIII Paralympics Games, Beijing 2008. During the experimentation we added in her sessions of training specific exercises to improve balance control systems such as walking along a line or on a wood support with open and closed eyes (OCE); swaying on proprioceptive footboard with OCE ect. Before and during the experimentation the typical week of training included 5 sessions of ~2 hours. Every session included a warm up pattern for about 20 minutes (min), a training period including about 20 min of specific pre-athletic exercises and 50 min of specific work, and a cool down step for 20 min. Balance control indicators, such as mean speed (MS), lateral-lateral mean speed (MS-x), anterior-posterior mean speed (MS-y), sway path (SP) and ellipse surface area (ESA) of the body mass center were analyzed by unipedal test on left foot (UTLF) with open or closed eyes using a stabilometric platform. All data were acquired before and after the experimentation. Results During unipedal test on left foot with open eyes all stabilometric parameters did not show any relevant modifications; while in UTLF with closed eyes MS, MS-x, SP and ESA decreased after 7 weeks of training. Discussion The exercises stressing balance control system appears to affect the postural stability of an athlete with trans-tibial amputation. We suppose that these kinds of exercises can improve the proprioceptive system of body balance control and preserve the subject from the fall risk (Viton et al., 2000). References Curtze C, Hof AL, Otten B, Postema K: Balance recovery after an evoked forward fall in unilateral transtibial amputees. *Gait Posture*. 2010 Jul;32(3):336-41. Viton JM, Mouchnino L, Mille ML, Cincera M, Delarque A, Pedotti A, Bardot A, Massion J: Equilibrium and movement control strategies in trans-tibial amputees. *Prosthet Orthot Int*. 2000 Aug;24(2):108-16.

## **AUTISM – A TREKKING PROGRAM TO IMPROVE HEALTH PROFILES**

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The autism spectrum disorder (ASD) is a chronic and severe pervasive neurodevelopmental disorder characterized by 3 specific symptoms: reduced social interaction; impairments in reciprocal communication; and repetitive-stereotyped behavioural patterns (APA, 2002). The prevalence of deficits on motor behaviour and the risk of inactivity due to specific features are elevated, being two of the most common co-morbidities in ASD. Owing to these co-morbidities, people with ASD are a very high group risk. There is a, real and significant, decay on their health, longevity and quality of life. Health profits of regular exercise are well recognized in literature (Booth, Gordon, Carlson, & Hamilton, 2000). Current recommendations name that people: should engage in at least 60 minutes or more of developmentally appropriated physical activity every day or most days of the week or should be active every day, including 20 minutes bouts of continuous, moderate to vigorous physical activity, 3 or more times per week. Research has established a positive impact of exercise programs on behavioural outcomes in people with ASD increasing exercised capacity and caloric expenditure, which could improve or control health profiles (Beets, 2007). APPDA North develops a sports training program to service users, which is developed on a weekly basis, providing a full training program targeted to their needs. The central activity is TREKKING and the main goal is to decrease the risk factors presented by this population (obesity, heart disease, type 2 diabetes, and epilepsy), due mainly to: inactivity, medication and aging. The trekking program is developed in 2 different subprograms: (i) daily (Monday to Friday) trekking program with 45 minutes length every day and (ii) weekly (developed once a week on Wednesdays) trekking program with 3 hours length. The subjects are adults with ASD, age 18 to 43 years, mainly males and nonverbal. Two groups were established, Group 1 composed by 6 adults age 25 to 43 years, presenting all the risk factors and Group 2 composed by 24 adults age 18 to 43 years, presenting some risk factors. Group 1 participates on both programs (i and ii) and Group 2 participates only on the weekly trekking program (ii). Weight, blood pressure and heart-beat are accessed every week. Results show us that these programs have good results in controlling the risk factors, improving the subjects' health and quality of life in both groups. APA (2002). Manual de Diagnóstico e Estatística das Perturbações Mentais. 4ª Edição. Climepsi Editores, pp. 69-75. Beets, M.; Vogel, R.; Chaoman, S.; Pitetti, K. & Cardinal, B. (2007). Parent's Social Support for Children's Outdoor Physical Activity: Do Weekdays and Weekends Matter. *Journal of Autism and Developmental Disorders*, Vol. 56, Nº 1-2, 125 – 131. Booth, F.; Gordon, S.; Carlson, C. & Hamilton, M. (2000). Waging war on modern chronic disease: Primary prevention through exercise biology. *Journal of Applied Physiology*, Nº 88, 774–787.

## **NEW DATA ABOUT LATERALITY OF PEOPLE WITH INTELLECTUAL DISABILITY**

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Introduction This study exposes a communication about laterality in people with fragile X syndrome (SXF), based from the works of McManus & Cornish (1997) and of Cornish, Pigram & Shaw (1997) about fragile X syndrome and also from the works of Carlier & col. (2006) and of Gérard-Desplanches & col. (2006), about others intellectual handicaps. The people with intellectual disabilities may be left-handed or ambidextrous. In the works of Cornish, Pigram & Shaw (1997), the people SXF are preferably left-handed regarding group of people with Down's syndrome and control group. In the works of McManus & Cornish (1997), the people SXF are right-handed and resemble the control group of people without handicap. Methods The study groups are composed by 30 people (15, 2 years), another group composed by 34 people with intellectual disabilities (16, 5 years) and a group composed by 160 people without disability (14, 7 years). The method is the test of handedness preference by Annett (1970) adapted for this study. It added three proves for measuring footedness, two proves for eyedness and one for eardness. Results The results of this experience confirm the preference of right-handedness (93, 3 %) in people with syndrome fragile X and provide new data regarding footedness and sensorial laterality of these people. They submit inconsistent footedness and ocular cross laterality. The people with syndrome fragile X are different from the people with other intellectual disabilities (73, 5 % right-handedness) and they resemble the people without intellectual disabilities. Discussion The results are in the same way than the works of McManus & Cornish (1997). It's not possible explain why the group of people with syndrome fragile X is different from group with other intellectual disabilities but get attention that the syndrome fragile X is a syndrome linked with the chromosome X and is hereditary. References Carlier, M., et al. (2006). Laterality in persons with intellectual disability: I- Do patients with trisomy 21 and Williams-Beuren syndrome differ from typically developing people? Retrieved 06/06/06, 2006, from: <http://www.up.univ-pc/pagesperso/Carlier/behavior%20genetics.pdf> Cornish, K. M., Pigram, J., & Shaw, K. (1997). Do anomalies of handedness exist in children with fragile-x syndrome? *Laterality*, 2, 91-101. Gerard-Desplanches, A., et al. (2006). Laterality in persons with disability II. Hand, foot, ear, and eye laterality in persons with trisomy 21 and Williams-Beuren syndrome. *Developmental Psychobiology*, 48, 482-491. McManus, I. C., & Cornish, K. M. (1997). Fractionating Handedness in Mental Retardation: what is the Role of the Cerebellum? *Laterality*, 2, 81-89.

### A TEST TO EVALUATE SPORT SPECIFIC ABILITIES OF INTELLECTUALLY DISABLED ELITE ROWERS.

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A test to evaluate sport specific abilities of intellectually disabled elite rowers. Varalda C1, Grizzetti P1, Capranica L2, Piacentini MF2. Italian Rowing Federation, Rome, Italy 2 DISMUS, University of Rome Foro Italico, Italy Introduction Only three sports will include athletes with an intellectual disability (ID) in the 2012 Paralympic games while rowers with ID should be included in the 2016 Paralympic Games. Due to the fact that intellectual disability of athletes is measured on the basis of an internationally recognized IQ test (www.inas.org), the purpose of the present study is to propose a novel rowing test (Varalda Adapttest) to evaluate sport specific abilities of intellectually disabled rowers. Methods Thirty-four (F:17, M:17; age: 24±10yr) adapted and 5 elite (F:2, M:3) rowers performed the Varalda Adapttest, which includes three 1-min steps at a 28, 32, and 28n/min stroke cadence, respectively. Variability in stroke cadence and acceleration (i.e. range and delta between peak and average values) were measured by means of an accelerometer (Free Sense, Sensorize, Italy) positioned on the ergometer seat. A 2 (groups)x 2 (gender) x3 (steps) ANOVA for repeated measures was used to ascertain differences ( $p<0.05$ ). Results For stroke cadence, 59% of the adapted rowers failed to maintain the requested stroke cadence during the 1st step, 53% during the 2nd and 50% during the 3rd steps respectively. Regarding acceleration, differences ( $p=0.002$ ) for range emerged between groups (elite  $2.04\pm1.70$  m/s<sup>2</sup> adaptive  $1.92\pm0.75$ m/s<sup>2</sup>). Between steps only the elite showed significant differences between the first ( $3.25\pm1.05$  m/s<sup>2</sup>) and the other 2 steps ( $1.98\pm2$  m/s<sup>2</sup> and  $1.99\pm1.50$  m/s<sup>2</sup> respectively). Delta acceleration was constant ( $0.48\pm0.2$  m/s<sup>2</sup>) for adapted athletes, whereas elite rowers showed significantly higher values during the 1st step ( $0.5\pm0.2$ m/s<sup>2</sup>) with respect to the following ones ( $0.28\pm0.08$ m/s<sup>2</sup> and  $0.23\pm0.18$ m/s<sup>2</sup> respectively). Discussion Adapted rowers show a high variability in rowing cadence and acceleration. In fact, more than half of these athletes were unable to observe the required cadences. These findings support the use of the Varalda Adapttest for classifying athletes with intellectual disabilities on the basis of their sport specific abilities. Acknowledgments: We would like to thank Sensorize, Italy

### WHEELCHAIR DANCE SPORT: PHYSICAL AND SOCIAL CHANGES FOR PEOPLE WITH PHYSICAL DISABILITIES

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This study focuses on wheelchair dance sport for people with physical disabilities. It is a modality in expansion in Brazil and in the world, with several national and international tournaments. The aims of this research are: a) to find out the senses of dance for people with physical disabilities, b) to understand the contribution of wheelchair dance sport for the group studied, c) to understand the role of wheelchair dance as a possibility to physical and social changes. METHOD. The method was done through qualitative research, with the wheelchair dancer groups associated to the Brazilian Confederation of Wheelchair Dance. The information was obtained through choreography video archives from different regions of Brazil. Furthermore, it was carried out formal interviews with dancers and choreographers of these groups during their presentations in the national events, from the years of 2001 to 2010. RESULTS AND CONCLUSIONS The wheelchair dance sport gives new perspectives of life for the studied group. They perceive an improvement in health and in social relationship. The dance permits the exercise of citizenship and gives a place where the disabled dancer uses its subjectivity and builds up his identification. There has been an attempt to overcome the individual ethics put by the dance into a more cohesive ethics. Hence, this research brings essential contributions for understanding dance in a wheelchair to the physically handicapped person, and in return contributes to a better understanding of what is the dance in itself. It indicates dance as an instrument of non-verbal language that allows the understanding of the communicability of the senses meant by the body.

### THE IMPORTANCE OF MOTOR STIMULATION WITH SPECIFIC MEANS OF PHYSICAL EDUCATION AND SPORT APPLIED TO THE CHILD WITH SEVERE MENTAL DISABILITY

SUTA, V.E.N.2, MARINESCU, G.1, BALAN, V.1, PETRISOR, L.1, TICALA, L.1, PAUNESCU, M.1, DUMANGIU, M.1, TATARU, T.1, SUTA, L.I.2

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THE IMPORTANCE OF MOTOR STIMULATION WITH SPECIFIC MEANS OF PHYSICAL EDUCATION AND SPORT APPLIED TO THE CHILD WITH SEVERE MENTAL DISABILITY Suta, V.E.N.2, Marinescu, Gh.1, Balan, V.1, Chesnoiu, L.1, Ticala, L.1, Paunescu, M.1, Dumangiu, M.1, Tataru, T.1, Suta, L.I.2 1: UNEFS (Bucharest, Romania), 2: Special School no. 11 (Bucharest, Romania) Introduction The research aims to demonstrate that the students with severe mental disability can enhance their movement ability, through the development and implementation of a motor stimulation program, with the duration of a school year, adapted to the biometrical potential of these students. Methods The reference study, the test method and statistical - mathematical data processing methods were used to carry out the research. The biomotor standardized tests used to evaluate the subjects were The Biomotor Potential of the Romanian School Population, the Brockport Test Battery, the Motorin Test and the Flamingo Balance Test of Eurofit Test Battery. To process the collected data we used a statistical mathematical program called SPSS 16 for Windows and we chose to apply Wilcoxon Test as well as the effect of the size index on two identical samples, reporting ourselves to a significance level of  $p<0.05$ . Results After we implemented the intervention program during the school year 2009 - 2010 there were significant statistical differences between the values obtained at the initial evaluation and the final evaluation for the tests aiming the arm and leg coordination, overall coordination and balance. All the students with severe mental deficiency involved in the program have obtained better values to the tests which targeted the coordination skills. At the end of the stimulation program, students with severe mental disability and an IQ between 40 and 49 who have used specific means of the aerobic gymnastics obtained an improved level of the motor conditional quality endurance. Discussion In conclusion, students with severe mental disability are a category of subjects who can be educated in terms of motor performance. We propose the introduction in the Romanian curriculum of a minimum of three weekly Physical Education lessons for the students with severe mental deficiency. Also, Physical Education lessons should be carried out with groups of students with a close motor potential and level of understanding. The annual design and planning of the curriculum should start from the biometrical potential diagnosed on the initial evaluation and the stimulation program needs to address the poor components of the motor ability. References Marinescu Gh. (1998). Copiii si performanta in inot, Institutul National de Informare si Documentare, 174-232 Winnick J.P., Short F.X. (2005). Adapted Physical Education and Sport, Fourth Edition, Human Kinetics, 55-155. Winnick J.P., Short F.X. (1995). The Brockport Physical Fitness Test Manual, A Health-Related Test for Youths with Physical and Mental Disabilities, Human Kinetics, 74-111.

## LEARNING A DYNAMIC BALANCE TASK EVEN THOUGH SUFFERING FROM PARKINSON'S DISEASE WITHIN AN OBSERVATION PERIOD OF 6 WEEKS

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**Introduction** Retaining the mobility is a main keyfactor to keep a good quality of life up to an old age. A proper dynamic balance plays an important role in this. Postural instability is one of the main symptoms by patients with Parkinson's disease (PD) (Visser & Bloem, 2005). The aim of the study is to evaluate firstly if it's possible for affected patients (PD) to learn and stabilize a dynamic balance task and secondly how strong can they improve in comparison to a coeval control group. **Methods** Seven PD-patients (1♀; 6♂; age M=62,71; SD=5,21) and fifteen coeval controls (6♀; 9♂; Alter M=65,2; SD=6,38) were involved in the study. Both groups were confronted with a pendalons stabilometer platform task over a period of time of six weeks (one session per week). Each training session consists of 15 repetitions, 30 seconds each with two-minutes breaks. The participants had to deal with the challenge to balance a free-running (in a plane) pendalons stabilometer platform as long as possible for max. 30 seconds within a predetermined interval of 5 °. The time in balance (TBL) has been measured. The overall kinematic parameters of the board movement were counted up (acceleration and deceleration profile of the deflection of the platform) to measure the deflection in total for further analysis purposes. The general linear model with repeated measures with the within-subject factors of training days and group affiliation were chosen as statistical approaches. **Results** Both groups showed significant improvements in the TBL throughout the learning process (PD patients: M1=8.11s, SD1=1.56s; M6=11.02s; SD6=3.50s; controls: M1=10.56s; SD1=3.59s; M6=16.53s; SD6=6.70s,  $p < 0.05$ , e.g. M1  $\triangleq$  mean training session 1). PD-patients reached a significant lower base level (t1) in comparison to the control-group ( $p < 0.05$ ). Subsequently, the PD-patients were able to keep the balance on average as long as the coeval controls at t1 at final testing (t2). **Discussion** The results are first indicators that the possibility to train motor abilities is given in old adulthood as well as for people suffering from Parkinson's disease. **References** Visser, JE, Bloem, BR (2005). Neural Plasticity, 12 (1-2), 161-174.

## THE COMPARATIVE DAILY PHYSICAL ACTIVITY BETWEEN MENTALLY CHALLENGED BOYS AND HIGH SCHOOL BOYS IN JAPAN

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**Introduction** Previous studies have indicated that mentally challenged children have low physical fitness levels, with the main factor being that they do not have an adequate amount of physical activity in their daily lives. But actually there has not been much research about this within Japan. The aim of our study is to illustrate the condition of physical activity in mentally challenged children in Japan. In this first step, we have measured the quantity of daily physical activity in mentally challenged students and compared it with students who go to regular high school. **Results** The subjects of this study are 7 boys who go to a special needs education school for the mentally challenged (S-group) and 8 boys who go to regular high school (H-group) in Japan. We measured their quantity of physical activity by a pedometer (Lifecorder) for 2 weeks, and compared weekdays and weekends of physical activity between S-group and H-group. On weekdays, there was no significant difference in physical activity in the number of steps ( $9749 \pm 2457$  vs  $9116 \pm 4338$ ), walking times ( $86.6 \pm 24.9$  vs  $84.3 \pm 37.8$ ), running times ( $8.8 \pm 4.8$  vs  $7.0 \pm 6.1$ ). On weekends, S-group's physical activity was significantly lower than H-group in the number of steps ( $4928 \pm 2373$  vs  $10696 \pm 4798$ ,  $p < 0.05$ ), walking times ( $48.4 \pm 21.6$  vs  $99.7 \pm 49.0$ ,  $p < 0.05$ ), running times ( $0.8 \pm 0.5$  vs  $10.4 \pm 4.0$ ,  $p < 0.001$ ). **Discussion** It is said that mentally challenged children are inactive in their daily lives, but in our study, there was no significant difference between mentally challenged children and high school students in their physical activity from Monday to Friday. This is due in part to a difference in the curriculum for students with special needs. Specifically, there are 4 physical education classes a week in schools for special needs. On the other hand, there are only 2 classes a week in high school. However, mentally challenged students performed much lower physical activity than the high school students on weekends. It is important to support the maintenance of children's physical activity on weekends and especially long holidays like during summer vacation. This support should be in cooperation with teachers and family in order to prevent decline in the student's physical strength and weight gain. After leaving school it will be necessary for students to maintain a certain amount of physical activity to keep being healthy. Therefore, we must use their schooling years to develop healthy routines that will last throughout their lives.

## PHYSICAL EDUCATION TEACHERS' PERCEPTIONS OF AND ATTITUDES TOWARDS PUPILS WITH SPECIAL EDUCATIONAL NEEDS

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**Introduction** The aim of this study is to gain deeper insight into physical education teachers' perception of their pedagogical strategies when working with pupils with special educational needs (SEN), a concept that in this context encompasses both disabled pupils and those with behavioural disorders. To this end, we examined the attitudes and opinions of a sector of physical education teachers employed at secondary schools in Barcelona (Spain). **Methods** The sample was obtained from the population of physical education teachers at secondary schools in the province of Barcelona (N=339), the total sample amounting to N=57. The questionnaire on which the study was based was formulated by a team of experts in the field. The questions were grouped into three categories: characteristics of the teachers; teachers' pedagogical strategies; and external factors. The questionnaire, once administered and validated (N=45), was shown to have a reliability range of between 0.85 and 0.90. **Results** The literature reviews showed consistent evidence for the direct relationship between different items studied. The analysis of and conclusion drawn from the results present the variables that the teachers regarded as important when it comes to improving attitudes to the integration of such pupils into the educational system. **Discussion** The qualities teachers require to work with SEN pupils are empathy, patience, a sense of ethics and educational experience. Integration of such pupils is favoured and reinforced firstly by flexible grouping and secondly by group splitting and adaptation of curricula. As a complementary factor, adapted facilities, materials and hygiene services foster SEN pupils' participation in activities on an equal footing with the rest of their classmates. **References** Avramidis, E. and Kalyva, E. (2007), "The Influence of Teaching Experience and Professional Development on Greek Teachers' Attitudes towards Inclusion". *European Journal of Special Needs Education*, 22, pp. 367-389. Bryant, L. G. and Curtner-Smith, M. D. (2008), "Impact of a Physical Education Teacher's Disability on Elementary Pupils. Perceptions of Effectiveness and Learning". *Adapted Physical Activity Quarterly*, 25, p. 118. Kudláček, M. (2007), "Components of Attitudes toward Inclusion of Students with Physical

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## Poster presentations

### PP-PM22 Physical Activity Promotion and Assessment

#### DIMENSIONS OF PHYSICAL ACTIVITY EXPECTATIONS: IMPLICATIONS FOR DESIGNING AND MARKETING EXERCISE

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Introduction: Gyms, swimming pools and clubs are selected by many individuals as the place where to practice physical exercise. Normally exercise program providers are privately-held businesses, which success depends on satisfying their customers. Knowing what their customers expect from the practice of exercise allows exercise programs providers to design more motivating exercise programs (Peterson et al., 2006). Therefore, the aim of this study was to determine major motivation factors to be physically active, and to assess the perceived relative importance of these motivation factors. Methods: The study included 745 individuals (35.0±19.6 years). A survey designed to assess the expectations of individuals when doing exercise, on interview form, using Likert scales (1-5). A principal components analysis was performed, and descriptive statistics of the components computed, which were compared using paired samples t-tests. Results: Kaiser-Meyer-Olkin was 0.84, Bartlett's test of sphericity was significant, and the Measures of Sampling Adequacy of the original variables were all above 0.67. Four components were extracted using Varimax rotation, explaining 71% of total variance. First component represents Performance (21% of variance), the second Enjoyment (20%), the third Beauty (15%), and the fourth Health (15%). Health has the highest mean (4.45) and the lowest standard deviation (0.73), followed by Enjoyment with 3.63 (0.91), Performance with 3.38 (0.97), and finally Beauty 2.89 (1.31). Beauty is the only factor with "negative" mean, below 3, the indifference point. All means are statistically different ( $p < 0.05$ ) from each other. Discussion: When design and marketing their exercise programs, exercise programs providers should take into consideration that the most important factor for individuals is Health. These results suggested that programs should seek and show important health benefits for participants, according Mears and Kilpatrick (2008). But also very important is Enjoyment. Exercise programs providers should have fun programs that enhance socializing between participants. Beauty reasons are less important in general. Nevertheless one should note that the large standard deviation indicates that individuals are very different in what respects to the Beauty aspects of exercise practice. There may be a niche market for individuals who value Beauty. References: -Mears, J & Kilpatrick, M (2008). Motivation for exercise: Applying Theory to Make a Difference in Adoption and Adherence. ACSM's Health & Fitness Journal, 12 (1) pp 20-26. -Peterson, J., Tharret, S. & Bryant, C. (2006). Health and Fitness Programs Development and Operation. In ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription. 5th ed., Lippincott Williams & Wilkins.

#### THE POSSIBILITY TO MONITOR PEAK PERFORMANCE WITH AN ONLINE TRAINING DIARY: A CASE STUDY

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The possibility to monitor peak performance with an online training diary: a case study Piacentini MF1, Di Castro A1 De Ioannon G1 Capranica L1 Meeusen R2 IDISMUS, IUSM, Rome Italy 2Dpt of Human Physiology, VUB, Belgium Triathlon is a multidiscipline endurance sport with a sequential swim, cycle, and run phases. Monitoring multidiscipline sports is complex. The use of online training diaries has been used in the prevention of non functional overreaching-NFOR (Piacentini et al. 2008, 2009) by monitoring subjective parameters of training (BLITS®) but never used to predict peak performance in athletes. Therefore, the purpose of the present study was to monitor 10 weeks of training of an elite triathlete prior to an important competition. Methods A female elite triathlete (23 yrs) filled in an online training diary (BLITS®) for 10 weeks, and a weekly Profile of Mood states (POMS). Subjective data regarding training are reported on a 10 cm visual analogue scale (VAS). Quantification of, and adaptation to training were measured by training load (TL: intensity x duration), monotony of training (day by day variability in training), and strain (load x monotony). Moreover, we visualized with only one parameter the subjective response to training (BLITS®). During these 10 weeks the athlete competed mainly in duathlon races (run-cycle-run). Performance was evaluated by a 2x2km time trial (95-100% lactate threshold speed) during a combined cycle-run training. RESULTS Performance significantly increased (from an average of 8'12"50 to 7'39"50 in the 2x2km test) in the 10-week period. Total mood improved by 17% over the whole period. POMS subscales showed a decrease in depression (-33%), tension (-42%) and anger (-20%) and an increase in fatigue (15%) and vigor (6%). Motivation to train increased by 39% from the first to the 10th week of training. Strain increased significantly after 3 weeks of intensive training (by 119%) and thereafter started to decrease while TL remained constant. BLITS® showed an increase (23% at week 6) and thereafter decreased by 100% the week before competition. DISCUSSION A steady increase in BLITS® indicates maladaptive responses to training, extreme fatigue and negative mood. In the present study, BLITS® decreased by 100% the week prior to competition, indicating a positive adaptation to training, and a decrease in total mood. Strain increased until the 3rd week and thereafter started to decrease despite the TL remained constant. This suggests that monotony of training decreased, data supported by the high motivation to train the athlete demonstrated. These data indicate that the use of the BLITS® online training diary is a valuable tool also for predicting peak performance. REFERENCES Piacentini MF et al ECSS 2008 pg 300 Piacentini MF et al. ECSS 2009 pg 227

#### A COMPARISON OF VISUAL ANALOGUE SCALE MEASURES IN FREE-LIVING, WEIGHT-LOSING ADOLESCENTS.

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Lauren C Duckworth<sup>1</sup>, Roderick FGJ King<sup>1</sup>, Andrew J Hill<sup>2</sup> and Paul J Gately<sup>1</sup>. <sup>1</sup>Carnegie Faculty, Leeds Metropolitan University, Fairfax Hall, Headingley Campus, Leeds, UK. <sup>2</sup>Academic Unit of Psychiatry and Behavioural Sciences, Leeds University School of Medicine, UK. Introduction: The use of visual analogue scales (VAS) has been established for the quantitative measurement of subjective experiences in both exercise and nutrition intervention studies. Collecting data at several time points to produce a temporal profile can provide information on appetite in response to a pre-load, meal or diet/exercise intervention programme. In addition, the increasing cost-effectiveness and reliability of hand-held computers has encouraged the development of electronic rating systems. The aim of this study was to compare the type and timing of ratings of appetite and mood in free-living overweight and obese children attending a residential weight-loss

camp. Methods: Participants: 44 overweight and obese children (BMI  $34.3 \pm 5.7$  kg/m<sup>2</sup>, age  $14.5 \pm 1.8$  years). Intervention: An eight-week (max) programme of physical activity, reduced-energy intake and behaviour change education. Assessments: Participants completed the two types of assessment at the beginning and end of their camp stay. Across-the-day ratings were made before and after each meal and at two hours post meal (9 timepoints) using a hand-held electronic rating system. These ratings were averaged to provide a single score for comparison. End-of-day ratings were paper questionnaires measured using a 0-100mm scale. Results: All end-of-day ratings correlated significantly with across-the-day ratings at both pre ( $r=0.32-0.74$ ) and post ( $r=0.31-0.73$ ) camp. However, there were significant differences between measurement tools with mean values for across-the-day ratings showing a narrower range than end-of-day ratings (68mm vs. 96mm respectively;  $p<0.05$ ). In assessing pre-meal ratings: hunger and desire to eat showed a moderate increase across the day and fullness decreased; a pattern which had disappeared by the end of camp. Discussion: These findings show the merits of both assessment approaches in a free-living environment. Across-the-day ratings are relatively labour intensive but provide detailed profiles of appetite/mood that vary meaningfully over the waking hours. End-of-day ratings are simple to administer, describe overviews of appetite/mood that can be collected prospectively, and are as sensitive as averaged across-the-day ratings. Inter-changeable use of these approaches however is not advised given differences in precision at rating scale end-points.

#### RELATIONSHIP AMONG PHYSICAL ACTIVITY AND EPICARDIAL ADIPOSE TISSUE IN POST-MENOPAUSE.

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Introduction Epicardial adipose tissue (EAT) is the fat deposited under the visceral layer of pericardium and may be considered as ectopic fat. Studies suggest that visceral adipose tissue and EAT have the same origin, and both are strongly related to the development of coronary artery disease. Sedentary lifestyle promotes the storage of ectopic adipose tissue whereas high physical activity (PA) level prevent its accumulation. PA may be expressed as metabolic equivalents (METs) or Steps and ACSM guidelines recommend 10.000 steps per day to be active, for most healthy adults. Aim of the study was to investigate the relationships between main parameters of PA and EAT, in sedentary post-menopausal women. Methods Fifty-five post-menopausal women ( $57.4 \pm 4.7$  years) without history of physical exercise and cardiovascular diseases were recruited after initial screening including medical history. EAT was measured by echocardiography. Total daily energy expenditure (TEE), mean daily PA intensity, daily steps, and both daily time and daily energy spent on PA with intensity  $>3$  METs were measured by the SenseWear Pro 3 Armband. Physical activity level was calculated as the TEE/basal metabolic rate ratio. Own software calculated the daily steps spent above and below the intensity of 3 METs (steps  $>3$  and steps  $<3$ , respectively). Cardiovascular risk (CVR) was calculated by "PROGETTO CUORE" equation. Results Steps  $>3$  was inversely correlated with EAT independently steps  $<3$  ( $r=-0.279$ ,  $p=0.04$ ,  $r=-0.438$ ,  $p=0.01$ , semi-partial and zero order correlation respectively). No correlation was found among EAT and the other parameters of PA. Further, there was a direct correlation between EAT and CVR ( $r= -0.403$ ,  $p<0.001$ ). Conclusion In post-menopause active lifestyle is the way to prevent the storage of EAT and then CVR. In particular the quantity of PA above a specific intensity, expressed as steps  $>3$ , might plays a central role.

#### IS UNIVERSITY A GOOD ENVIRONMENT FOR PHYSICAL ACTIVITY?

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Ruiz, G.1, De-Vicente, E.2, Vegara, J.2 1: UCM (Madrid, Spain), 2: UCAM (Murcia, Spain). Introduction Physical activity (PA) is considered a fundamental link by the World Health Organization for control of non-communicable diseases (World Health Organization, 2004). Workplace is recognized internationally as a framework for the study and promotion of health (Boslaugh, Kreuter, Weaver, Naleid, & Brownson, 2005). The aim of this study is to quantify, using pedometers, PA levels in different professional layers of a university campus. Methods The sample is composed by 77 participants (19-50 years old) recruited from 4 groups on a Spanish University Campus: students ( $n=33$ ), teachers ( $n=17$ ), administrative officers ( $n=13$ ) and cleaning staff ( $n=14$ ). Yamax Digi-Walker, sw.630 model was the instrument used to record steps for four consecutive days (from Thursday to Sunday). The instrument and time period selected have been established as valid in scientific literature (Kang, et al., 2009). Results The results show a characteristic pattern common to all strata, determined by the decrease of PA during the weekends. Cleaning staff is the most active group in working days ( $p<.05$ ). No PA differences were found comparing groups (students plus professors together) belonging to different areas of study (Sport Sciences vs. Architecture and Engineering), but analyzing Sport Science students separately, they were found to be the most active in teaching hours. ( $p<.05$ ). Except for the administration sector, the other groups are meeting the daily recommendations of PA according to the steps. Discussion Comparing our data with Tudor and Bassett's study (Tudor-Locke & Bassett, 2004), the university sample described can be considered as very active ( $>12.500$  daily steps). Depending on the day (working day or weekend), similar results were found in other studies (Miller & Brown, 2004; Ruiz, Salinero, Webster, & Aznar, 2006), in whom PA was higher in working days. References Boslaugh, S., Kreuter, M., Weaver, N., Naleid, K., & Brownson, R. (2005). Misclassification of Physical Activity Level Due to Exclusion of Workplace Activity. *Measurement in Physical Education & Exercise Science*, 9(1), 21-34. Kang, M., Bassett, D. R., Barreira, T. V., Tudor-Locke, C., Ainsworth, B., Reis, J. P., et al. (2009). How many days are enough? a study of 365 days of pedometer monitoring. *Research Quarterly for Exercise and Sport*, 80(3), 445 - 453. Miller, R., & Brown, W. (2004). Steps and sitting in a working population. *Int Jorunal of Behavioral Medicine*, 11(4), 219-224. Ruiz, G., Salinero, J. J., Webster, A. L., & Aznar, S. (2006). Measurement of physical activity levels of workers on a spanish university campus using accelerometer technology. *Journal of Human Movement Studies*, 51(5), 321 - 335. Tudor-Locke, C., & Bassett, D. R. (2004). How many steps/day are enough? preliminary pedometer indices for public health. *Sports Medicine*, 34(1), 1 - 8. World Health Organization. (2004). *Global strategy on diet, physical activity and health*. Geneva: WHO.

#### BARRIERS AND FACILITATORS FOR THE REGULAR PRACTICE OF PHYSICAL ACTIVITY IN WHITE AND PAKISTANI TODDLERS

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BARRIERS AND FACILITATORS FOR THE REGULAR PRACTICE OF PHYSICAL ACTIVITY IN WHITE AND PAKISTANI TODDLERS Costa S.1, Clemes S.1, Barber S.2, Akhtar S.2, Varela-Silva M.I.1, Griffiths P.1, Cameron N.1 1: Loughborough University (UK), 2: Born in Bradford Cohort Study (UK) Introduction Childhood obesity is a worldwide public health problem. Regular physical activity (PA) is protective against numerous

chronic diseases, while time spent in sedentary behaviours (SB) is considered an independent risk factor for many illnesses. UK South Asians are at higher risk for several chronic diseases, and are also reported as less active than Whites (Fischbacher et al, 2004). The preschool age is considered a crucial period of life for the establishment of lifestyle behaviours such as PA and SB. Research has cited various personal (personality), interpersonal (parents' lack of time), and organizational (childcare activities) or community (neighbourhood safety) influences on young children's PA (Dwyer et al, 2008). In order to design policies and interventions targeting PA and SB in young children, knowledge of the facilitators and barriers for the practice of PA is vital. The aim of this research was to assess barriers and facilitators for the regular practice of PA in an ongoing study of White and Pakistani toddlers from Bradford. Methods Five focus groups (N= 3 to 6 per group) were performed to date with White and Pakistani mothers of 2-3 year olds, at Children's Centres (CC) that offer local support for families of children under 5 years of age (e.g. childcare; early education). The focus groups were conducted in English or Urdu. Audio recordings were transcribed verbatim and analysed following a Thematic Analysis approach. Results Across all focus groups, lack of time and high cost of activities were the main barriers identified by mothers to take the toddlers to activities available in the community. A need to take transport to activities and bad weather (Winter) were also identified as major barriers, the latter being mentioned more strongly by Pakistanis. Free of charge activities, available crèche/babysitter and someone to help during activities were reported as the main facilitators. Furthermore, playgroups available at CC were highly valued and regularly attended by all mothers. Discussion Main reported barriers represent interpersonal, organizational and community factors, with little variation between ethnicities. Playgroups available at CC have great potential as an intervention tool targeting both mothers and toddlers' PA, as they address many of the reported barriers. Additionally, CC are already part of these mothers' routines, reducing additional burdens and risk of mistrust from the mothers, especially Pakistanis (Bhopal, 1998). References Fischbacher C.M., Hunt S., Alexander L. (2004) *J Public Health (Oxf)*, 26, 250-8 Dwyer J., Needham L., Hardy L.L., Baur L.A. (2008) *Appl Physiol Nutr Metab*, 33, 338-346 Bhopal K. (1998) *J Gender Stud*, 7(2), 143-156

### THE RELATIONSHIP OF PARTICIPATION MOTIVATION TO FITNESS IN CHILDREN AGED 9 AND 10 YRS

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**Introduction** Since low level of fitness, associated with childhood obesity, is a major public health concern there is growing interest in all of the factors which could influence children's participation in exercise. Motivation for exercise is recently among the most important ones. We tried to establish the relationships between different levels of motor fitness and intrinsic motivation in children aged 9 and 10 yrs. **Methods** Seventy sixth children aged 9 and 10 yrs participated in study. Motor fitness was assessed using the 6 motor, 1 functional and 5 anthropometry tasks. Body mass index as well as sum of skinfolds were also calculated. Intrinsic motivation was evaluated with the Participation Motives Inventory (PMI; Gill et al., 1983). Fitness scores were standardized and summarized in overall motor score, based on that score children were further divided into low, average and high ability group. Differences according to gender were established in both domains. Cronbach ALPHA was calculated to establish the consistency of PMI scales. ANOVA were used to determine the differences in motivation for participation between low, average and high motor ability groups. Results Children differentiated by gender in three motor and one functional test in favor of boys. There was also differences in motive subscales "team" and "skill/mastery" – in both boys scored higher. Overall children scored higher in subscales "skill/mastery", "avoidance of boredom", "achievement" and "team". ANOVA established differences between low, average and high motor ability groups in participation motivation. Namely, low and average groups scored the same but high ability groups showed significantly higher values in "skill/mastery" ( $F=4.64$ ;  $p=.01$ ), "fitness" ( $F=4.78$ ;  $p=.01$ ), and "team" ( $F=4.11$ ;  $p=.02$ ) subscales. In high ability group BMI was significantly lower than in other groups. Cronbach ALPHA coefficients were rather low and ranged from .31 to .66. **Discussion** The results indicate that to have fun was not the only reason for participation in exercise. Although rankings varied all three groups identified similar motives for participation. Children with better fitness performance showed higher motives for participation than children with lower fitness scores. References Gill, D., Gross, J., & Huddleston, S. (1983). Participation Motivation in Youth Sports. *Int Jour of Sp Psych*, 14, 1-14.

### ATTITUDES TOWARD PHYSICAL EDUCATION OF ALBANIAN SECONDARY SCHOOL STUDENTS

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**Abstract** ATTITUDES TOWARD PHYSICAL EDUCATION OF ALBANIAN SECONDARY SCHOOLS STUDENTS Lalazi, Y.1, Lile, A.1, Rizvanolli, V.1, 1: UST (Tirana, Albania) **Introduction** The goal of this study was to investigate attitudes toward physical education preferences in Albanian secondary high school students. Several studies (Colley, & Berman, & Millingen, 2005; Wersch, & Trew, & Turner 1992) reported that high school boys had a higher positive attitude toward PE compared to girls. **Methods** Participants of this study consisted of 197 students from seven and eight secondary general schools of Tirana, Albania. In The participants were 102 girls ( $M = 12.69 \pm 0.79$ ) and 95 boys ( $M = 12.64 \pm 0.71$ ) aged 12 to 14. An instrument of the Attitude Toward PE Scale for Albanian students with 12 items with 5-point Likert-type scales was developed. Statistical analysis was performed using the SPSS package for windows, version 17.0. Analyses of Variance (ANOVA) was used to determine differences in attitude toward PE between girls and boys. Results The alpha reliability coefficient of the Attitude Toward PE Scale developed was .78 indicating that the instrument was reliable. 91% of students have positive attitude toward sport leisure, 36% where participants in the school team or school sports events, 87% were satisfied from the PE class, 37% stated that tools and equipments were not sufficient etc. The PE attitude mean scores of boys ( $M = 3.98$ ) were higher than those of girls ( $M = 2.99$ ). Results revealed a significant gender difference in high school students attitudes toward PE ( $F = 29.869$ ;  $p < 0.01$ ). **Discussion** Results of this study indicated that Physical education course syllabus should be enhanced in order to enable students to obtain necessary skills and attitudes for a healthy life style. Findings of this study had also shown that there was a significant difference related to gender, where boys have more positive attitudes toward PE class and leisure activities than girls. References Colley, A., Berman, E. & Van Millingen, L. (2005) Age and Gender Differences in Young People's Perceptions of Sport Participants, *Journal of Applied Social Psychology*, 35 (7), 1440-1454. Van Wersch A, Trew K, Turner I. (1992). Post-primary school pupil's interest in physical education: age and gender differences. *Br J Educ Psychol*. Feb;62, 56-72

## PHYSICAL ACTIVITY LEVELS AND DETERMINANTS TO PRACTICE ACCORDING TO AGE IN GIRLS THAT ATTENDED PORTUGUESE PUBLIC SCHOOLS

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**Introduction:** The percentage of children and adolescents presenting low levels of physical activity (PA) is cause for great concern, and girls are a group with particular risk of inactivity. **Objective:** This study aimed to examine the relationship between perception of competence, goal orientation, attitude towards school and Physical Education (PE), PA participation, and the ages of girls that attended Portuguese public schools. **Methods:** A total of 2270 girls, aged from 10 to 18, participated in the study. They attended 6 Basic and Secondary schools from 5th to 12th grade. The girls were separated into 3 groups according to their age: 10 to 12 (1071 girls – 47.2%), 13 to 15 (753 girls – 33.2%) and 16 to 18 (446 girls – 19.6%). Data was collected using a questionnaire. ANOVA was used to analyse the effect of age in the attitude towards school. Kruskal-Wallis was used to analyse the effect of attitude towards PE, perception of competence, goal orientation and PA participation according to age. Significance level was  $p < 0.05$ . **Results:** The perception of competence decreased with age and significant differences were found between all age groups ( $X^2KW(2)=19.092$ ,  $p < 0.001$ ). The same trend was observed concerning ego orientation, with significant differences between all groups ( $X^2KW(2)=56.970$ ,  $p < 0.001$ ). As for the task orientation the average value increased from 10-12 years to 16-18 years. Kruskal-Wallis revealed that the youngsters differed from the others ( $X^2KW(2)=10.806$ ,  $p=0.005$ ). Regarding subjects' attitudes, 58% and 70 % of the girls showed a positive attitude both toward school and PE. In the first case, ANOVA showed no significant differences between the groups ( $F(2,1267)=0.711$ ,  $p=0.491$ ). However, we observed that their attitude towards PE had decreasing tendency, with significant differences between all groups ( $X^2KW(2)=75.717$ ,  $p < 0.001$ ). Concerning informal and formal PA participation, respectively, 47% and 23% of the girls have reported to practice every week or every day. Nevertheless, an accentuated decrease was observed as the age increased, presenting the 16-18 years group the lower values for PA participation. Through comparative analysis among age-groups, there were significant differences in informal participation ( $X^2KW(2)=55.687$ ,  $p < 0.001$ ). **Conclusion:** Low levels of PA participation are particularly marked among adolescent girls, suggesting they are at risk. The low levels of perceived competence and a weak attitude towards PE, seem to explain these results. Schools and PE professionals should be able to build up an educational climate to promote a positive attitude towards PA and encourage activity, considering specific strategies for risk groups.

## INFLUENTIAL FACTORS OF CHOOSING SPORT IN CHILDHOOD

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SEMELWEIS UNIVERSITY FACULTY OF PSYCHICAL EDUCATION

**Introduction** Sport experts are interested in finding out the influential factors of choosing of sports in childhood years. It is important to understand the influences, main components and the key players in the process in order to realize high improvement and success. Swimming is one of the most popular and successful sport in Hungary. Our athletes have great accomplishments at the international level. In the last few decades competitors won medals in almost all the Olympic Games, World Championships and European Championships. This is the main reason why we have chosen swimming for the analyses. From the aspect of competitive sport motivations, success, achievement and aims of athletes seem to be the most deciding factors. The primary aim of this research was to identifying the key factors what affect choosing sport of swimmers. **Methodology** We surveyed 424 (N=424) swimmers through questionnaires. Every athlete is a member of a swimming team and takes part in the Hungarian competition system. 214 men (50.4%) and 210 women (49.6%) were questioned. Their average age was 14.42 years, and based on competition results they were placed in two groups. One of them was (Group I.) when swimmers reached minimum 1st-3rd place in Hungarian National Championship and/or 1-16 places in international age-group competition (European Championship, Word Championship). Group II. consisted of swimmers who could not reach this results so were not successful as elite competitors. The data were analysed by SPSS 16.0. **Results** Results show that a relatively high percentage of swimmers begin swimming for health-related reasons. 43,2% of participations began the sport because of health conscious life styles. The impact of success (13,1%) parents (9,6%) and role of peers (6,3%) were low. There were significant differences between the two groups. Swimmers in Group I. ( $2,93 \pm 1,58$ ) started sport activity for competitive sport more than members of Group II ( $2,42 \pm 1,36$ ). Also, men mentioned ( $2,74 \pm 1,45$ ) that competition play more important role in choosing sport than women ( $2,36 \pm 1,40$ ). In choosing swimming the most influenced factor was the own decision (20,7%) and athletes felt that this sport is the better sport for them (26,9%). Success swimmers ( $2,99 \pm 1,51$ ) wanted to take part in swimming more, than non-success ( $2,49 \pm 1,44$ ). **Conclusion** We can conclude, that in choosing sport there are many influential factors. The role of parents and peers in choosing sport activity are less important than health. Athletes began the sport mostly because of health conscious life styles. The own decision was most influential factor in choosing swimming.

## OBJECTIVE MEASUREMENT OF PHYSICAL ACTIVITY IN SCHOOLCHILDREN WITH ACCELEROMETRY AND HEART RATE MONITORING

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**Purpose** International recommendations encourage children to achieve more than 60 min regular physical activity (PA) per day (U.S. Department of Health & Human Services, 2008). Accelerometers provide objective and valid data of PA, particularly in children. The device Actiheart (CamNTEch, Cambridge, UK) measures acceleration (15 sec epochs) in counts per minute (cpm) in combination with heart rate (HR) monitoring in beats per minute (bpm). On the basis of HR classifications it is possible to record the daily activity levels in a quantitative and qualitative manner over a long period of time. The purpose of the study was to determine how much time children spend in moderate and vigorous PA. **Methods** On a total number of 376 children PA was measured. First analyzed data exist of 100 schoolchildren (7.30 $\pm$ 0.54 yrs; male: 53%). Participants wore the Actiheart for six consecutive days, including two weekend days and weekdays in each case. First and last recording days and individual sleeping time were excluded from analysis. Activity levels were categorized as follows: light = HR<140bpm, moderate = HR>140 and <160bpm, vigorous = HR>160bpm (Armstrong & Welsman, 2006). Data were analyzed by a repeated measure ANOVA. **Results** First analyses including all four days (n=72) reveal that children spent 13.1 hours per day (SD 0.77) in light, 36.4 min per day (SD 16.7) in moderate and 18.6 min per day (SD 11.8) in vigorous intensity. PA was significant higher at weekdays vs. weekend days both in moderate (42.2 $\pm$ 22.4 vs. 30.3 $\pm$ 18.4 min per day;  $p=0.001$ ) and vigorous intensities (23.7 $\pm$ 18.0 vs. 13.9 $\pm$ 13.1 min per day;  $p < 0.001$ ). There was no significant difference between boys and girls being moderate active. But boys achieved more time in vigorous intensity (weekdays: 30.3 $\pm$ 19.0 vs. 17.1 $\pm$ 14.3; weekend: 17.0 $\pm$ 14.1 vs. 10.8 $\pm$ 11.4;  $p=0.003$ ). Interaction



between gender and point in time was not significant. Conclusion Consistent with other research (e.g. Riddoch et al, 2007) children spent more time being active during weekdays and boys were more active than girls. In this population PA of 60 min in moderate and vigorous intensity was only achieved for boys at weekdays. References Armstrong, N & Welsman, JR (2006). The Physical Activity Patterns of European Youth with Reference to Methods of Assessment. *Sports med*, 36(12), 1067-1086. Riddoch, CJ et al (2007). Objective measurement of levels and patterns of physical activity. *Arch Dis Child*, 92, 963-969. U.S. Department of Health & Human Services (2008). Physical Activity Guidelines Advisory Committee Report. Washington, DC.

### FACTORS AFFECTING PRACTICE OF PHYSICAL ACTIVITY AMONG UNIVERSITY STUDENTS

MORENO GÓMEZ, C., TAULER, P., AGUILÓ, A.

UNIVERSITAT DE LES ILLES BALEARS

**Introduction** Regular physical activity is an important contributor for a healthy lifestyle, having both physical and mental significant health benefits. The aim of the study was to assess the socio-demographic and lifestyle determinants of physical activity in a representative sample of students from the University of the Balearic Islands. **Methods** Cross-sectional study on a sample of 987 students enrolled in university studies. Individuals participated in a survey, which collected information on lifestyles, sports habits and eating habits. A multi-nomial logistic regression analysis was conducted to determine which variables determine the practice of sports among the individuals of the sample. **Results** The sample consisted of 45.5% men (mean age  $21.7 \pm 3.4$ ) and 54.5% women (mean age  $21.3 \pm 3.3$ ). The representation of the different studies in the sample was similar to that of the total enrolled throughout the University. 54.0% of the total sample practiced physical activity regularly. The practice of physical activity was significantly associated to males (OR = 2.68, 95% CI=2.07 to 3.48) with a high quality diet (OR =1.58, 95% CI=1.23 to 2.04), and to be non-smokers (OR =1.64, 95% CI=1.26 to 2.13). These associations remained statistically significant after adjustment for various confounding factors. Physically active men were more likely to have a higher BMI, and to spend fewer hours in front of a computer. Physical activity practice was twice more likely among non-smoker males compared to frequent smokers. Men whose mothers had a high educational level were 3 times more likely to be physically active, compared to men with less educated mothers. An older age and less TV viewing was associated with being physically active among women. **Discussion** Results of the study showed that the practice of sports among students at the University of the Balearic Islands was associated with healthy lifestyles such as no smoking and maintaining a balanced diet. This study proves that the promotion of physical activity in this university will not only improve the physical fitness of students but also will contribute to acquire other healthy lifestyles. We have been able to observe even the different socio-economic factors that influence the practice of physical exercise.

### NATIONAL SPORT POLICIES AND PROMOTION OF HEALTH-ENHANCING PHYSICAL ACTIVITY IN THE EUROPEAN UNION

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WORLD HEALTH ORGANIZATION, REGIONAL OFFICE FOR EUROPE

**Introduction** National sport policies are an important framework for government action to increase sport and physical activity levels in the population. However, the potential of the sport sector to foster health-enhancing physical activity (HEPA) remains under-utilized. To better understand how the sport sector can contribute to promote physical activity, a joint WHO / European Commission Directorate General for Education and Culture project on promotion of networking, exchange and greater synergy between sport and HEPA sectors was carried out (NET-SPORT-HEALTH). It includes for the first time a systematic collection and content analysis of national sport promotion policies in Europe. **Methods** To identify national sport policies in the EU countries, an already available overview, targeted internet searches and a call to the 27 EU Sport Directors were used. Non-English documents have been translated. The most recent national and subnational sport policies were selected for analysis. A grid covering key indicators was developed for systematic content analysis based on a previous grid for analysing national policy documents on physical activity (Daugbjerg et. al, 2009). **Results** In total 103 national and subnational documents on sport and physical activity resulted from the search. Twenty-six national and subnational sport policies from 15 countries were included into the content analysis and assessed using the analysis grid. The grid includes general items such as year of publication and issuing body as well as target groups addressed, HEPA related items such as specific goals on sport and health, and inclusion of HEPA recommendations. Preliminary observations show that most of the analysed sport policies do formulate overall goals on health; more detailed results will be presented. **Conclusion** The content analysis will be finalized in March 2010. One of the foreseen outcomes is a policy brief with the aim to inform future policy development and support coherence in national strategies to promote HEPA more effectively. **References** Daugbjerg SB, Kahlmeier K, Racioppi F, Martin-Diener E, Martin B, Oja P, Bull, F. (2009). *Journal of Physical Activity and Health*, 6, 805-817.

### AN ECONOMIC ANALYSIS OF EXTRA TIME: A FOOTBALL ORIENTATED COMMUNITY PROGRAMME USING SOCIAL RETURN ON INVESTMENT

TROTTER, L., RICHARDSON, D., PARNELL, D.

THE FOOTBALL FOUNDATION

**AN ECONOMIC ANALYSIS OF EXTRA TIME: A FOOTBALL ORIENTATED COMMUNITY PROGRAMME USING SOCIAL RETURN ON INVESTMENT (SROI)** Trotter, L1., Richardson, D2., and Parnell, D2. 1The Football Foundation (Registered Charity 1079309), Whittington House, 19-30 Alfred Place, London, WC1E 7EA. 2 The Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, UK. **Introduction** Extra Time (ET) is a national programme that aimed to promote positive physical and social opportunities in older people (over 55 years) and tackle social exclusion (Social Exclusion Unit, 2006). ET was delivered by Football in the Community (FitC) schemes across England. The aim of this research is to present the social and economic impacts of the ET programme. **Methods** Social Return on Investment (SROI) is an adjusted cost-benefit analysis that quantifies the value of social, environmental and economic outcomes that result from a service/programme (NEF, 2004). Individual SROI analyses were carried out on five FitC schemes undergoing in-depth study. Stakeholder (i.e., participants and the state) engagement helped identify the outcomes. The 1st Author employed informal and interactional research techniques (including observations, informal interviews and personal reflections). The identified outcomes were measured via the development of entrance and exit participant surveys. 422 participants, 90% over 60 years old, (41% male and 59% female) completed both the entrance and exit surveys (after approximately 8 month's engagement within the ET, Sept 2009–July 2010). Social and economic analysis was conducted employing SROI methodology, using the aforementioned data to provide evidence-based parameter values for use in the calculations. **Results** Results indicate that the measurable social benefits outweigh the investment by more than 1:5.22. Most

value is created for the participant. Authors are keen to tell the story of the complex measures and data involved and not merely focus on the SROI headline. In this sense, the data collected alludes to the development of positive physical, social and emotional changes in the participants, alongside a self reported reduction in use of health services. Discussion This work is vital in building upon the sparse literature available on SROI. The process was extensive, time consuming and expensive. Whilst this provided invaluable context and data, concerns are raised of the 'pressure' of a positive headline, at a cost to 'telling the story' of complex of positive change experienced by participants involved. References New Economics Foundation (2004). Social Return on Investment: Valuing What Matters: Findings and Recommendations from a Pilot Study. Editors: D. Boyle and M. Murphy. London: New Economics Foundation. Social Exclusion Unit (2006). The Social Exclusion of Older People: Evidence from the First Wave of the English Longitudinal Study of Ageing (ELSA) – Final Report. Retrieved from: <http://www.communities.gov.uk/> on 27th February 2011.

## 15:00 - 16:00

### Poster presentations

#### PP-PM23 Biochemistry 1

##### GLYCOGEN SUPER-COMPENSATION IN THE BRAIN FOLLOWING EXERCISE

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1: UNIVERSITY OF TSUKUBA (TSUKUBA, JAPAN), 2: NIIGATA UNIVERSITY OF HEALTH AND WELFARE (NIIGATA, JAPAN), 3: JSPS RESEARCH FELLOW (TOKYO, JAPAN)

**Introduction** The energy source for the brain is not only blood glucose (Glc) but also glycogen (Gly), the Glc storage molecule in the brain (astrocytes), especially when the Glc supply from blood is inadequate (during hypoglycemia) (Brown, 2004). We found that prolonged exhaustive exercise and the resulting hypoglycemia induces a decrease in Gly in five brain loci (the cortex, hippocampus etc.) (Matsui et al., 2011). However, whether Gly is replenished in the brain following exercise is still uncertain. Gly super-compensation in skeletal muscles following exercise with Glc supplementation is well known (Bergstrom & Hultman, 1966). Here we aimed to clarify whether brain Gly would be super-compensated following exercise. **Methods** Rats were separated into three groups: 50% Glc supplementation (+Glc) after exercise, saline supplementation (+Sal) after exercise, and +Glc after sedentary. The rats were exercised on a treadmill running at 20 m/min until exhaustion. The brain was fixed pre-exercise, immediately after exercise, and 3, 6, and 24 hours after exercise by high-power microwave irradiation (MI), which can momentarily inactivate glycogenolysis enzymes. Following MI, samples from the five brain loci (the cortex, hippocampus etc.), skeletal muscles, and the liver were collected to determine Gly levels. **Results** Gly levels in the skeletal muscles were depleted with exercise, and were super-compensated at 24 hours after exercise with +Glc ( $p < 0.01$ ). Gly levels in five brain loci were significantly decreased with exercise, and followed by super-compensated Gly levels at 6 hours after the onset of exercise with +Glc ( $p < 0.05$ ). Furthermore, Gly levels in the cortex and medulla oblongata were super-compensated 3 hours after exercise with +Glc ( $p < 0.05$ ). Additionally, 6 hours after exercise with +Sal, we found that Gly in four brain loci excluding the hypothalamus were super-compensated ( $p < 0.05$ ). On the other hand, 6 hours after sedentary with +Glc, Gly levels in five brain loci were unchanged, although the Gly levels in the skeletal muscles were significantly increased ( $p < 0.01$ ). **Discussion** We found for the first time that Gly super-compensation could also occur in the brain (the cortex, hippocampus etc.) as well as in muscles, but that it appeared earlier than in muscles. Further, in contrast to skeletal muscles, the Gly super-compensation in the brain was not enhanced with Glc supplementation, suggesting a non insulin-dependent mechanism of Gly super-compensation in the brain. Collectively, it is tempting to propose that storage of glycogen in the brain increases with endurance training, and this might be a new target for central fatigue. **References** Bergstrom J, Hultman E. (1966). *Nature*, 210, 309-310. Brown AM. (2004). *J Neurochem*, 89, 537-552. Matsui T, Soya S, Okamoto M, Ichitani Y, Kawanaka K, Soya H. (2011). *J Physiol*, submitted.

##### TEN WEEKS OF ENDURANCE OR RESISTANCE TRAINING DOES NOT ALTER DESMIN PROTEIN CONTENT.

FARUP, J., KJØLHEDE, T., SØRENSEN, H., DALGAS, U., VISSING, K.

AARHUS UNIVERSITY

**INTRODUCTION** The cytoskeletal protein desmin is of importance for both the passive muscle stiffness and active force production [1, 2]. The few existing studies on long-term training adaptations of desmin protein content in humans suggest that desmin content increases with resistance [3, 4] but not with endurance training [4]. Furthermore a possible relation between fiber type distribution and desmin content [3, 5] has been proposed. However, the literature is still scarce and in need of further high quality studies on desmin protein content adaptations to long-term training. The purpose of this study was to investigate the effects of ten weeks of either resistance or endurance training on muscle desmin content and fiber type distribution. **METHODS** 14 young, untrained men underwent ten weeks of either lower body resistance (RT,  $n = 7$ ) or endurance cycle (END,  $n = 7$ ) training. Muscle biopsies were harvested from m. vastus lateralis before and after training. Assessment of fiber type area distribution and mean fiber cross-sectional area (CSA) was obtained by ATPase histochemistry, and desmin and actin protein content by immunoblotting [3]. Isometric maximal voluntary contraction (MVC) for knee extensors was obtained in a dynamometer. **RESULTS** ANOVA revealed a tendency for an increase in desmin content ( $p = 0.07$ ), but with no change in actin or desmin to actin ratio in either group following training. Histochemical analysis revealed an overall effect (RT and END pooled) of training for the fiber type area distribution with an increase of Type IIa area % from  $31 \pm 3$  to  $39 \pm 3\%$  ( $p < 0.05$ ) and a tendency towards a decrease of Type IIx area % from  $22 \pm 3$  to  $17 \pm 3\%$  ( $p = 0.069$ ). RT increased mean fiber CSA by  $19 \pm 7\%$  ( $p < 0.05$ ) and MVC by  $19 \pm 5\%$  ( $p < 0.001$ ). **DISCUSSION** The results from immunoblotting revealed no effect of training on desmin content or desmin to actin ratio in either training group unlike previous findings [3, 4]. Fiber type changed similarly in both groups as expected [6], while only RT increased mean fiber CSA. Combining the change in fiber type with the lack of change in desmin protein content contradicts that desmin protein content and fiber type are interrelated as previously suggested [3]. **REFERENCES** 1. Balogh J, Li Z, Paulin D, Arner A: *J Muscle Res Cell Motil* (2003), 24 (7):453-459. 2. Shah SB, Su FC, Jordan K, Milner DJ, Friden J, Capetanaki Y, Lieber RL: *J Exp Biol* (2002), 205 (Pt 3):321-325. 3. Woolstenhulme MT, Conlee RK, Drummond MJ, Stites AW, Parcell AC: *J Appl Physiol* (2006), 100 (6):1876-1882. 4. Parcell AC, Woolstenhulme MT, Sawyer RD: *J Strength Cond Res* (2009), 23 (2):359-365. 5. Yu JG, Malm C, Thornell LE: *Histochem Cell Biol* (2002), 118 (1):29-34. 6. Spangenburg EE, Booth FW: *Acta Physiol Scand* (2003), 178 (4):413-424.

## A SINGLE BOUT OF EXERCISE ACTIVATES SKELETAL MUSCLE SATELLITE CELLS DURING SUBSEQUENT OVERNIGHT RECOVERY

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MAASTRICHT UNIVERSITY

A single bout of exercise activates skeletal muscle satellite cells during subsequent overnight recovery Snijders, T.I, Verdijk, L.B.I, Beelen, B.I, Kadi, F.2, van Loon, L.J.C.1 1: Department of Human Movement Sciences, NUTRIM School for Nutrition, Toxicology and Metabolism, Maastricht University Medical Centre+, Maastricht, The Netherlands. 2: School of Health and Medical Sciences, Örebro University, Örebro, Sweden. Introduction Skeletal muscle satellite cell content has been reported to increase following a single bout of exercise. Data on muscle fiber type-specific satellite cell (SC) content and/or SC activation status are presently lacking. Therefore the aim of this study was to determine the impact of a single bout of exercise on skeletal muscle fiber type-specific SC content and activation status following subsequent overnight recovery. METHODS Eight healthy males (age:  $20 \pm 1$  yrs; height  $1.77 \pm 0.03$  m; weight:  $65 \pm 2$  kg) performed a single bout of combined endurance and resistance type exercise. Muscle biopsies were collected before and immediately after exercise, and following 9 h of post-exercise, overnight recovery. Muscle fiber type-specific SC and myonuclear content, and SC activation status were determined by immunohistochemical analyses. SC activation status was assessed by immunohistochemical staining for both FA1 and Ki-67. RESULTS Muscle fiber size and fiber area per nucleus were greater in type II compared with type I muscle fibers ( $P < 0.05$ ). At baseline, no differences were observed in the percentage of SC staining positive for FA1 and/or Ki67 between fiber types. No significant changes were observed in SC content following 9 h of post-exercise recovery. However, the percentage of FA1 positive SC increased significantly during overnight recovery, from  $22 \pm 5$  to  $41 \pm 5\%$  and from  $24 \pm 6$  to  $51 \pm 9\%$  in the type I and II muscle fibers, respectively. No changes were observed in the percentage of Ki-67 positive SC (from  $4 \pm 2$  to  $5 \pm 3\%$  and from  $7 \pm 3$  to  $3 \pm 2\%$  for the type I and type II muscle fibers, respectively). DISCUSSION A single bout of exercise activates both type I and II skeletal muscle fiber SC but does not increase SC content during post-exercise overnight recovery.

## SPRINT MODEL DETERMINES THE SKELETAL MUSCLE SIGNALLING RESPONSE TO EXERCISE

PONCE-GONZÁLEZ, J.G., FUENTES, T., GUERRA, B., MORALES-ÁLAMO, D., GUADALUPE-GRAU, A., OLMEDILLAS, H., RODRÍGUEZ-GARCÍA, L., CHAPINAL, E., FEIJOO, D., PÉREZ, I., MARTÍNEZ, P., CALBET, J.A.L.

UNIVERSITY OF LAS PALMAS DE GRAN CANARIA

Sprint exercise leads to the activation of several signalling cascades, particularly those involved in the regulation of metabolism and the response to cellular stress in the skeletal muscle. Although metabolically isokinetic and isotonic sprint exercise are rather similar, the pattern of neural recruitment is likely different and, hence exercise-induced skeletal muscle signalling could also be different. Purpose. To determine if the pattern of muscle recruitment influences skeletal muscle AMPK, MAPK/ERK and STAT3 phosphorylation during sprint exercise on the cycle ergometer (Wingate test). Methods. Fifteen volunteers (ten men and five women) performed a isokinetic 30-s Wingate test and another twelve (seven men and five women) performed a isotonic 30-s Wingate test. Muscle biopsies were taken before, immediately after the exercise and at 30 and 120 minutes during the recovery period. Results. The ACC and p38MAPK phosphorylation responses were similar, whilst the AMPK, STAT3 and ERK phosphorylation responses were significantly different between the isotonic and isokinetic Wingate tests. ACC phosphorylation increased immediately after and 30 min after the isotonic and isokinetic sprint exercise. Compared to pre-exercise values, Thr172-AMPK $\alpha$  and Thy202/Thy204-ERK1/2 phosphorylation was enhanced by about fourfold 30 min after the isotonic sprint ( $P < 0.01$ ), while it remained unchanged 30 min after the isokinetic Wingate. Compared to the value observed right after the end of the exercise, Thy705-STAT3 phosphorylation was increased 30 minutes after the isotonic Wingate test ( $P < 0.01$ ), being the increase 8-fold higher in the isotonic than in the isokinetic sprint ( $P < 0.01$ ). The mean power developed per kg of lower extremities lean mass was linearly related to the 30 min increase in Thy705-STAT3 phosphorylation ( $r = 0.58$ ,  $P < 0.01$ ). Conclusion. Marked increases in AMPK, STAT3, and ERK phosphorylation were observed after a single isotonic 30s all-out sprint (Wingate test) and in ACC phosphorylation after both isotonic and isokinetic 30s all-out sprint (Wingate test) in the musculus vastus lateralis. Only the magnitude of the STAT3 phosphorylation appeared to be determined by the mean power developed during the sprint exercise after accounting for the active muscle mass, indicating that exercise intensity is a main determinant of the STAT3 phosphorylation in response to sprint exercise. Supported by grants from FUNCIS 10/07 and Ministerio de Educación y Ciencia, Spain (DEP2010-21866).

## INCREASED MUSCULAR DEHYDROEPIANDROSTERONE LEVELS ARE ASSOCIATED WITH IMPROVED HYPERGLYCEMIA IN OBESE RATS

SATO, K., IEMITSU, M., AIZAWA, K., MESAKI, N., FUJITA, S.

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Introduction: Dehydroepiandrosterone (DHEA) is most abundantly localized in blood before it is used by target tissues. We reported acute DHEA administration induces improvement of muscular glucose metabolism signaling (Akt/PKC $\zeta$ /GLUT-4) in streptozotocin induced diabetic rats. Exercise training has also been shown effective in restoring glycemic control and reducing insulin resistance in type 2 diabetes. The molecular mechanisms that govern the effects of long-term DHEA administration on muscular glucose metabolism in obesity and hyperglycemia, however, are still unclear. Purpose: The purpose of this study was to assess the effects of DHEA administration and exercise training on muscular DHEA and 5 $\alpha$ -dehydrotestosterone (DHT) levels and hyperglycemia in diet-induced obese and hyperglycemic rats. Methods: After 14 weeks of a high-sucrose diet, obese male Wistar rats were assigned randomly to one of three 6-week regimens: control, obese DHEA treatment or obese exercise training (running at 25 m/min for 1 hour, 5 days/week) ( $n = 10$  each group). Results: The results indicate that either 6 weeks of DHEA treatment or exercise training significantly attenuated serum insulin and fasting glucose levels compared with the control group. Plasma and muscle concentrations of DHEA and DHT, and expression levels of 5 $\alpha$ -reductase were significantly higher in the obese DHEA-treated and exercise-training groups. Moreover, both DHEA administration and exercise training upregulated GLUT4 translocation with concomitant increases in protein kinase B and protein kinase C- $\zeta$ / $\lambda$  phosphorylation. Muscle DHEA and DHT concentrations closely correlated with blood glucose levels (DHEA treatment:  $r = -0.68$ ,  $P < 0.001$ ; exercise training:  $r = -0.65$ ,  $P < 0.001$ ), serum insulin levels, and activation of the GLUT4-regulated signaling pathway. Conclusion: Thus, it is speculated that increased levels of muscle sex steroids may contribute to improved fasting glucose levels via upregulation of GLUT4-regulated signaling in diet-induced obesity and hyperglycemia.

## THE INTERACTIVE EFFECTS OF EXERCISE TYPE AND AMBIENT TEMPERATURE ON HSP72 IN ACTIVE FEMALES

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**Introduction** Skeletal muscle adapts to the stress of contractile activity via changes in gene expression to yield an increased content of a family of highly conserved cytoprotective proteins known as heat shock proteins (HSPs) (Smuder et al. 2011). We aimed to determine the interactive effects of endurance or weight training in the normal or moderate heat environments on HSP72, the major heat shock protein's response in active young females. **Methods** Forty-five female students were randomly assigned to five groups; endurance training+normal heat (ET+NH), endurance training+moderate heat (ET+MH), weight training+normal heat (WT+NH), weight training+moderate heat (WT+MH) and heat group (HG). The training protocols included running to exhaustion on treadmill at %65-75 V02max in ET groups and 4 sets of eccentric actions of elbow flexors in WT groups in the normal and moderate heat environments. The heat group (HG) only exposed to heat. A sandwich ELISA, enzymatic assay and ELISA were used for determination of HSP72, CK and cortisol values respectively. **Results** The ET and WT, in the moderate heat ambient resulted in an increase in the HSP72, CK and cortisol values, as compared to ET+NH and WT+NH groups and the baseline. The HG group did not demonstrate any considerable changes in these parameters. **Discussion** This research is the first time studying interactive effects of exercise type (concentric vs. eccentric) and ambient temperature (moderate vs. normal) on HSP72 changes in active young females. The data showed endurance and weight training, particularly, in the moderate heat ambient increase the serum HSP72, CK and cortisol values. Furthermore, the HSP72 and CK concentrations significantly increased in the WT+NH group. In summary, exercise training, particularly, training in moderate ambient increased serum HSP72 in the young active females and its magnitude was related to the type of exercise and environment heat. These findings support the theory that the eccentric exercise and exercise-induced body temperature (not passive heating) may be the reason for further increase in HSP72 levels compared to non-damaging exercise such as endurance training (Yamada et al. 2008, Murlasits et al. 2006). Although in this study the last sampling of subjects was done 30 min after the endurance or weight training, we suggest using multiple post exercise sampling in future studies. **References** Smuder AJ, Kavazis AN, Min K, Powers SK. (2011). Exercise protects against doxorubicin-induced oxidative stress and proteolysis in skeletal muscle. *J Appl Physiol.* Feb 10. [Epub ahead of print] Yamada P, Amorim F, Moseley P, Schneider S. (2008). Heat shock protein 72 response to exercise in humans. *Sports Med*;38(9):715-33. Murlasits Z, Cutlip RG, Geronilla KB, Rao KM, Wonderlin WF, Alway SE. (2006). Resistance training increases heat shock protein levels in skeletal muscle of young and old rats. *Exp Gerontol*;41(4):398-406.

## EFFECTS OF ENDURANCE TRAINING AND IMMOBILIZATION ON INTRACELLULAR OXYGEN DYNAMICS DURING MUSCLE CONTRACTION

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**Introduction** Myoglobin (Mb) desaturates without time delay during muscle contraction, reflecting rapid decrease in the intracellular oxygen (O<sub>2</sub>) tension of Mb (PmbO<sub>2</sub>), which expands the O<sub>2</sub> gradient to increase the O<sub>2</sub> flux in order to meet the increased energy demands (Takakura et al., 2010). However, the effects of endurance training (eTR) and immobilization (IM) on intracellular O<sub>2</sub> dynamics during muscle contraction are unknown. Therefore, the present study investigates the effects of eTR and IM on the dynamics of Mb saturation (SmbO<sub>2</sub>) and PmbO<sub>2</sub> in contracting muscles, using a hindlimb perfusion model. **Methods** Male Wistar rats were randomized into the eTR, IM, or Control (Con) group. Rats in the eTR group underwent a 4-week swimming eTR (6 days/week, 30 min × 4 sets/day) with a weight of 2% body mass. IM group rats had their left hindlimbs immobilized at the full plantar flexion using a thermoplastic cast for 3 weeks. After the eTR or IM periods, the muscle tension and muscle oxygen consumption (mVO<sub>2</sub>) in the gastrocnemius-soleus-plantaris (GPS) muscle were measured under hemoglobin-free medium perfusion. During muscle contraction, the deoxygenated Mb signal was monitored by near-infrared spectroscopy. SmbO<sub>2</sub> at the steady state, calculated by quantified Mb deoxygenation kinetics, was converted into PmbO<sub>2</sub> and the release rate of O<sub>2</sub> from Mb was calculated by multiplying Mb deoxygenation rate as a percentage per second and Mb concentration (IMb). Citrate synthase (CS) activity, [IMb], ATP concentration, and lactate to pyruvate ratio (L/P) in the venous effluents were measured spectrophotometrically. **Results** After eTR, the maximal muscle tension, mVO<sub>2peak</sub>, [IMb], and CS activity increased, whereas L/P decreased. The increase in the release rate of O<sub>2</sub> from Mb after eTR accelerated the rate increase in ΔmVO<sub>2</sub>. eTR shifted the ΔmVO<sub>2</sub>-PmbO<sub>2</sub> curve upward regardless of the increase in ΔmVO<sub>2</sub>. CS activity, [IMb], and L/P were unaffected by IM, but GPS muscle mass, maximal muscle tension, and ATP resynthesis efficiency decreased, and the mVO<sub>2peak</sub> and ΔmVO<sub>2</sub> at the same absolute tension increased. The release rate of O<sub>2</sub> from Mb at the maximal twitch tension and the same oxygen demand was attenuated after IM. IM shifted the ΔmVO<sub>2</sub>-PmbO<sub>2</sub> curve upward. **Discussion** Although PmbO<sub>2</sub> was not likely to be involved in the increase in ΔmVO<sub>2</sub> after eTR and IM, the release rate of O<sub>2</sub> from Mb fluctuated in accordance with the level of physical activity, which might be associated with altered mitochondrial respiration rate at the onset of the muscle contraction. **References** Takakura H, Masuda K, Hashimoto T, Iwase S, Jue T. (2010). *Exp Physiol*, 95, 630-640.

## ALBUMIN, A LIPID TRANSPORTER OR A WEIGHT LOSS STRATEGY?

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**Introduction:** Lipid deriving energy from the adipocytes has some steps before it turns completely into energy. (JEUKENDRUP et al., 1998). FFA bond to albumin to be transported to the muscle where it will be burned. **Objective:** Our study had the objective to investigate the effects of acute albumin supplementation on body composition and its relation with lipid transport and utilization. **Methods:** We had 5 male subjects with 21.8 ± 2.17 years old in two different days. On the first day (Albumin group), subjects ingested 20g of albumin in 250mL of water after a 4hour fast, 60 minutes before the test. On the second day (Control group) we had the same protocol but subjects ingested whey protein. Test consisted of 1hour of running at 65% of max FC (Karvonen et al, 1957) with compulsory ingestion of 500mL of water during the test. We evaluated weight, skinfold (Jackson & Pollock, 1978) and circumferences (before and after the test) we also measured blood lactate and glucose on rest, 20, 40 and 60 minutes within the test. **Results:** Albumin group had an average weight of 77.14 ± 5.32 (pre test) and 76.4 ± 5.03 (post test), Control group had 77.04 ± 5.0 (pre test) and 76.68 ± 5.02 (post test), sum of skinfold from Albumin group was 88.80 ± 2.22 (pre test) and 83.86 ± 2.39 (post test) and Control group had 99.52 ± 2.92 (pre test) and 93.05 ± 2.63 (post test), all these reductions had p<0.05 level of significance. Body fat percentage from Albumin group was 11.65 ± 2.96 (pre test) and 10.82 ± 2.85 (post test), with a significant reduction (p<0.05) when compared to Control group 14.42 ± 7.42 (pre test) and 12.34 ± 3.96 (post

test). Discussion/Conclusion: The circumferences studied decreased significantly only on the abdomen. The glucose and lactate profile observed suggested greater involvement of lipids as the predominant energy substrate, especially at the end of the test, according to the literature. Thus, we conclude that albumin group showed significant fat loss, evidencing the effects of acute albumin supplementation on reducing body fat when combined with moderate exercise. Bibliographic Reference: JACKSON, Andrew; POLLOCK, Michael. Generalized equations for predicting body density of men. *British Journal of Nutrition*, n.40, p. 497-504, 1978. Jeukendrup AE, Saris WHM, Wagenmakers AJM. Fat metabolism during exercise: A review-Part I: Fatty Acid Mobilization and Muscle Metabolism. *Int J Sports Med* 1998;(9):231-44. KARVONEN MJ, KENTALA E, MUSTALA O, The effects of training on heart rate; a longitudinal study. *Annales Medicinæ Experimentalis et Biologiae Fenniae*, v. 35, n. 3, p. 307-315, 1957

## EFFECTS OF DIET AND AEROBIC EXERCISE ON LIPOPROTEINS, BASAL METABOLIC RATE AND ACYLATED GHRELIN IN GRADE 1 OBESITY

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**Introduction** A number of strategies have been tested to determine the best approach in order to prevent and control obesity. The reduction of 5% to 10% of body weight through diet and exercise is suggested as effective for health improvement. Lipoproteins (LP), Basal Metabolic Rate (BMR) and Acylated Ghrelin (AG) are important markers to monitor this population, since they keeps relationship with vascular health, energy expenditure and appetite, respectively. **Methods** In order to investigate the effects of diet and physical exercise on BMR, Lipid profile and AG, 18 subjects (20 to 40 years, BMI 30kg.m<sup>-2</sup>) were randomly allocated in two groups, Diet (DG) or Diet plus Aerobic Exercise (D+EG). Blood samples were taken before and after a 5% reduction in body mass to evaluate the levels of acylated ghrelin, cholesterol and glucose. BMR was evaluated through gas analysis in an automated metabolic cart. A two way ANOVA and a Bonferroni Test were carried out. The study was approved by the local Ethics in Research Committee. **Results** The D+EG got a 5% loss in body mass faster than DG (74.1±26 vs. 85.1±26.5 days). After the weight loss, DG reduced total cholesterol (194.2±28.51 vs. 174±45.8 mg.dl<sup>-1</sup>), LDL cholesterol (107.2±20.2 vs. 88.85±9.2 mg.dl<sup>-1</sup>) and Fat-Free Mass (61.4 ±10.0 vs. 59.3 ± 9.2 kg). By contrast, D+EG has a significantly decrease in AG (54.4±35.3 vs. 33.2±29.1 pg.ml<sup>-1</sup>), and increased BMR (1363±379 vs. 1633± 223 kcal.day<sup>-1</sup>). **Discussion** The results were intervention dependent. The reductions in total cholesterol and LDL in GD are possibly justified by a reduction of fats and an increase in fibres in the diet composition (Nieman et al., 2002). Furthermore, the FFM reduction was due to lack of muscle stimulation and catabolic effect of diet on the tissue (Bielinski et al., 1985). The D+EG showed an AG reduction and a BMR increase. The AG reduction may be related to the type (aerobic) and the intensity (70% VO<sub>2</sub>max) of exercise (Broom et al., 2007). Moreover, the BMR increased thanks to the maintenance of fat-free mass promoted by exercise (Bielinski et al., 1985). In summary, the DG seems to induce an improvement on the lipid profile whereas D+EG induces a decrease on AG. It seems to be related to appetite regulation. Such differences can be associated with differences in the total intervention time. **References** Nieman, DC, Brock, DW; Butterworth, D. J. *Am Coll. Nutr.* v. 21, p. 344-350, 2002. Bielinski, R; Schutz, Y; Jéquier, E. *Am J Clin Nutr*; v. 42:p. 69-82, 1985. Broom, SD; Stensel, DJ, Bishop, NC, Burns SF, Miyashita, M. *Appl. Physiol.*, v. 102, n. 6, p. 2165-2171, 2007.

## Poster presentations

### PP-PM24 Cardiovascular Health 1

## ANABOLIC STEROID USE AND CARDIAC MORPHOLOGY AND FUNCTION: NOVEL INSIGHTS FROM MRI AND SPECKLE TRACKING

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The prevalence of anabolic steroid (AS) use has increased in recent years. Whilst case studies of arrhythmia and myocardial infarction in AS users are common, the cardiovascular (CV) health consequences of AS abuse remain controversial. Previous case-control data in AS users have largely failed to document a consistent risk or arrhythmic substrate in AS users. MRI represents a gold-standard technique for cardiac structure and function and gadolinium enhancement of MRI allows detection of interstitial fibrosis. Both approaches have not been used previously in AS users. We hypothesise there will be a significant effect of AS use on systolic and diastolic cardiac function as well as a reduced strain (ε) and strain rate (SR) in AS users at a regional and global cardiac level. Regular resistance training individuals who self-reported a minimum of 2 years of AS use (n=6) or who had never used AS (NAS, n=7) underwent CV assessment. Cardiac MRI assessed maximum left ventricular (LV) wall thickness (WT), LV mass (LVM), LV and right ventricular (RV) ejection fraction (EF) as well as the presence of fibrosis. Speckle tracking echocardiography assessed ε and SR in 3 planes of cardiac motion. Blood pressure, resting heart rate (HR) were recorded as well as standard lipid profiles. Data was analysed using independent T-Tests or Mann-Whitney U-tests. All data given as mean±SD except E:A values which are presented as median. Resting HR (AS: 82±6 v NAS: 65±14 b.min<sup>-1</sup>), LVM (AS: 202±28 v NAS: 170± 21 g) and peak LVWT (AS: 11.3±1.0 v NAS: 9.7±1.0 mm) were significantly increased in AS. There was no significant difference in LVEF (AS: 62±3 v NAS: 63±4%) whilst RVEF was significantly reduced in the AS (AS: 53±31 v NAS:59±5%). There was no evidence of interstitial cardiac fibrosis. In AS users the early:atrial (E:A) peak diastolic flow velocity filling ratio (AS: 1.48 v NAS: 1.91) and early:atrial peak tissue (E':A') velocity filling ratio (AS: 1.26 v NAS: 1.87) were significantly reduced. Longitudinal peak ε (AS: -12.8±1.7 v NAS: -16.3±1.8%), systolic (AS:-0.83±0.13 v NAS:-1.15±0.12 .s<sup>-1</sup>) and E SR (AS: 1.17±0.22 v NAS:1.67±0.30 .s<sup>-1</sup>) were significantly decreased in the AS group. Apical peak rotation (AS: 2.57±5.63 v NAS: 8.60±4.27o) was significantly decreased in AS. A significant reduction in high-density lipoprotein (HDL) and an increase in triglycerides and total cholesterol: HDL ratio was seen in AS users (p<0.05). Using gold standard MRI techniques and speckle tracking echocardiography, this study reported that AS users have significant LV hypertrophy and reduced LV and RV function that may precipitate an increased risk of arrhythmia or cardiac event. A lack of interstitial cardiac fibrosis would suggest risk of arrhythmia is not further augmented.

**PLASMA OXIDIZED LDL CONCENTRATION INCREASES IN STRENGTH-TRAINED MEN**

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Background: Oxidative stress, the imbalance in oxidants and antioxidants, may play an important role in the development of major health-related events such as mobility limitation, disability, and mortality. Oxidized low-density lipoprotein (oxLDL) has been shown to play a major role in the progression of atherosclerosis and cardiovascular disease. Aerobic exercise training has been reported to decrease plasma oxLDL levels. There are no studies, however, regarding the effect of strength exercise training on plasma oxLDL levels. The purpose of this study was to investigate the plasma oxLDL concentration and antioxidant capacity in plasma in strength-trained men. We specifically assessed the total scavenging activity against plasma hydroxyl radical (HO•) and alkoxyl radical (RO•) by using the electron spin resonance (ESR) with spin-trapping, because both radicals are involved in oxLDL production. Methods: The subjects included young strength-trained men (SA group; shot put, hammer, javelin throwers, or power lifters; n = 9), and sedentary individuals (control group; n = 9). We measured plasma oxLDL concentrations and total scavenging activity against HO• and RO•. Results: Maximal muscle strength, assessed by isokinetic tests of the knee and elbow joints and maximal handgrip strength, was significantly greater in the SA group than in the control group. Plasma oxLDL concentrations were found to be significantly higher in the SA group than in the control group. The total scavenging activity against HO• and RO• in plasma did not differ between the 2 groups. Conclusion: The present study showed that the plasma oxLDL concentrations were significantly higher in strength-trained men than in sedentary individuals. We also showed that the total scavenging activity against HO• and RO• in plasma did not differ between the strength-trained men and sedentary individuals. These findings suggest that high-intensity strength exercise training increases plasma oxLDL concentrations without upregulating the scavenging activity against plasma HO• and RO•. This work was supported by Grants-in-Aid for Scientific Research 21300234 and 21650179 from Japan Society for the Promotion of Science.

**CARDIORESPIRATORY FITNESS OR BODY COMPOSITION: WHICH FACTORS INFLUENCES CARDIAC MORPHOLOGY?**

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Background: Athletic training is associated with changes in left ventricular morphology, a phenomenon known as 'athlete's heart'. However, heart size also varies with body size and composition, making training-induced differences between subjects difficult to interpret. In the past, body surface area, body mass index and height have been widely used in the clinical domain as indices to scale for heart size. However, assessment of the importance of different scaling factors has been limited by the use of echocardiography and indirect or gross methods of body composition analysis. We therefore assessed relationships between body composition, cardiorespiratory fitness levels (CRF) and left ventricular cardiac morphology using dual-energy X-ray absorptiometry (DXA) and cardiac MRI. Methods: Twenty five recreationally active males (27±5 years) were recruited and underwent assessments of cardiac morphology, CRF levels and body composition. CRF was assessed using a maximal aerobic capacity (VO2peak) treadmill exercise test while cardiac morphology was assessed using cardiac MRI. Body composition was measured using DXA. Bivariate correlations were performed between all variables and a backwards stepwise regression model was used to independently assess the relationships between regional components of body composition and left ventricular morphology. Results: Left ventricular mass (LVM) was significantly correlated with VO2peak ( $r=0.735$ ,  $p<0.001$ ), lean body mass (LBM) ( $r=0.832$ ,  $p<0.001$ ) and fat mass ( $r=0.469$ ,  $p<0.02$ ). Backwards stepwise regression analysis involving the regional mass components of LBM and fat mass revealed LBM of the legs ( $t=5.58$ ,  $p<0.001$ ), fat mass of the trunk ( $t=4.65$ ,  $p<0.001$ ), legs ( $t=-3.2$ ,  $p<0.005$ ) and android ( $t=-4.11$ ,  $p<0.002$ ) were the strongest predictors of LVM. Conclusion: This study used MRI and DXA technology to address the question of appropriate cardiac scaling for CRF and body composition. CRF was strongly correlated with LVM however this relationship failed to be significant once VO2peak scores were normalised for body weight. Highly significant associations were evident between LVM and LBM, particularly of the lower limbs. LBM predominantly consists of skeletal muscle, a highly metabolic active tissue. A physiological explanation for the relationship between LBM and LVM may relate to haemodynamic stress associated with skeletal muscle activation during exercise. LBM of the legs may be a more appropriate scaling variable for cardiac morphology than other variables such as body surface area and height, which are widely used clinically.

**CLUSTERED CARDIOMETABOLIC RISK, CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY IN 10-11 YEAR OLD CHILDREN. THE CHANGE! PROJECT.**

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Introduction: Evidence suggests that insufficient levels of physical activity (PA) and cardiorespiratory fitness (CRF) are associated with cardiometabolic risk (Andersen et al 2008). This study aims to investigate the relationship between CRF, PA and clustered cardiometabolic risk in children, employing both traditional, (e.g. Total Cholesterol [TC]) and emerging non invasive (e.g. LV Mass Index), risk markers. Methods: Participants (n=60) were recruited from 12 primary schools (mean age = 10.6 (±0.3) years) in Wigan. Habitual PA was measured using 7 day accelerometry and CRF by VO2peak. Assessments of body composition (DEXA), cardiovascular structure (LV Mass Index) and function (blood pressure) were completed. Fasting capillary blood samples were taken and analysed for TC, High Density Lipoprotein Cholesterol (HDL-C) and glucose. Twenty-eight participants had valid data for all components of the clustered risk score, calculated using TC:HDL-C, glucose, systolic BP, LV Mass Index, and trunk fat mass (g). Participants with a clustered risk score greater than 1SD above the mean, were categorised as 'high' risk (n=5); all others were categorised as 'normal' risk. ANCOVA, with somatic maturity and gender as covariates, was used to determine differences in VO2peak; Total PA; moderate to vigorous PA (MVPA), and vigorous PA (VPA) between risk groups. Pearson's correlation coefficients, controlling for gender and maturation, were completed to assess the relationship between clustered risk score and VO2peak, Total PA, MVPA, and VPA. Results: Those in the 'normal' risk group were more fit than those in the 'high' risk group (mean 'normal' 43.8 ± 8.6 vs. mean 'high' 35.1 ± 8.9 ml/kg/min ( $t(1,24)=4.518$ ,  $p=0.044$ )). Those in the 'normal' risk group accrued more VPA than the 'high' risk group (mean 'normal' VPA= 16.0 ± 8 vs. mean 'high' VPA=11.7 ± 4.9 mins/day,  $p>0.05$ ). Furthermore, clustered risk score correlated with VPA ( $r=-0.413$ ,  $p=0.045$ ) and VO2peak ( $r=-0.514$ ,  $p=0.007$ ). Total PA and MVPA did not correlate significantly with clustered risk. Discussion: Cardiometabolic risk is negatively associated with VPA and CRF. This study advances knowledge with further evidence of the importance of promoting CRF and PA, for cardiometabolic risk reduction, combining traditional risk

markers with non invasive emerging measures. Furthermore, this study emphasises the importance of promoting VPA in children. Reference: Andersen, L. B., Sardinha, L. B., Froberg, K., Riddoch, C. J., Page, A. S. & Andersen, S. A. (2008). *Int J Pediatr Obes*, 3, 58-66.

### CARDIOVASCULAR RESPONSES TO A LOW VOLUME HIGH INTENSITY EXERCISE INTERVENTION IN MIDDLE AGED ADULTS

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**Introduction:** Recent research (Gibala & McGee 2008) has demonstrated that high intensity interval training (HIT) stimulates physiological adaptations similar to those observed following a traditional endurance training programme, despite a greatly reduced total exercise volume. Although these results show promise in improving health and fitness, the sprint training involved demands a high level of motivation and responses have only been examined in young adults. The aim of the present study, therefore, was to investigate the cardiovascular response to a 4 week progressive step exercise training protocol in a middle-aged population. Stepping is a high-intensity activity that can be carried out in a controlled manner in an indoor setting and is therefore a variant of HIT that may be more suited to older populations. We hypothesised that cardiovascular fitness would be improved following 4 weeks of step training compared with a 4 week control period of no exercise. **Methods:** Thirty three sedentary healthy middle aged adults (age: 59.8, 2.71yrs (mean, SD), height: 167.2, 7.53, weight: 74.3, 13.63kg) took part in the step exercise training programme. Starting at baseline (PRE), participants acted as their own controls over a 4 week period (CTL) immediately preceding the intervention. They then accumulated up to 9 minutes of exercise per day on 3 days of the week over the 4 weeks experimental period. Step height and cadence were individually prescribed using a linear regression prediction model, producing a target intensity of 80% of heart rate reserve (HRR). Measures of VO<sub>2</sub>, HR and RPE were obtained during an incremental step test whereby step height remained constant and cadence was increased every 2 minutes until HR reached 85% of predicted maximum. This was repeated on 3 occasions: PRE, CTL and POST (following the 4 week training period) and ANOVA with repeated measures was used to detect differences in the dependent variables. **Results:** No differences were found between PRE and CTL for any measured variable ( $p>0.05$ ). The main effects for training (PRE vs POST) were statistically significant as decreases were observed in VO<sub>2</sub>, HR & RPE ( $p=0.001$ ) at a given sub-maximal intensity. **Discussion:** These results show that accumulated bouts of stepping exercise equivalent to only 21 minutes per week over a 4 week period are sufficient to improve cardiovascular fitness in sedentary middle-aged participants. Thus, stepping is a variant of HIT that appears effective, safe and well tolerated by a middle aged population, and could be well suited to public health initiatives based on exercise prescription for older populations. **References:** GIBALA MJ & MCGEE SL (2008) *Exerc Sport Sci Rev*, 36 (2), 58-63

### THE ACUTE EFFECT OF ISCHEMIC PRECONDITIONING ON REPEATED HIGH-INTENSITY EXERCISE PERFORMANCE OF ELITE RUGBY PLAYERS

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**THE ACUTE EFFECT OF ISCHEMIC PRECONDITIONING ON REPEATED HIGH-INTENSITY EXERCISE PERFORMANCE OF ELITE RUGBY PLAYERS** Bailey, T.1,2, Atkinson, P.3, Atkinson, G. 1, Jones, H. 1, Drawer, S. 4, Thijssen, D.H.J. 1, 5. 1 RISES, LJMU, 2 S&PA, Edge Hill University, 3 EIS, Bisham Abbey, 4 UK SPORT, UK, 5 Dept. of Physiology, Radboud University, Netherlands. **Introduction** Previous animal studies have shown that repeated bouts of ischemia followed by reperfusion, known as ischemic preconditioning (IPC), leads to beneficial vascular and muscular adaptations. Interestingly, recent data in humans found that IPC improves exercise performance during an aerobic exercise test in moderately and well-trained individuals. To date, no research has examined the potential effect of IPC on high-intensity (HI) exercise performance in humans and we hypothesised that IPC would improve workload and attenuate fatigue during HI performance. The aim was to establish the effects of IPC on HI running and cycling performance in elite rugby players. **Methods** In a randomised, single-blind, crossover study, 13 elite male rugby players performed two different sprint protocols, which were preceded by IPC or a control (C). On 2 subsequent days, subjects performed an indoor, running Repeated Anaerobic Sprint Test (RAST). Then 6 days later, performed a repeated sprint test on a stationary ergometer (10 cycles of 15s sprint – 30s active recovery, 60rpm) on 2 subsequent days. IPC involved 4 series of 5 min ischemia (~170 mmHg) on alternate legs, followed by a standard warm-up. C consisted of 40 min seated rest. The order of IPC and C between the 2 tests was randomised between- and within-subjects. From the RAST, we calculated sprint time, power-output and fatigue index, whilst heart rate, total work, peak and mean power-output were measured during the ergometer tests. Data were analysed using a repeated measures ANOVA, with 95% confidence intervals (CI). **Results** Power declined during both RAST in all subjects ( $P<0.05$ ), but did not differ significantly between IPC and C. IPC tended to improve peak power (IPC:  $1278\pm150$  vs. C:  $1269\pm140$  W), fatigue index (IPC:  $54\pm5$  vs. C:  $52\pm4$  %) and mean power (IPC:  $659\pm54$  vs. C:  $653\pm53$  W). The upper limit of the 95%CI favoured a beneficial effect on performance (Mean power: 95%CI -8.2 to 18.4W; Fatigue Index: 95%CI -1.8 to 4.8%). A significant familiarisation effect was observed during the cycling test, with a significantly higher work produced on day 2 (Day 1:  $6509\pm574$ , Day 2:  $6626\pm493$  W;  $P<0.05$ ). **Conclusion** This is the first study to examine the performance effects of IPC in elite athletes. Our data suggest IPC potentially enhances power in HI exercise in elite rugby players. However, future laboratory-based studies, that include familiarisation and improve precision of estimates of change, are necessary to provide further insight into the potential impact of IPC for HI performance in elite athletes. **References** De Groot. et al. (2010). *EJAP*, 108, 141

### PREVALENCE OF RISK FACTORS FOR CARDIOVASCULAR DISEASE AND DIABETES IN CHILDREN AGED 11-13: A SCHOOL BASED CROSS-SECTIONAL STUDY.

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**Objective:** Risk factors for cardiovascular disease (CVD) and Type 2 diabetes (T2DM) originate during childhood. This study examines the prevalence of risk factors for CVD and T2DM in children aged 11-13 years and investigates factors associated with high risk of these diseases. **Methods:** Data from 10 schools from South Wales were used. 1147 children (490 male: 657 female) took part. A high risk child was one with 2 or more of the following features; overweight or obese, waist circumference >90th centile for age and sex, high blood pressure, high cholesterol, high fasting glucose, unfit or high percentage of body fat. Logistic regression was used to analyse the data. **Results:** A third of children were overweight and 42% were classed as unfit. Children in deprived schools were 1.8 times more likely to have high blood pressure compared to those in non-deprived schools (15% compared to 8%, respectively). Adjusted logistic regression analysis

sis revealed that having overweight parents, living in a deprived area, low self reported activity levels and a high birth weight, were factors that were independently associated with a child being at a high risk (i.e. two or more risk factors). Conclusions: This study presents data from a wide spectrum of schools across South Wales. The high number of children with risk factors for CVD and T2DM suggests future interventions will need to focus on community and change rather than targeting high risk individuals' behaviour.

### THE IMPACT OF EXERCISE INTENSITY UPON LEFT VENTRICULAR FUNCTION AND CARDIAC TROPONIN I DURING RECOVERY

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The impact of exercise intensity upon left ventricular function and cardiac troponin I during recovery Chan-Dewar F.1, Gregson W.1, Whyte G.1, King J.1, Gaze D.2, Carranza-García L.3, Legaz-Arrese A.4 and George K.1 1: LJMU (Liverpool, UK), 2: St George's Healthcare NHS Trust (London, UK), 3: UANL (Nuevo Leon, Mexico), 4: University of Zaragoza (Zaragoza, Spain) Introduction Multiple reports provide evidence of a transient depression in left ventricular (LV) global and regional myocardial function, and a delay between the electrical activation and peak tissue velocity post-exercise (Neilan et al. 2006; Chan-Dewar et al. 2010). Release of cardiac troponin I (cTnI) also has been observed in many prolonged exercise settings. Exercise intensity might alter the nature and magnitude of cardiac function, cardiac electro-mechanical delay (cEMD) and cTnI appearance during recovery. Therefore the study focuses of assessing LV functional changes before and after two bouts of cycling at different intensities. Methods Twelve healthy male recreational cyclists (age:  $34 \pm 9$  years) performed two 40 km cycling time-trials at high (H) and moderate (M) intensities (80-95% and 60-75% of maximal heart rate) in a controlled environment. Echocardiograms were recorded digitally pre/post exercise and analysed off-line. Blood samples were collected at the same time. Analysis was by two-way ANOVA. Results Global LV diastolic function was reduced after both cycle bouts (Doppler peak early diastolic flow velocity E, H:  $0.71 \pm 0.12$  vs.  $0.63 \pm 0.09$  m.s<sup>-1</sup>; M:  $0.73 \pm 0.12$  vs.  $0.66 \pm 0.13$  m.s<sup>-1</sup>,  $P < 0.05$ ; peak early diastolic tissue-Doppler myocardial velocity E', H:  $0.14 \pm 0.04$  vs.  $0.12 \pm 0.03$  m.s<sup>-1</sup>; M:  $0.12 \pm 0.03$  vs.  $0.11 \pm 0.02$  m.s<sup>-1</sup>,  $P < 0.05$ ). Evidence of an extended cEMD after cycling was present from QRS onset to peak S' (H:  $174 \pm 52$  vs.  $198 \pm 26$  ms; M:  $151 \pm 40$  vs.  $178 \pm 52$  ms,  $P < 0.05$ ) and peak E' (H:  $524 \pm 95$  vs.  $664 \pm 68$  ms; M:  $495 \pm 62$  vs.  $604 \pm 91$  ms,  $P < 0.05$ ). Global LV systolic function was not altered with sporadic evidence of regional changes (basal longitudinal strain, H:  $-19.6 \pm 3.1$  vs.  $-16.6 \pm 3.9\%$ ; M:  $-18.7 \pm 2.5$  vs.  $-15.3 \pm 2.3\%$ ,  $P < 0.05$ ). cTnI was elevated in two participants after High-trial (0.06 ug.L<sup>-1</sup>; 0.04 ug.L<sup>-1</sup>) and one participant after M-trial (0.02 ug.L<sup>-1</sup>). Discussion The decline in LV diastolic function is consistent with the past work, and is seemingly independent of exercise duration/volume. An increase in time-delay suggests that some mechanism intrinsic to myocardial relaxation is involved. There were no noticeable differences in LV function or cTnI appearance during recovery after the two bouts of different intensity cycling. References Neilan T, Januzzi J, Lee-Lewandrowski E et al. (2006). Circulation. 114:2325-2333. Chan-Dewar F, Oxborough D, Shave R et al. (2010). Eur J Appl Physiol. 108:581-587.

### IS CARDIAC REHABILITATION EFFECTIVE AT MAINTAINING HEALTHY LIFESTYLES?

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Introduction Secondary Preventive Cardiac Rehabilitation (CR) programmes are cost effective in reducing mortality and morbidity associated with CVD(1). However, many patients revert to their original lifestyle once they are discharged from the clinic(2), highlighting the need to understand behavioural mechanisms and influences that can surround maintaining healthy behaviours. Ultimately this will enhance successful CR interventions. The aim of this study was to show how effective CR programmes were in improving and maintaining healthy lifestyle changes, comparing CR clinics in different environments; the UK and NZ. It assessed the experiences of former patients after their respective CR programme. Methods: Participants were previously discharged from CR by at least 6-12+ months; 16 males and 5 females from the Massey Cardiac Exercise Rehabilitation Clinic, NZ (phase III); 16 males and 6 females from the Wirral Heart Beat, UK (phase IV). These patients took part in focus groups consisting of 6-10 participants, which were recorded, transcribed and thematically analysed. In addition the CR programmes were observed over 2 months to enable 'reflection in practice'. Results: Both CR programmes were successful in supporting individuals to maintain healthy lifestyles. Similar positive CR experiences between groups and countries were noted; support, education, positive mental attitude, motivation facilitated maintaining healthy lifestyles. Diet and exercise were the main themes influenced, exercising in a friendly environment that provided support and companionship from other similar patients. Physical disabilities, time constraints, and weather conditions inhibited healthy behaviour maintenance. Those in NZ were more affected by other external factors; opportunity, access, and work commitments. Therefore, NZ participants had to be more active in seeking rehabilitative treatment, and be able to afford the service. Conclusion Continued support and a friendly structured exercising environment was the most prominent factor affecting behavioural change. The influence of external factors was more a reflection of the organisation of the respective health services and out of the individual's control, particularly in NZ. Overall, confidence appeared higher in the UK participants where they were more independent in monitoring their own symptoms. Future developments for NZ could include an improved referral process for CR intervention, along with less continual monitoring. For both countries, the introduction of education discussion groups could help tackle drop-out rates. 1. British Heart Foundation (BHF) (2007a). National Campaign for cardiac Rehabilitation. Retrieved on 2nd December 2009 from [www.cardiacrehabilitation.org.uk/docs/scientific.pdf](http://www.cardiacrehabilitation.org.uk/docs/scientific.pdf) 2. Blair, S.N., et al., (1993). Circulation, 88, 1402-1405

### DIFFERENTIAL IMPROVEMENTS IN CARDIOMETABOLIC RISK AND FRAMINGHAM RECURRENT RISK SCORE IN PATIENTS WITH AND WITHOUT DIABETES MELLITUS UNDERGOING LONG-TERM CARDIAC REHABILITATION.

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Introduction: We evaluated whether cardiometabolic risk factors and recurrent coronary heart disease (CHD) risk could be modified in patients with and without diabetes mellitus, undergoing longer-term cardiac rehabilitation (CR). Methods: Patients attending a community-based CR, focusing on structured aerobic and resistance training, were retrospectively stratified into (i) patients with diagnosed CHD; (ii) patients with CHD and diabetes mellitus (CDM). Cardiometabolic risk factors and the 2-4 year Framingham recurrent CHD risk scores (FRS) were assessed at baseline and 15 months following CR. Results: One hundred and fifty four CHD patients (89% males; mean age  $59.6 \pm 8.5$  years; BMI  $27.0 \pm 3.5$  kg•m<sup>-2</sup>) and 20 patients with CHD and diabetes (CDM) (81% males; mean age  $63.0 \pm 8.7$  years; BMI  $28.7 \pm 3.3$  kg•m<sup>-2</sup>) completed 15 months of CR. At follow up, a significant main effect for time was evident for reduced body mass and waist circumference, and improved LDL-cholesterol concentration and sub-maximal cardiorespiratory fitness (all  $P < 0.05$ ), showing the benefits of CR



in both groups. However, a significant group by time interaction effect was evident for high density lipoprotein cholesterol (HDL-c), and total cholesterol/high density lipoprotein cholesterol ratio (TC/HDL-c ratio) (both  $P < 0.05$ ). CHD patients improved their TC/HDL-c ratio ( $5.0 \pm 1.5$  to  $4.4 \pm 1.3$ ), whereas this showed no improvement in CDM patients ( $4.8 \pm 1.6$  v  $4.9 \pm 1.6$ ). Conclusion: Anthropometric and sub-maximal fitness variables improved in all CHD patients following long-term CR. However, with the exception of a lowering of LDL-cholesterol, cardiometabolic risk profile improved only in the CHD group. Clinicians may consider more aggressive lipid-lowering and ACE inhibitor therapy in CHD patients especially amongst diabetics in order to improve cardiometabolic risk.

### THE EFFECT OF CONTINUOUS AEROBIC EXERCISE ON HOMOCYSTEINE OF CAD PATIENTS

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F.Fathollahi Shoorabeh1, B.Sheikhsaraf2, H. Maleknia3, B. Tarverdzadeh4 1-BSc of physical Education, Shahrekord University 2-Faculty member of IA University, Najafabad Branch 3-Faculty member of IA University, Koozdasht Branch 4-Faculty member of IA University, Booshehr Branch Abstract Hyperhomocysteinemia is a risk factor for several disease especially coronary artery diseases (CAD). CAD patients have higher homocysteine (Hcy) levels. Little is known about the effect of exercise on Hcy. This study aimed to evaluate whether continuous exercise reduce Hcy levels for patients who had coronary artery bypass graft (CABG). For this purpose, 36 subjects who elapsed 3 months after their open heart surgery were selected. They didn't have exercise activity record and their BMI were under 30. They didn't have pulmonary disease like asthma, bronchitis and active chest pains or angina. Orthopedics and cerebra-neural which was an obstacle for exercise was not observed. They were randomly divided into groups: control (n=17) and experimental (n=17). Experimental group (continuous aerobic exercise) exercised for 8 weeks and each week for 3 sessions and each session for 41 minutes continuously with the intensity of 50-70% maximum heart rate (50-60% peak). 3-5 of first and last minutes were warm up and cool down. The ACSM formula was used for maximum rate of consumed oxygen. After 8 weeks the Homocysteine level was measured again. T-test was used for comparisons at significant level of 0.05 and SPSS version 16.0 for data analysis. Continuous aerobic exercise has significant effect on serum total homocysteine concentration of CABG patients ( $p=0.006$ ), while control group didn't have any significant change. The results of this study indicate that homocysteine can be kept at almost moderate, healthy levels if continuous aerobic exercise is used as a method of rehabilitation. Key word:

### MODIFICATIONS IN THE LIPID PROFILE AND CARDIOVASCULAR RISK FACTORS IN MARATHON RUNNERS.

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Introduction: Recently it has been shown that marathon runners present a coronary artery calcification (CAC) index similar to sedentary match controls. Oxidative stress caused by the marathon increases oxidation of LDL and can be involved with endothelial damage, which is implied with atherogenesis. The plasmatic percentage of cholesterol fractions is regulated by some mechanisms such as reverse transport promoted by HDL cholesterol that is regulated by donor and receptor lipoproteins. Methods: We evaluated the effect of marathon in lipoproteins, lipid profile and its effects on lipid transference, after the race. The study group was composed by 14 male runners with a range of age from 25 to 60 years (mean 41.4). The control group was composed by sedentary male, age matched to the study group. We evaluated the level of oxidative LDL (oxLDL, U/L), apolipoprotein A1 (ApoA1, g/L), apolipoprotein B (ApoB, g/L) and the transfer percent of free and esterified cholesterol (FC and EC), phospholipids (PL) and triglycerides (TG) in both groups at rest and in the marathoners immediately and 72 hours after race. Results: Our results showed that marathon runners had basal lipids transfer percent of FC [6.8(5.7-7.2)], PL [21.7(20.4-22.2)] and TG [3.7(3.1-4)] higher than control [5.2(4.5-6), 8.2(7.7-8.9) and 1.3(0.8-1.7),  $p=0.001$ ]. The transfer percent of EC [3.2(2.2-3.8)] and the serum levels of ApoA1 [161 (143-185)], ApoB [74 (64-85)] and oxLDL [85(76-96)] in marathoners at rest didn't show statistic differences comparing to controls [EC = 2.7(2.2-3), ApoA1 = 142(121-157), ApoB = 78(71-96), oxLDL = 86(55-118)]. However, immediately after the marathon we observed a significant decrease in percentual of all lipids transfer [FC = 5.8(4.9-6.6), PL = 19.1(18.6-19.3), EC = 2.3(2.2-2.9) and TG = 2.6(2.1-2.8),  $p < 0.05$ ] and increase in serum levels of ApoB [83 (61-101)] and oxLDL [110 (89-183),  $p < 0.05$ ] when compared with the results at rest. Only the ApoA1 levels [153(124-171)] didn't show statistical difference comparing to rest values. When we analyzed the lipids transfer percent and serum metabolites levels 72 hours after the marathon we observed that FC [6.4(5.8-6.9)], PL [20.9(19.8-22.1)], TG [3(2.6-3.5)] and ApoA1 [170(138-202)] were significantly increased ( $p < 0.05$ ) in relation to immediately after running percent, but other parameters didn't show statistical difference. Discussion: Although marathon runners at rest have more efficient mechanisms of lipid transport, immediately after the race they show a period of failure in lipid transference and an increase in oxidized LDL. Both alterations of lipid metabolism are associated to an increased risk of atherogenesis and could explain a CAC index in marathoners similar to controls.

### PHYSICAL ACTIVITY, PHYSICAL EXERCISE AND HIGH-DENSITY LIPOPROTEIN CHOLESTEROL

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Introduction Menopause is characterised by both hormonal and metabolic changes linked with an increased risk of cardiovascular disease. Low blood levels of HDL-cholesterol (HDL-c) are an independent risk factor for cardiovascular disease. Daily physical activity and aerobic exercise have been found linked with serum levels of HDL-c. Our study investigates the influencing variables of HDL-c, and the effect of 14 weeks of aerobic training. Methods Forty-nine post-menopausal women ( $56.25 \pm 4.74$  yrs) were enrolled in the study. Body composition was assessed by electrical bioimpedance technique, while SenseWear Pro3 Armband (Bodymedia) measured daily physical activity characteristics. The device gives information on total daily energy expenditure (DEE m/die), mean intensity of daily physical activities (METs m/die), and both time and energy spent (PAEE m/die) on physical activities with intensity  $> 3$  METs. By our software, we calculated the daily numbers of bouts of physical activities, with intensity  $> 3$  METs, lasting almost 5 (B5) and 10 (B10) consecutive minutes. Plasma lipoproteins were measured by ELISA kit. A dietician assessed dietary habits. Maximal stress test was performed to assess maximal aerobic capacity (Max METs). Women walked 4 days/wk, for 14 weeks, at moderate intensity. Results Pearson's correlation, performed on basal values, showed HDL-c negatively correlated with BMI ( $r = -0.304$ ,  $p = 0.034$ ), waist circumference ( $r = -0.353$ ,  $p = 0.013$ ), percentage fat mass ( $r = -0.303$ ,  $p = 0.034$ ), and positively correlated with METs m/die ( $r = 0.333$ ,  $p = 0.019$ ), B10 ( $r = 0.426$ ,  $p = 0.002$ ) and fiber intake ( $r = 0.287$ ,  $p = 0.045$ ). Linear regression indicated that basal values of B10 and fiber intake were the predictor variables of HDL-c

( $p < 0.001$ ). At the end of the study only daily steps ( $p = 0.010$ ) and METs m/die ( $p = 0.05$ ) were significantly improved. According to the variation of the HDL-c, participants were shared in GROUP+ ( $n = 28$ ), composed by women that increased it, and in GROUP- ( $n = 21$ ) composed by women that decreased it. Logistic regression was performed to investigate the influencing variables of HDL-c variation: basal value of HDL-c was the only significant ( $B = -0.079$ , Wald = 10.128,  $p = 0.001$ ). Discussion Together with fiber intake, qualitative-quantitative characteristic of spontaneous physical activity (i.e. B10) is important for plasma HDL-c of post-menopausal women. Several bouts of almost 10 consecutive minutes of physical activity at moderate intensity positively affect HDL-c profile. After the training, the variation of plasma HDL-c has been found linked with its basal value.

## EFFECTIVENESS OF POLAR ACTIVITY COMPUTER ON PHYSICAL ACTIVITY IN DAILY LIFE

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**Introduction** Feedback and monitoring physical activity (PA) may have a role decreasing sedentary behavior. The aim of this study was to test the effectiveness of a Polar Activity Computer (FA20, Polar Electro Oy, Kempele, Finland) in increasing PA in daily life over 6 months. **Method** 50 volunteer healthy subjects were randomly assigned to an intervention (IG) (13 men, 13 women,  $48.9 \pm 2.3$  y,  $25.8 \pm 7.5$  kg/m<sup>2</sup>) and control group (CG) (14 men and 11 women,  $45.8 \pm 2.2$  y,  $24.9 \pm 7.6$  kg/m<sup>2</sup>) after baseline measurements. At baseline, all subjects wore an accelerometer (GT1M, Actigraph, Florida, USA) for 8 days and completed an online questionnaire on health and PA habits. After these measures the groups were randomised and the IG was given a general information on PA and provided with a Polar FA20. FA20 detects activity based on in-built accelerometer and gives the user feedback about active time spent in health and fitness related activity, accumulated steps and energy expenditure. The CG did receive only general information on PA. After one week and after two, four and six months, 8 days activity measures with the GT1M and the survey were repeated in both groups. The averaged GT1M data over the week (counts/min) was taken as mean PA per week. GT1M data was assigned to sedentary when activity was less than 100 counts. The remaining activity data was classified as light, moderate or vigorous according to Swartz et al (1). The data was analysed using Mixed Models to determine time and group effects on mean PA per week and time spent in moderate and vigorous activity (MVPA). **Results** The mean daily PA in the IG and CG was  $350 \pm 138$  and  $365 \pm 109$  counts/min at baseline, respectively. Time spent in MVPA was  $144 \pm 51$  and  $142 \pm 37$  min at baseline in the IG and CG, respectively. Mean daily PA and MVPA did not change over 6 months. There were no significant differences in PA between the groups at any measurement period. However, wearing the FA20 during the whole trial increased time spent in moderate activity ( $p = 0.007$ ) and nearly increased overall mean weekly PA ( $p = 0.059$ ). There was no effect of wearing the FA20 on light or vigorous activity. **Discussion** Mean daily PA at baseline was comparable to a population study (376 counts/min) (2) indicating that the participants of the present study are active at an average. Polar FA20 seems not to have a major effect on the general activity behaviour. However, wearing the FA20 regularly could increase moderate PA significantly over time in moderately active adults. **References** (1)Swartz, A. M., S. J. Strath, D. R. Bassett, JR., W. L. O'Brien, G. A. King, and B. E. Ainsworth: Estimation of energy expenditure using CSA accelerometers at hip and wrist sites. *Med Sci Sports Exerc* 32: S450-S456, 2000. (2)Hagströmer M, Oja P, Sjöström M: Physical Activity and Inactivity in an Adult Population Assessed by Accelerometry. *Med Sci Sports Exerc* 39: 1502-08, 2007.

## Poster presentations

### PP-PM25 Muscle Function

#### SHORT AND MID TERM EFFECT OF EMS STIMULATION ON CALORIC COST DURING DYNAMIC WHOLE BODY EXERCISE IN WOMEN

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**Introduction** Different studies have shown that Electromyostimulation (EMS) increases muscle activity during training (Colson et al., 2006). It could be hypothesized that during EMS training an additional energetic demand should be measured. Thus, the aim of the present study was to compare the caloric cost during dynamic whole body training with and without EMS. Furthermore it was examined if a repeated application attenuates the EMS effect after several training units of identical intensity. **Methods** Seven trained women ( $24.6 \pm 4.2$  yrs,  $172 \pm 6$  cm,  $63.6 \pm 7.0$  kg body mass,  $21.4 \pm 1.5$  BMI) participated in this study. All subjects completed an identical dynamic whole-body exercise protocol (8 exercises, each 2 min for a total duration of 20 min) on six experimental days. The subjects were trained with a pulse frequency of 85Hz, additionally to a pulse duration and interval of 4 seconds. During the first and second TU all subjects performed exercises with (TU1+) or without EMS (TU1-). The order of EMS applications was administered in a cross over design. For subsequent TU, similar EMS parameters were applied. The energetic cost during TU 1, 2 and 6 was calculated by means of spirometry and indirect calorimetry and the blood lactate concentration before and immediately after finishing the exercise was measured. **Results** No significant differences were found for energy consumption between TU1+ ( $4.37 \pm 0.80$  kcal·min<sup>-1</sup>), TU1- ( $4.09 \pm 0.93$  kcal·min<sup>-1</sup>) and TU6+ ( $4.46 \pm 0.68$  kcal·min<sup>-1</sup>,  $p > 0.05$ ). Likewise, blood lactate measurements did not show significant differences between TU1+ ( $5.20 \pm 2.45$  mmol·L<sup>-1</sup>), TU1- ( $5.20 \pm 1.09$  mmol·L<sup>-1</sup>) and TU6+ ( $5.37 \pm 2.45$  mmol·L<sup>-1</sup>,  $p > 0.05$ ). **Discussion** The present study demonstrates that caloric consumption remains unchanged during dynamic whole-body exercise despite EMS application. Obviously, the potential effects of EMS-workout on muscle fiber recruitment and on overall muscle work seem to be lower than expected under the conditions of our study. Only a slight trend towards a higher caloric cost with EMS application was identified, which was stable until TU6+. Further studies with different EMS parameters and exercises have to be performed. Nevertheless, the overall effect seems to be lower than promoted. **References** Kemmler, W.; Schliffka, R., Mayhew, J. & von Stengel, S. (2010). *J. Strength Cond. Res.*, 24 (7), 1880-1887. Müller, E.; Löberbauer, E. & Kruk, M. (2003). *Leistungssport*, 33 (4), 4-10.

#### FATIGUE-INDUCED CHANGES IN LONGITUDINAL RELAXATION TIME OBTAINED BY MAGNETIC RESONANCE IMAGING

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**Background** Several studies have reported that the transverse relaxation time (T2) obtained by magnetic resonance imaging (MRI) is well related to muscle fatigue. However, the relation between longitudinal relaxation time (T1) and fatigue has not been well investigated.

**Objective** The purpose of this study was to clarify the relation between T1 and muscle fatigue. **Methods** In experiment 1 (Exp. 1), 11 subjects performed a fatiguing exercise involving 3 bouts (i.e., E1, E2, and E3) of 120-sec repeated right-ankle dorsiflexion at 1 Hz frequency with 5-min between-bout rest. Thirty percent of maximum voluntary dorsiflexion torque (MVC) measured at an ankle angle of 90° was used as resistance in the exercise. T1 values were obtained for lower thigh muscles (tibialis anterior [TA], extensor digitorum longus [EDL], and soleus [Sol]) using a 3.0-tesla MRI scanner (Verio; Siemens, Erlangen, Germany) before the first bout, immediately after each bout, and 15 and 30 min after the last bout. In experiment 2 (Exp. 2), another 8 subjects performed the same exercise described above and the MVCs were measured at the same time points as T1 measurement in Exp. 1. In addition, an electromyography (EMG) was obtained from the TA muscle during the exercise and the MVC measurement. **Results** In Exp. 1, the T1 values for the TA and EDL muscles increased gradually along with the progression of the test periods E1, E2, and E3. Thereafter, the values decreased in the recovery period, though they remained higher than the pre-exercise value. The T1 value for the Sol muscle was unchanged throughout the experiment. In Exp. 2, the MVC after each bout decreased gradually. On the other hand, during each bout, the root mean square (RMS) of EMG of the TA muscle gradually increased during the exercise. **Conclusions** The T1 values of the TA and EDL muscles increased gradually along with the development of muscle fatigue (increase in the RMS of EMG and decline in the MVC of the exercised muscle). The present results suggest that T1 is also well related with muscle fatigue, similar to T2.

## HUMAN MUSCLE FORCE RECOVERY IN RELATION TO MUSCLE OXYGENATION LEVEL

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**Human muscle force recovery in relation to muscle oxygenation level** Ufland, P.1, Lapole, T.1, Ahmaidi, S.1, Buchheit, M.1.2 1: EA-3300, UPJV (Amiens, France), 2: ASPIRE (Doha, Qatar) **Introduction** In many sports, such as rugby or judo, the ability to repeat maximal force application separated by short recovery periods is one of the principal determinants of physical performance. The aim of this study was therefore to investigate the relative contribution of human muscle reoxygenation on force recovery following a maximal voluntary contraction (MVC). **Methods** Ten athletes ( $22.9 \pm 4.0$  yr,  $181.9 \pm 6.3$  cm,  $78.6 \pm 5.8$  kg) were asked to execute a plantar-flexion sequence including repeated MVCs (a 30-s MVC (MVC30) followed by a 10-s MVC (MVC10) separated by either 10, 30, 60, 120 or 300 s of passive recovery. A 10-min passive recovery period was allowed between each MVC sequence. This procedure was randomly repeated with two different recovery conditions: without (CON) or with (OCC) arterial occlusion of the medial gastrocnemius. During OCC, the occlusion was maintained from the end of MVC30 to the end of MVC10. Muscle oxygenation (Near infrared spectroscopy, NIRS, [HbDiff]) was continuously measured during the all MVC sequences and expressed as a percentage of the maximal changes in optical density (diffOD) observed during MVC30. Maximal torque was analyzed at the beginning of each contraction (within the first 5 s, when the force production was stable). Torque values during MVC10 were expressed as a percentage of the maximal torque observed during each MVC30. **Results** While torque recovery was complete within 3 min after MVC30 during CON (MVC10 =  $101.8 \pm 5.0\%$ ), only  $88.6 \pm 8.9\%$  of the torque was recovered during OCC ( $P = 0.005$ ). There was also a moderate correlation between absolute level of muscle oxygenation and torque ( $r = 0.32$ ,  $P = 0.02$ ). **Discussion** While the possible detrimental effects of the occlusion on metabolite clearance cannot be determined, present findings confirm the role of human muscle oxygenation in muscular force recovery during repeated maximal efforts. However, the correlation between absolute muscle oxygenation level and force recovery is only moderate, suggesting that other mechanisms not evaluated here are involved in the force recovery process (e.g., phosphocreatine resynthesis, peripheral neuromuscular adjustments).

## DIFFERENCES IN CO-ACTIVATION AROUND THE HIP AND KNEE JOINT DURING THE ROUNDHOUSE KICK: ELITE VS. AMATEUR KARATEKA

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**DIFFERENCES IN CO-ACTIVATION AROUND THE HIP AND KNEE JOINT DURING THE ROUNDHOUSE KICK: ELITE VS. AMATEUR KARATEKA** Quinzi, F.1, Sbriccoli P.1, Camomilla V.1 1: Department of Human Movement and Sport Sciences, Università degli Studi di Roma "Foro Italico" **Introduction** The issue of agonist and antagonist co-activation during the execution of a movement is of interest especially considering sport activities like karate where a fine control of movement has to be associated to a great ability to perform the main technical actions as fast as possible (Sørensen et al., 1996). Sbriccoli et al., (2010) reported in elite Karateka (vs. Amateurs) a reduced co-activation of knee flexor and extensor muscles during an isokinetic task that was paralleled by a higher antagonist activation during the extension phase of a front kick. Because of its high speed and excellent accuracy, the roundhouse kick (RK) seems to be a better model to quantify the ability of a karateka to perform complex actions. This work was then designed to study the co-activation pattern adopted during the RK performed by elite Karateka and Amateurs, with two different techniques: Low Roundhouse Kick (LRK) and High Roundhouse Kick (HRK). **Methods** Six elite Karateka ( $24.8 \pm 1.0$  yrs,  $1.78 \pm 0.03$  m,  $73.8 \pm 4.0$  kg) and six Amateurs ( $27.8 \pm 1.0$  yrs,  $1.80 \pm 0.03$  m,  $77.0 \pm 3.6$  kg) performed 3 LRK and 3 HRK. The surface Electromyographic (sEMG) signal was recorded from the Vastus Lateralis (VL); Biceps Femoris (BF), Rectus Femoris (RF), Gluteus Maximus (GM), and Gastrocnemius Lateralis (GAL) muscles of the kicking leg using a wi-fi EMG amplifier (BTS PocketEMG) during LRK and HRK. Co-activation ratios of antagonist vs. overall activity were computed for knee and hip flexion and extension. Considering the bi-articular role of RF, for the knee joint three co-activation indexes were computed: extension with mono and bi-articular muscles (KClextM and KClextB, respectively), and flexion (KCiflex). For the hip joint, the Hip flexion (HCiflex) and Hip extension (HCext) co-activation indexes were calculated. The effect of Group (Karateka and Amateurs) and Kick (LRK and HRK) on all co-activation indexes was tested through a two-way ANOVA ( $p < 0.05$ ). **Results** The ANOVA demonstrated an effect of Group on all co-activation indexes computed ( $p < 0.001$ ). Namely, Elite Karateka showed lower HCiflex, KClextM and KClextB and higher KCiflex and HCext. **Discussion** Elite Karateka exhibited in general a neuromuscular strategy towards antagonistic activity reduction. Increases in such activity could be attributable to the RF muscle agonist activities (hip extensor during knee flexion and hip abductor during hip extension). Surprisingly, this inhibitory or facilitating response does not seem to be Kick-related. This may be attributed to slight differences in the execution technique between the subjects. **References** Sørensen, H. et al (1996). J Sports Sci, 14, 483-495. Sbriccoli, P. et al (2010). Eur J Appl Physiol, 108, 1269-1280.

### TRAINING AT AN ELONGATED MUSCLE LENGTH MAXIMISES MUSCLE SIZE AND STRENGTH

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**Introduction** Muscle strength adaptations to resistance training (RT) are joint-angle specific (Thepaut-Matieu, Van Hoecke & Maton, 1988). However the effects of RT at different muscle lengths on concomitant changes to muscle size, architecture and strength remain largely unreported. Therefore the aim of this study was to identify differences to training at a longer (LL) compared with a shorter (SL) muscle length, as well as the time-course of any changes during detraining. **Methods** LL (aged  $19 \pm 2.6$  years;  $n=8$ ) and SL (aged  $19 \pm 3.4$  years;  $n=8$ ) groups undertook 8 weeks of dynamic RT and 4 weeks detraining. Muscle volume, architecture and strength were measured at weeks 0, 8, 10 and 12. A control group (aged  $23 \pm 2.4$  years;  $n=10$ ) was also monitored during this period. **Results** There was a significant effect of training group ( $P<0.05$ ) on strength ( $13 \pm 2\%$  vs.  $6 \pm 2\%$ ) and fascicle length ( $22 \pm 4\%$  vs  $13 \pm 2\%$ ), with LL exhibiting greater adaptations than SL. Muscle volume increased significantly ( $P<0.05$ ) as a result of the training protocol and compared to controls ( $P<0.05$ ) in both training groups ( $69 \pm 21\%$  LL vs  $39 \pm 12\%$  SL) with no difference between groups. Detraining resulted in significant ( $P<0.05$ ) deteriorations in all muscle parameters measured in both groups, with SL group experiencing a more rapid relative loss of post-exercise increases in strength than LL ( $P<0.05$ ). **Discussion** Training at a longer muscle length increases muscle stretch (Tabary et al., 1972) and mechanical stress via alterations to the tendon moment arm (Kubo et al., 2006), compared to a shorter muscle length, with each factor being a potent stimulus for protein synthesis (Goldspink, 1999). Increased serial sarcomeregenesis in fascicle length, translated externally as a greater increase in muscle volume, produced greater adaptation and retention of functional capabilities. Therefore a protocol which maximises training gains in a limited amount of time would be key to helping with compliance to exercise training and/or reversing the deleterious effects of prolonged bed rest/ immobilisation (e.g. caused by illness or injury). In addition, whilst the paradigm of 'use it or lose it' is still true, longer muscle length training provides a much better prognosis for long-lasting maintenance of the benefits of exercise, even after cessation of the training regime. **References** Goldspink, G (1999). *J Anat*, 194, 323-334. Kubo K, Ohgo K, Takeishi R, Yoshinaga K, Tsunoda N, Kanehisa H & Fukunaga T (2006). *Scand J Med Sci Sports*, 16, 159-167. Tabary J, Tabary C, Tardieu C, Tardieu G & Goldspink G (1972). *J Physiol*, 224, 231-244. Thepaut-Mathieu C, Van Hoecke J & Maton B (1988). *J Appl Physiol*, 64, 1500-1505.

### DISTINCT SPATIAL DISTRIBUTION ACTIVATION PATTERN IN THE HUMAN RECTUS FEMORIS MUSCLE DURING KNEE EXTENSION AND HIP FLEXION

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**Introduction** Strain injury of the rectus femoris (RF) muscle is a frequent problem in many athletic activities (Hasselman et al., 1995). On the other hand, functional role or activation properties of this muscle had not been fully understood. RF muscle had reported to be innervated by two nerve branches attached at proximal and distal regions of the muscle in humans (Sung et al., 2003). In animal studies (e.g., Pratt et al., 1991), distinct functional roles among the regions innervated by different nerve branches were demonstrated within a muscle. However, functional role of the human RF muscle related with specific innervation pattern has not been investigated in detail. The purpose of the present study is to clarify the possible region-specific functional role in the human RF muscle. **Methods** Eleven healthy men performed isometric knee extension and hip flexion at 20, 40, 60, and 80% of maximal voluntary contraction. During these tasks, multi-channel surface electromyography (SEMG) was recorded from the RF muscle by using 128 electrodes (26 rows and 5 columns with 2 missing electrodes). The rows of electrodes were placed along the longitudinal axis of RF muscle. Superficial region of the RF muscle was defined by ultrasonography and the most part of that was covered with electrodes. Root mean square (RMS) was calculated for all electrode pairs along the rows. **Results** Central locus activation during hip flexion was at more proximal region compared with that during knee extension ( $p < 0.05$ ). While similar RMS values were obtained among different regions during knee extension, significantly higher RMS values were observed at the proximal regions when compared with those at middle and distal regions during hip flexion ( $p < 0.05$ ). **Discussion** The results of the present study suggest that in human RF muscle most part of the muscle play as knee extensor and the proximal regions mainly plays as hip flexor. Moreover, these region-specific EMG patterns for different tasks could be explained by the specific innervation pattern i.e., the proximal and distal regions of the RF muscle are innervated by different nerve branches (Sung et al., 2003). The present study shed some light into the understanding of functional roles or mechanisms of sports injuries such as strain injury in the RF muscles and other bi-articular muscles during athletic activities. **References** Hasselman C T, Best T M, Hughes C, Martinez S and Garrett W E Jr. (1995) *Am J Sports Med*, 23 (4):493-9 Pratt C A, Chanaud C M and Loeb G E. (1991) *Exp Brain Res*, 85 (2):281-99. Sung D H, Jung J Y, Kim H D, Ha B J and Ko Y J. (2003) *Arch Phys Med Rehabil*, 84 (7):1028-31.

### LOW-LOAD FATIGUING RESISTANCE TRAINING WITH HIGH REPETITION PRODUCES MUSCLE HYPERTROPHY, BUT NO STRENGTH GAINS, COMPARABLE TO THAT ELICITED BY TRADITIONAL HIGH-LOAD RESISTANCE TRAINING

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**Introduction** It is generally accepted that Low-load (<50% of 1-repetition maximum [1-RM]) resistance training is not of optimal intensity to elicit muscle hypertrophy, while muscle fatigue (until failure) is considered an important factor to optimize the effect of resistance training. A recent study reported that low-load (30% of 1-RM) resistance exercise with repetition to failure increases post-exercise myofibrillar protein synthesis to a similar extent as high-load resistance exercise (Burd et al. *PLoS One* 5: e12033, 2010). We hypothesized that low-load fatiguing resistance training (LL-RT) would produce muscle hypertrophy. Thus, the purpose of the current study was to examine the effect of LL-RT on muscle size and strength and compare it with the effect of traditional high-intensity resistance training (HI-RT) on the same subjects. **Methods** Nine young men who had previously participated in 6 weeks of HI-RT (3 d/wk, 75% 1-RM  $\times$  10 repetitions  $\times$  3 sets) performed LL-RT for 6 weeks (3 d/wk, 30% 1-RM until failure  $\times$  4 sets). At least 7 months prior to LL-RT, none of the subjects had regularly participated in a resistance training program. The cross-sectional area (CSA) of the triceps brachii (TB) and pectoralis major (PM) muscles was measured using magnetic resonance imaging before and 3 days after the final training session. Maximal dynamic bench press (1-RM) strength and isometric elbow extension (MVC) strength were measured three times (before, after week 3, and after week 6). Electromyographic (EMG) activity of TB and biceps brachii (BB) muscles during MVC was recorded. **Results** At baseline, there were no significant differences in TB and PM muscle CSA between the two groups. After 6 weeks of training, The TB and PM muscle CSA increased 11.9% and 17.6% (both  $P<.001$ ), respectively, in the HI-RT group, and 9.8% and 21.1% (both  $P<.001$ ), respectively, in the LL-RT group. The percent increases in TB and PM muscle CSA were not significantly different ( $P>.05$ ) between the two groups. On the other hand, pretrain-

ing 1-RM strength ( $P<.001$ ) and MVC strength ( $P<.05$ ) were significantly higher in the LL-RT group (1-RM, 61.1 kg; MVC, 34.5 Nm) than in the HI-RT group (1-RM, 51.1 kg; MVC, 31.9 Nm). Percent increases in 1-RM and MVC strength in the HI-RT group (1-RM, 21.0%,  $P<.001$ ; MVC, 13.9%,  $P<.05$ ) were greater than in the LL-RT group (1-RM, 8.6%; MVC, 6.5%). Integrated EMG (iEMG) tended ( $P=.08$ ) to increase in the HI-RT group (32.7%), but not in the LL-RT group (-5.9%,  $P=.79$ ). Conclusion Our results suggest that low-load, 30% 1-RM intensity resistance training can elicit muscle hypertrophy that is comparable to that elicited by HI-RT. However, increases in dynamic and isometric strength were greater in the HI-RT group than in the LL-RT group, which may be due to retraining-induced neuromuscular adaptation.

### IS AGE-RELATED THIGH MUSCLE MASS LOSS MUSCLE SPECIFIC?

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Introduction Skeletal muscle mass loss with increased age is greater in the lower limbs than in the upper extremities (Janssen et al., J Appl Physiol 89:81-88, 2000). However, it is not fully understood whether age-related changes in muscle mass differ between muscle groups in the lower limbs. The purpose of this study was to compare the muscle mass of the thigh muscle groups in young and old Japanese men. Methods Fifteen young ( $24.3 \pm 1.6$  yrs) and 13 old ( $68.6 \pm 7.8$  yrs) men were recruited for this cross-sectional study. The subjects in both groups were physically active, but none of the subjects had regularly participated in strength/resistance training (less than once a week) for a minimum of 3 years prior to the study. Contiguous transverse MRI (1.5-T scanner) images with 1.0-cm slice thickness were obtained from the thigh, and the total thigh and individual (quadriceps, hamstrings, and adductor) muscle tissue volumes were calculated by multiplying the muscle cross-sectional area (CSA) by slice thickness and the total number of slices. Muscle length (number of slices) and average muscle CSA (muscle volume divided by muscle length) were determined for each muscle. Isometric knee extension and flexion torques were measured using a Biodex System-3 dynamometer. Results The young men were taller than the old men ( $1.71 \pm 0.04$  m and  $1.62 \pm 0.03$  m, respectively), while body weight was similar in both groups ( $65.4 \pm 6.3$  kg and  $63.8 \pm 6.4$  kg, respectively). Total thigh muscle volume was 13.4% lower ( $P<.05$ ) in the old men ( $2890 \pm 421$  cm<sup>3</sup>) than in the young men ( $3338 \pm 372$  cm<sup>3</sup>). Quadriceps muscle volume was also 20.3% lower in the old men than in the young men ( $1716 \pm 204$  cm<sup>3</sup> and  $1368 \pm 237$  cm<sup>3</sup>, respectively), while hamstrings ( $704 \pm 120$  cm<sup>3</sup> and  $641 \pm 79$  cm<sup>3</sup>, respectively) and adductor ( $918 \pm 124$  cm<sup>3</sup> and  $882 \pm 149$  cm<sup>3</sup>, respectively) muscle volumes were similar in both groups. There was a significant correlation between quadriceps and adductor muscle volume in both the young ( $r=0.59$ ,  $P<.05$ ) and old ( $r=0.60$ ,  $P<.05$ ) men, but quadriceps muscle volume did not correlate with hamstrings muscle volume in both groups ( $r=0.38$  and  $r=0.50$ , respectively). Isometric knee extension and flexion torques were lower in the old men ( $167 \pm 21$  Nm and  $73 \pm 15$  Nm, respectively) than in the young men ( $246 \pm 55$  Nm and  $90 \pm 21$  Nm, respectively). However, relative strength (torque divided by average muscle CSA) was similar in both the young and old groups. Conclusion Our results indicate that age-related thigh muscle mass loss is muscle specific, in that greater quadriceps muscle loss was found in the old group. A main contributor to decreased muscle strength with aging is the loss of muscle mass, which surpasses the neural factor in importance.

### RELIABILITY OF SOME PARAMETERS FREQUENTLY USED FOR THE EVALUATION OF EXPLOSIVE FORCE PRODUCTION

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RELIABILITY OF SOME PARAMETERS FREQUENTLY USED FOR THE EVALUATION OF EXPLOSIVE FORCE PRODUCTION Trošt Bobić, T.1, Marković, G.1, Šarabon, N.2 1: School of Kinesiology, University of Zagreb, Croatia, 2: Science and Research Centre, University of Primorska, Koper, Slovenia Introduction The aim of this study was to evaluate the intra- and inter-session reliability of numerous dynamometric (DY) and electromyographic (EMG) parameters which are frequently used for the evaluation of explosive force production (EFP). Methods Thirty-seven physical education students ( $22.5 \pm 1.3$  years) were included in the intra-session, while ten ( $22.7 \pm 0.9$  years) were included in the inter-session reliability study. Sitting on a custom made dynamometer, participants were asked to perform three unilateral maximal voluntary isometric plantar flexions of the right foot stressing EFP. EMG signals of m. soleus were recorded by means of surface bipolar electrodes. Altogether sixteen DY and EMG parameters, which are frequently used to evaluate EFP, were computed from the recorded and preprocessed force and EMG signals. Three components of reliability were calculated: systematic bias, within-individual variation, and retest correlation (Hopkins, 2000). Results Intra-session reliability - Within individual variation (CV) varied 13.8-18% for almost all the DY parameters (i.e. k slope, max. average force, RFD) established in the time intervals of 30 and 50 ms. When the same parameters were extracted for 100 and 200ms CV remained in the range of 7.3-12.9%. The majority of DY parameters had a high intra-session ICCs (ICC=0.84-0.94), while the EMG ICCs (for variables like root mean square and rate of EMG rise) were quite low (almost all ICC values under 0.45). Inter-session reliability - CV ranged 5.8-17.5% for the DY and 17.9-109.7% for the EMG parameters. High inter-session reliability was obtained only for almost all DY parameters (ICC=0.81-0.9 compared with the ICC for the EMG parameters being mostly under 0.5). Setting the beginning of the action at 3% MVC level showed slightly better reliability results than the other criteria used. Discussion The results showed a better inter- and intra-session reliability of the DY parameters compared with the EMG parameters. This is in line with the so far knowledge (Claiborne et al., 2009). The main finding of this investigation is that the DY parameters have better inter- and intra-session reliability when calculated for the time interval of 100 and 200ms MVC, rather than for 30 and 50ms respectively. Such data suggests that the indicators of EFP should be calculated in the time range of 100 to 200ms MVC. It also seems that setting the starting point on 3% MVC could be an appropriate choice for the calculation of EMG parameters. References Hopkins WG (2000). Sports Med, 30(1):1-15. Abernethy P, Wilson G, Logan P (1995). Sports Med, 19(6):401-17. Claiborne TL, et al. (2009). J Electromyogr Kinesiol, 19(5):345-352.

### EFFECTS OF CONDITIONING AND PLYOMETRIC JUMPS TRAINING ON THE BODY COMPOSITION OF YOUTHS WITH DOWN SYNDROME

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Introduction: Children and adolescents with Down syndrome (DS) tend to have unhealthier body composition compared with their peers without DS in regard to fat, lean and bone masses.(1) Material and methods: 28 participants with DS (15 males) aged from 10 to 18 years and 30 sex- and age-matched healthy controls without disabilities joined the study. Participants with DS were divided into two groups:

DS-exercise and DS-control. The DS-exercise group conducted a 21-week conditioning consisted of 2 sessions per week of circuits including different kind of jumps, press-ups, exercises with elastic fitness bands and adapted medicine balls, for approximately 15 to 25 minutes/day. The DS-control group and the non-DS controls continued with their typical weekly activities. Percentage of body fat (%BF), total lean mass, bone mineral content (BMC) and density (BMD) were measured by dual energy X-ray absorptiometry (DXA) at baseline and after the training program. Percentages of change of total lean mass, BMC and BMD were calculated for each variable, and Mann-Whitney U tests were used to evaluate differences between groups. Results: Overall, the DS-exercise group increased significantly more the lean mass, BMC and BMD than the DS-control group (3.1, 3.8 and 1.8 % respectively; all  $p < 0.05$ ); however, these increments did not differ from the non-DS control group. No differences were found in %BF between groups neither pre nor post-training. Conclusion: The conditioning and plyometric jumps training may be useful to get higher increments in BMC, BMD and lean mass in a population of youths with DS, despite we did not find a reduction on the %BF. Further research in this area could help to clarify whether these changes occur in the same mode in non-disabled populations. Acknowledge: This study was supported by Gobierno de Aragón (Project 17/2007) References 1. González-Agüero A, Vicente-Rodríguez G, Moreno LA, Guerra-Balic M, Ara I, Casajus JA 2010 Health-related physical fitness in children and adolescents with Down syndrome and response to training. *Scand J Med Sci Sports* 20:716-724

## Poster presentations

### PP-PM26 Fatigue and Exercise Testing

#### MAXIMAL EXERCISE PERFORMANCE IN RELATION TO FATIGUE AND SELF-EFFICACY IN PATIENTS WITH POSTCANCER FATIGUE

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Background Fatigue after curative cancer treatment is a frequently occurring problem, impairing quality of life. Little is known about physiological factors determining postcancer fatigue. Purpose To examine maximal exercise performance in relation to fatigue and self-efficacy in patients with postcancer fatigue. Methods Severely fatigued ( $n=20$ ) and matched non-fatigued ( $n=18$ ) disease-free cancer survivors, who completed treatment for a malignant tumor at least one year earlier, participated in this case-control study. Fatigue severity was measured by the fatigue severity subscale of the Checklist Individual Strength (CIS-fatigue). Self-efficacy was measured using a task-specific self-efficacy questionnaire. Maximal oxygen consumption was measured during an incremental cycling exercise test using an automated gas analyzer. Results CIS-fatigue scores were significantly higher and self-efficacy scores were significantly lower in fatigued (men 48.3(5.7) and 26.8(2.6), women 49.1(4.3) and 25.6(1.6), respectively) compared to non-fatigued participants (men 13.2(4.4) and 32.1(3.0), women 13.8(6.2) and 30.5(3.4), respectively). Maximal oxygen consumption was significantly lower in fatigued (men 26.8(5.2), women 25.2(6.8) ml/min/kg) compared to non-fatigued postcancer patients (men 38.2(9.7), women 30.4(3.8) ml/min/kg). CIS-fatigue and self-efficacy scores significantly correlated with maximal oxygen consumption (-0.577 and 0.475, respectively). Discussion and conclusion Maximal exercise performance and related maximal oxygen consumption were reduced in fatigued compared to non-fatigued cancer survivors and correlated with higher CIS-fatigue scores and lower self-efficacy scores. The lower maximal exercise performance may be explained either by differences in pre-cancer fitness or by differences in self-efficacy in daily life between severely fatigued and non-fatigued cancer survivors, leading to an inactive lifestyle in the group suffering from postcancer fatigue.

#### FATIGUE AFTER RUNNING MODULATED SPECIFIC REFLEX COMPONENTS OF THE THIGH MUSCLES BUT DID NOT AFFECT POSTERIOR-ANTERIOR TIBIAL TRANSLATION

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Introduction Epidemiological data indicate that injury rates tend to be higher at the end of matches (Price et al., 2004), suggesting fatigue could be related to injury. Rupture of the anterior cruciate ligament (ACL) rank among the most common injuries in sports (Hootman et al., 2007). Therefore, the purpose of the present study was to investigate how posterior-anterior tibial translation and the activity of the hamstring and quadriceps muscles are influenced by fatigue. Methods In 19 healthy subjects, posterior-anterior tibial translation, onset latencies of reflex responses and muscle activity of hamstring and quadriceps muscles were assessed. Data were obtained before, immediately after (post), 30min after (post-30min) and 60min after (post-60min) fatigue which was induced by incremental treadmill running. Reflex responses were evoked by a mechanically induced posterior-anterior tibial translation in the sagittal plane during standing. The distance of posterior-anterior tibial translation was assessed using a knee arthrometer. For statistical analyses, One Way Repeated Measures ANOVA and Friedman Repeated Measures ANOVA on Ranks were used ( $p = 0.05$ ). Results Posterior-anterior tibial translation did not change after the fatigue protocol. The EMG onset latencies of the hamstrings were increased at post, post-30min and post-60min. At post and post-30min, background activity of the hamstrings was enhanced. The reflex responses of the hamstrings were decreased whereas quadriceps activity was increased at the same time. At post-60min, background activity of the hamstrings was highest and the reflex responses were partially recovered. Discussion Fatigue after running did not affect posterior-anterior tibial translation. At post and post-30min, the increased background activity of the hamstrings as well as the enhanced quadriceps activity probably compensated for the exercise-induced decline in hamstring reflex activity and therefore likely contributed to functional knee stability. The decreased reflex activity could originate from (I) fatigue-induced change of intrafusal properties (Zhang et al., 2001), (II) presynaptic inhibition of Ia afferents mediated by group III and IV afferents and (III) changes in intrinsic properties of motoneurons (Racinais et al., 2007). At post-60min measurement, the peaked background activity of the hamstrings and the partially recovered hamstring reflexes probably preserved functional knee stability. References Price RJ, Hawkins RD, Hulse MA, Hodson A (2004). *Br J Sports Med*, 38, 466-71. Hootman JM, Dick R, Agel J (2007). *J Athl Train*, 42, 311-9. Zhang LQ, Rymer WZ (2001). *J Neurophysiol*, 86, 1086-94. Racinais S, Girard O, Micallef JP, Perrey S (2007). *J Neurophysiol*, 97, 596-603.

## RELATIONSHIP BETWEEN RFD AND SPRINT PERFORMANCE IN RESISTED SPRINTING TOWING A RANGE OF RELATIVE LOADS

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**Introduction:** Resisted sprint running (RST) has become a specific strength training method for sprinters (Alcaraz et al., 2008). Cronin and Sleivert (2005) suggested the improvements in athletics tasks that involve significant power output would be gained by training at the load that maximised and individual's power output using an exercise similar to their athletic activity. These authors set strength qualities such as rate of force development (RFD) may better predict athletic performance. However, no studies have showed the relationship between RST and any strength qualities. The main purpose of this research was to determine the relationship between force values and sprint performance in RST, in order to determine the optimal load for RST in the acceleration phase of sprinting. **Methods:** Seventeen men were recruited for the study ( $17.9 \pm 3.3$  years,  $1.79 \pm 0.06$  m and  $69.4 \pm 6.1$  kg). The participants were active competitive athletes who specialized in sprinting. Subjects had previously sled-towing training experience. The athletes performed four 30-m sprints (unloaded sprints and sprints pulling resistances of 10, 15 and 20% of Bm) from a crouched start. The participants were placed 1-m behind the starting line, avoiding the influence of reaction time. The trials' order was randomized for each participant, and an unlimited rest period was given between trials to minimize the effects of fatigue on sprint performance. The sprint trials were performed using a weighed sled (4.7 kg) attached to each athlete by a 3.6-m cord and waist harness. The sprint times were recorded by a photocells system placed at 0, 20 and 30-m. A load cell was attached between waist harness and cord to assess changes in force production over 60-m sprint. RFD was recorded for each trial in the first step. RFD was calculated using the following equation in a 0.02-s period:  $RFD = \Delta F / \Delta t$ . The maximal velocity was measured through the use of a radar gun. **Results:** A Pearson's Product moment correlation coefficient showed that there was no significant association between RFD in resisted sprint and sprint performance in acceleration phase (20 and 30 m without load). No significant correlations were found between RFD and maximal velocity recorded in 30m-sprint unloaded and loaded. **Discussion:** The lack of correlation between sprint performance and RFD in resisted sprint suggested that the strength's behavior in resisted sprint is not representative of changes in sprint performance. In order to determine the optimal load for resisted sprint training new research should be developed in relation to strength qualities. **References:** 1. Alcaraz PE, Palao JM, Elvira JLL, Linthorne NP (2008). J Strength Cond Res, 22(3), 890-897. 2. Cronin & Sleivert (2005). Sports Med, 35, 213-234.

## ACUTE EFFECTS WITHIN 5 DAYS OF DAILY WHOLE-BODY VIBRATION TRAINING ON LEG MUSCLE ACTIVITY, HEART RATE, BLOOD PRESSURE, LACTATE AND IGF-1

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**Acute effects within 5 days of daily whole-body vibration training on leg muscle activity, heart rate, blood pressure, lactate and IGF-1** Rosenberger, A.(1,2), Bargmann, A.(1,3), Müller, K.(1), Beck, L.(1), Liphardt, A-M.(1,2), Mester, J.(2), Zange, J.(1,3) 1: German Aerospace Center (Cologne, Germany), 2: German Sport University Cologne (Cologne, Germany), 3: University of Cologne (Cologne, Germany) **Introduction** Whole-body vibration training (WBVT) has become a popular method in recreational and athletic training and rehabilitation medicine. Acute effects of WBVT as well as long term effects of WBVT have intensively been studied in recent years (for review see Rittweger, 2010). However, little is known about the changes in the acute effects of WBVT on muscle activity and autonomic functions during the initial days of a daily training. We tested the hypothesis that WBVT during slow squats in comparison to mere squats (conventional resistive training, CRT) causes excess muscular activity and cardiovascular reactions over 5 days of daily training. **Methods** Electromyography (EMG) was recorded on the m. rectus femoris and the m. gastrocnemius lateralis. Electrocardiogram (ECG) and continuous finger blood pressure was recorded using a separate data acquisition system (BIOPAC-Systems, Goleta, CA, USA). **Results** On day 1, EMG amplitudes in m. rectus femoris were higher by 36% during WBVT than during CRT. This difference was reduced to insignificantly different levels on day 5. During WBVT, the increase in heart rate (HR) was 15 beats per minute higher than during CRT on day 1. This difference declined and was not significant anymore on days 4 and 5. Net lactate formation was the highest on day 1 ( $3.8 \pm 2.6$  mmol/l in WBVT vs.  $1.2 \pm 1.9$  mmol/l in CRT). On the following days, these differences declined, but still reached statistical significance. Morning and post training levels of IGF-1 were not altered by WBVT and CRT. **Discussion** In most variables, excess effects of WBVT over CRT were largest on the initial day of training and declined to insignificant levels within following days. The higher initial values of the EMG, HR and lactate were expected because vibration training is an additional stress for the human body (Rittweger et al., 2003; Torvinen et al., 2002). Furthermore, WBVT was a new experience for all subjects and needed a more conscious execution of the squats which may have led to worse coordinated and less efficient squats at the beginning of the vibration training. However, the decreasing EMG amplitudes showed a rapid adaptation, also to the additional vibration stimulus, on the neuromuscular level after 5 days of daily training. **References** Rittweger J (2010). Eur J Appl Physiol, 108, 877-904. Rittweger J, Mutschelknauss M, Felsenberg D (2003). Clin Physiol & Func Im, 23, 81-86. Torvinen S, Kannu P, Sievanen H, Jarvinen TA, Pasanen M, Kontulainen S, Jarvinen TL, Jarvinen M, Oja P, Vuori I (2002). Clin Physiol & Func Im, 22, 145-152.

## THE EFFICACY OF A WHOLE-BODY, SELF-PACED INCREMENTAL TEST TO MEASURE MAXIMAL OXYGEN UPTAKE

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The traditional maximal incremental exercise test to exhaustion (MIE) as a measure of maximum oxygen consumption ( $VO_{2max}$ ) is the most widely used exercise test in exercise science. Although the basic design varies, the generic principle is that a pre-set protocol forces a linear, incremental increase in work rate until the subject cannot maintain the required intensity (volitional exhaustion). It has been suggested (Noakes, 2008) that this protocol produces an 'unnatural' form of exercise that disregards three key tenets of 'natural' self-paced or freely chosen exercise: 1. Because the test endpoint is unknown, an 'open-loop' form of exercise is created, where it is impossible effectively regulate work rate in an anticipatory manner and thus construct an appropriate pacing strategy; 2. The fixed incremental work rate is not observed in endurance sports (where  $VO_{2max}$  is considered an indicator of performance); 3. The only control the subject has over intensity is to stop (volitional exhaustion), thus adding a highly subjective and motivational element. A new, self-paced  $VO_{2max}$  protocol (Mauger & Sculthorpe, 2010) has previously been developed and tested in cycle ergometry, where a significantly higher  $VO_{2max}$  was observed when compared to a traditional MIE protocol. This new, self-paced protocol uses incremental 'clamps' on the RPE scale, allowing work rate to vary, which creates a closed-loop form of exercise and addresses those concerns stated by Noakes (2008). Although perceptually regulated exercise tests have been used previously in estimating  $VO_{2max}$  (Eston et al., 2006), self-paced protocols

have never been used to directly test maximal oxygen uptake. The present study tested the efficacy of the new, self-paced protocol in treadmill running and compared measured VO<sub>2</sub>max with a standard treadmill MIE. Significantly higher VO<sub>2</sub>max scores ( $p < 0.05$ ) were observed in the self-paced protocol, when compared to the traditional MIE, which supports previous findings in the use of this new method of VO<sub>2</sub>max testing. It has previously been shown that self-paced exercise is less of a physiological challenge to homeostasis than self-paced exercise of matched intensity, evidenced by a reduced [La] and core temperature (Lander et al., 2009). As these components have been suggested to inform putative central control mechanisms to regulate work rate, it may be that the self-paced exercise allowed by the new protocol increased participants' tolerance of exercise, which led to a higher incidence of achieving a 'true' VO<sub>2</sub>max. References Eston RG, Faulkner JA, Mason EA, Parfitt G. (2006). *Eur J Appl Physiol.* 97(5):535-41. Lander PJ, Butterly RJ, Edwards AM. (2009). *Br J Sports Med.* 43(10):789-95. Mauger, AR, Sculthorpe, N. BASES Annual Congress. Glasgow, September 2010. Noakes TD. (2008). *Br J Sports Med.* 2008; 42(7):551-5.

### ENERGY EXPENDITURE IN SIDE STEPPING

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**Introduction** Our preliminary study showed that there are three different gait patterns in side stepping; walk-like, run-like and gallop-like gait patterns. Walk-like pattern was preferably selected at low speeds, whereas gallop-like pattern was chosen at high speeds (run-like pattern was not normally performed). This study was aimed to answer why these gait patterns were preferred in side stepping. In forward locomotion, it has been shown that humans and other animals move in a way that minimize the cost of transportation (Alexander, 2001). We expected that the same principle can be applied to side stepping. To test this hypothesis, oxygen consumption was compared between walk-like, run-like and gallop-like side stepping on a treadmill. Methods Ten male participants were asked to step sideward on a treadmill. Each participant practiced in advance three gait patterns. Walk-like pattern has double support phase and no flight phase, run-like pattern has flight phase but no double support phase and gallop-like pattern has both of double support and flight phases. The treadmill speed was following; 2.0~4.5 km/h for walk-like pattern and 3.0~5.5 km/h for run-like and gallop-like patterns. Each speed had a duration of 2 min and VO<sub>2</sub> was measured for the last 1 min. Gait patterns and treadmill speed were randomly ordered. Results Walk-like pattern showed the smallest energy consumption at the speed of 3.5 km/h or less, for example, at the speed of 3.5 km/h, VO<sub>2</sub> was: walk-like pattern =  $21.8 \pm 3.3$ ; gallop-like pattern =  $25.3 \pm 3.2$ ; run-like pattern =  $27.1 \pm 2.0$  ml/kg/min. Whereas gallop-like pattern was the smallest at the speed of 4.5 km/h, for example, VO<sub>2</sub> was: walk-like pattern =  $28.7 \pm 2.3$ ; gallop-like pattern =  $27.4 \pm 3.4$ ; run-like pattern =  $28.8 \pm 3.0$  ml/kg/min. Run-like pattern required more energy than gallop-like pattern at any speed tested. Discussion Physiological energy expenditure can explain which type of side stepping is preferred. Walk-like pattern is the most efficient way of locomotion at low speeds and gallop-like stepping is economical at high speeds. Run-like pattern seemed to be a less efficient style than gallop-like pattern in sideward locomotion. During landing phase in any bipedal locomotion, legs must change downward momentum to upward and re-accelerate center of mass toward an intended direction. In gallop-like side stepping, the trailing leg absorbs downward momentum and the leading leg produces upward momentum. Also, the trailing leg produces propulsive force by kicking the ground. The observed efficiency of gallop-like side stepping might be explained by the appropriate role-sharing between the two legs. Reference Alexander R. (2001). *Nature*, 412, 591. Dawson T, Tailor C. (1973). *Nature*, 246, 313-314.

### 3 MINUTES STAGES ARE NOT SUFFICIENT TO OBTAIN STEADY STATE IN WALKING EXERCISE IN SEDENTARY MIDDLE-AGED MEN.

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**Introduction.** Measures of steady state substrate use can be obtained from indirect calorimetry during constant load submaximal exercise. A protocol using 3 minute cycling bouts to measure substrate use has been validated for use in young, moderately trained males (Achten et al., 2002), but was shown to be invalid for older, sedentary subjects for whom a longer submaximal bout was required to obtain steady state (Bordenave et al., 2007). The aim of this study was to evaluate the use of the short-bout protocol in walking exercise, which is known to elicit higher rates of lipid oxidation than cycling exercise at matched intensities (Achten et al., 2003), and to determine whether the short bout protocol may be sufficient to obtain steady state at lower but not higher exercise intensities. Methods. 12 overweight, sedentary males (mean age 55.1 years, mean BMI 30.7 kg/m<sup>2</sup>) performed four 6-minute submaximal treadmill walking trials at intensities corresponding to 20%, 30%, 40% and 50% of their estimated VO<sub>2</sub>max, predetermined from an incremental treadmill test. Oxygen consumption (VO<sub>2</sub>) and respiratory exchange ratio (RER) were measured by expired gas analysis, with lipid oxidation calculated using a stoichiometric equation (Peronnet and Massicotte, 1991). Data from the 2nd and 3rd minute of each exercise bout (SHORT protocol) were compared to the 5th and 6th minute (LONG protocol). Results. The SHORT and LONG protocols showed strong correlations for VO<sub>2</sub> ( $r = 0.98$ ) and lipid oxidation ( $r = 0.73$ ), and moderate correlation for RER ( $r = 0.69$ ). However, when agreement between SHORT and LONG was tested with Bland-Altman analysis, SHORT underestimated VO<sub>2</sub> (mean underestimation of 57 ml/min) and RER (a mean underestimation of 0.06) and overestimated lipid oxidation (mean overestimation of 121 mg/min). There was a significant effect of exercise intensity on the magnitude of the discrepancy; increasing with exercise intensity for all three variables (one way ANOVA,  $p < 0.05$ ). This effect persisted when absolute values were normalized to relative percentage differences between measures from the SHORT and LONG protocols. Conclusion. A 3 minute protocol of constant load walking exercise at intensities corresponding to between 20% and 50% of estimated VO<sub>2</sub>max is not sufficient to reach steady state in middle aged, sedentary men. Furthermore, the magnitude of the difference between SHORT and LONG protocols for metabolic variables increases with exercise intensity. References. Achten J, Gleeson M, Jeukendrup AE. *Med Sci Sport Exercise* 34(1): 92-97,2002. Bordenave S, Flavie S, Fedou C, Brun JF, Mercier J. *Diabetes Metabolism* 33(5): 379-384,2007. Achten J, Venables MC, Jeukendrup AE. *Metabolism* 52(6): 747-752, 2003 Peronnet f, Massicotte D. *Can J Sport Sci* 16(1): 23-29, 1991.



## QUADRICEPS AND INSPIRATORY MUSCLES FATIGUE DURING CYCLE EXERCISE TEST IN THE HEALTHY MIDDLE-AGED MEN

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**Introduction** Whether the inspiratory muscles may fatigue during intense exercise and thereby become a limiting factor to exercise performance is still debated. Little was known about the inspiratory muscles and quadriceps fatigue during exercise in the middle-aged population. This study was aimed to determine whether quadriceps or inspiratory muscles fatigue or both occurred during maximal exercise test in the middle-aged population, and to compare the extent of inspiratory muscles fatigue to that of quadriceps. **Methods** Eleven healthy men aged 50.6 (SD: 5.7) years participated into this study. The activation patterns of diaphragm and vastus lateralis (VL) during incremental maximal cycling exercise test were studied by surface electromyography (sEMG) (EMG100A, Biopac Systems Co., CA). The electrodes were placed in the seventh or eighth intercostal space on the right side of the body at the midclavicular line for recording of diaphragm (Verin et al, 2002). The extent of fatigue characteristics were compared by determining the increase in root-mean-square (RMS) of sEMG data obtained simultaneously during exercise test. To compare the different RMS values among subjects, RMS values were normalised with respect to the maximal sEMG RMS values during maximal contractions at the baseline. **Results** We found that the RMS of both diaphragm and VL increased significantly with increasing exercise workload in both groups. However, the VL fatigued more than the diaphragm at the higher intensity of peak exercise. **Discussion** Dyspnea and leg fatigue were commonly limiting factors to exercise performance. Some studies reported that exercise-induced diaphragmatic fatigue in both sedentary and physically active adults (Mador et al, 1993; Perlovitch et al, 2007). On the other hand, some studies have reported that significant fatigue of quadriceps occurred without induction of diaphragm during cycling exercise (Fitting et al., 1991; Mador et al, 2000). The conflict findings might be due to different exercise types, intensities, assessment tools, and populations. **In conclusion**, this study demonstrated that both diaphragm and VL muscles experience fatigue with increasing exercise intensity in healthy middle-aged men. However, significant fatigue of the quadriceps muscle occurred than the diaphragm with increased exercise load during cycle exercise test. **References** Fitting JW. (1991). Eur Respir J, 4, 103-108. Mador JM, Magalang UJ, Rodis A, Kufel TJ. (1993). Am Rev Respir Dis, 148, 1571-1575. Mador JM, Kufel TJ, Pineda LA. (2000). Am J Resp Crit Care Med, 162, 1760-1766. Perlovitch R, Gefen A, Elad D, Ratnovsky A, Kramer MR, Halpern P. (2007). Respir Physiol Neurobiol, 156, 61-8. Verin E, Straus C, Demoule A, Mialon P, Derenne JP, Similowski T. (2002). J Appl Physiol, 92, 967-974.

## EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON PERFORMANCE AND RATING OF PERCEIVED EXERTION DURING SUBMAXIMAL CYCLING EXERCISE

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**Introduction** Transcranial direct current stimulation (tDCS) is considered a neuromodulatory intervention and that induces excitability changes in the human motor cortex. It has already been shown that tDCS can reduce fatigue and improve endurance time during isometric forearm exercise in healthy subjects. To date, the effects of tDCS on the development of the rating of perceived exertion (RPE) and performance during dynamic exercise have not been studied. Therefore, the aim of this study was to investigate the effect of tDCS on the time to exhaustion (TE) and the development of RPE during submaximal cycling exercise to volitional exhaustion in healthy women. **Methods** Eleven female [24.3(3.0) years] volunteered to participate in this study. During the first session, the subjects performed a maximal incremental exercise test to determine peak power output (PPO). On the second and third sessions, volunteers underwent the experimental procedures (anodal tDCS on left insular cortex (IC) or sham (placebo) condition for 20 minutes followed by cycling exercise at 60%PPO until volitional exhaustion). RPE was recorded every six minute of the test. **Results** TE was significantly higher for anodal tDCS [35.1(6.1) min] than the sham condition [28.7(8.3) min]. RPE gradually increased from start toward the end of exercise, with significant differences between anodal and sham conditions at six [9.6(1.2) vs 11.8(1.6)] , 12 [11.7(2.2) vs 14.0(2.1)], 18 [13.5(1.9) vs 16.0(2.5)], and 24 minutes [15.3(1.6) vs 17.3(1.5)] of the test, respectively. **Discussion** Our first important finding was that anodal tDCS applied to the left IC twenty minutes before exercise improved exercise performance during cycling exercise at 60%PPO by reducing the RPE. Since cerebral hypoxia exerts a large influence on maximal exercise performance, we can speculated that the anodal stimulation improved performance via an increased cerebral oxygen availability after the end of stimulation. Regarding the RPE, there is evidence that the IC is the main brain site responsible for the awareness of subjective feelings from the body. The left anterior IC is activated mainly by positive and affiliative emotional feelings while stimuli that activate the right anterior IC are generally arousing to the body (for example, pain). The findings of the present study showed the possibility of use the tDCS to improve performance and reduce the RPE during submaximal cycling exercise to volitional exhaustion.

## DISSOCIATION IN CHANGES IN EMG ACTIVATION DURING MAXIMAL ISOMETRIC AND SUBMAXIMAL LOW FORCE DYNAMIC CONTRACTIONS AFTER EXERCISE INDUCED MUSCLE DAMAGE

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**Introduction** Exercise induced muscle damage (EIMD) is characterized by muscle pain, symptoms of swelling, muscle shortening, increased serum creatine kinase activity, decreased force output and altered neuromuscular function (Armstrong et al 1991). The aim of this study was to determine how the symptoms of EIMD influence the neuromuscular recruitment patterns during maximal and submaximal isometric and submaximal flexion-extension movements. **Methods** Twenty-five right-handed males were recruited for this study, and were allocated to either a control (n = 13) or experimental group (n = 12). In contrast to the control group, the experimental group participated in an EIMD protocol of the elbow flexor muscles. Subsequently, muscle soreness, arm circumference, resting elbow angle, serum creatine kinase activity, muscle function and EMG activity during maximal voluntary contraction, isometric low force contraction and a submaximal flexion-extension protocol were monitored in both groups for up to 132 hours after the EIMD protocol. **Results** After the EIMD protocol, muscle pain scores in the experimental group peaked after 36 hours with serum creatine kinase activity peaking after 108 hours. Twelve hours after the EIMD protocol, EMG activity had decreased by 20% during a maximal voluntary contraction in the experimental group ( $X_2 = 21.70$ ,  $p = 0.001$ ) and decreased by a further 10% until the end of the study (132 hours after the EIMD protocol) ( $X_2 = 21.70$ ,  $p = 0.01$ ). In contrast, EMG activity during submaximal movement increased significantly during the last two seconds ( $s_2$ ,  $s_3$ ) of the

flexion (s2:  $H = 9.61$ ,  $p = 0.0019$ ; s3:  $H = 11.01$ ,  $p = 0.0009$ ) as well as the first two seconds (s4, s5) of the extension movement (s4:  $H = 8.00$ ,  $p = 0.0047$ ; s5:  $H = 4.05$ ,  $p = 0.0442$ ) from 12 hours after the EIMD protocol. Discussion Classical symptoms of EIMD (increased muscle soreness, swelling, muscle shortening and increased creatine kinase activity, decreased muscle function and force output) (Lambert et al., 2002; Prasartwuth et al., 2005) were observed in the experimental group. A dissociation in EMG response was found in the experimental group between the EMG response during maximal voluntary contraction (decrease) and during submaximal movements (increase). This dissociated EMG response suggests that central regulation influences the neural firing patterns and motor unit activity. References Armstrong RB, Warren GL, Warren JA. (1991) Sport Med 12, 184-207 Lambert MI, Marcus P, Burgess T, Noakes TD. (2002) Med Sci Sport Exerc 34, 602-607 Prasartwuth O, Taylor JL, Gandevia SC. (2005) J Physiol 567, 337-348

### CAUSE OF THE FATIGUE DURING THE INTENSITY ABOVE MAXIMAL LACTATE STEADY STATE

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CAUSE OF THE FATIGUE DURING THE INTENSITY ABOVE MAXIMAL LACTATE STEADY STATE Peinado, AB1; Díaz, V2; Benito, PJ1; Álvarez, M2; Zapico, AG3; Calderón, FJ1 1: Facultad de Ciencias de la Actividad Física y del Deporte – INEF, Universidad Politécnica de Madrid (Spain). 2: Institute of Veterinary Physiology, University of Zürich (Switzerland). 3: Facultad de Educación, Universidad Complutense de Madrid (Spain). Introduction The maximal lactate steady state (MLSS) intensity corresponds to the transition between aerobic and anaerobic metabolism (1) and it is defined as the highest intensity where blood lactate concentration ( $[La]$ ) is maintained stable (2). The factors that influence the time to exhaustion at MLSS are still unclear (3,4). Therefore, the aim of the present study was to compare the physiological responses during cycling performed at MLSS and above MLSS (>MLSS), in an attempt to elucidate which factors are responsible of fatigue at this stage. Methods Twelve male amateur cyclists participated in the study ( $21 \pm 2.6$  years;  $179.8 \pm 7.5$  cm;  $72.2 \pm 9$  kg). Each subject performed an incremental test until exhaustion and two 30 min constant load tests to determine MLSS and >MLSS. MLSS was defined as the highest workload that could be maintained with an increase in  $[La]$  lower than  $1.0 \text{ mmol} \cdot \text{L}^{-1}$  during the final 20 min of the tests (2,3). Cardiorespiratory and blood parameters were measured throughout the tests. Two way ANOVA with repeated measures was used to determine differences between MLSS and >MLSS. The significant level was set at  $\alpha \leq 0.05$ . Results The power output at MLSS and >MLSS was  $280 \pm 28 \text{ W}$  ( $81.8 \pm 7\% \text{ VO2max}$ ) vs.  $297 \pm 29 \text{ W}$  ( $87.3 \pm 7.7\% \text{ VO2max}$ ). Due to exhaustion, only three cyclists were able to complete the 30 min at >MLSS test. There were not significant differences between MLSS and >MLSS tests in cardiorespiratory variables, except in oxygen uptake and ventilation at 30 min. The acid-base response was similar between the two intensities respect the pH values at 30 min ( $7.35 \pm 0.03$  vs.  $7.33 \pm 0.05$ , for MLSS and >MLSS respectively), however we found significant differences in  $[La]$  at 30 min:  $3.80 \pm 0.75$  vs.  $6.85 \pm 2.37 \text{ mmol} \cdot \text{L}^{-1}$ , for MLSS and >MLSS respectively. Discussion Despite there were no differences in cardiorespiratory variables and pH response between the end of MLSS and >MLSS tests, fatigue occurred in 75% of the subjects. Related studies have shown that exhaustion at MLSS appears whilst homeostasis is still maintained, according to the central governor model (3). The similar response between MLSS and >MLSS does not explain the cause of the fatigue at >MLSS and therefore there is an open question concerning why most of the cyclist are not able to maintain exercise performance at >MLSS. References 1. Deckerle, J, et al. Eur J Appl Physiol (2003);89:281-8 2. Beneke, R. Eur J Appl Physiol (2003);89:95-9 3. Baron, B, et al. Br J Sports Med (2008);42:528-33 4. Fontana, P, et al. Eur J Appl Physiol (2009);107:187-92

### THE EFFECT OF MODERATE DEHYDRATION ON STRENGTH AND FATIGUE OF SKELETAL MUSCLE

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Introduction There are conflicting reports as to whether moderate dehydration impairs muscle function (decreased strength and increased fatiguability). This may be due to many studies not isolating dehydration from confounding influences such as hyperthermia and fatigue, or it could be that subjects could not or would not fully activate the muscle. This study investigated the effect of moderate dehydration (~3% bodyweight deficit through sweating) induced by exercise-heat exposure on strength and fatigue of skeletal muscles. Methods Nine physically fit men (mean  $\pm$ SD: age,  $27.8 \pm 5.3$  yr; height,  $182.7 \pm 7.1$  cm; weight,  $79.4 \pm 10.0$  kg) had their body weight and muscle function determined over 3 consecutive days (familiarization-baseline period). Muscle function tests were (1) maximal voluntary isometric contraction (MVIC) of the quadriceps (dominant leg) with a brief superimposed electrical stimulus (TES). (2) fatiguability of the quadriceps (non-dominant leg) with 15 repeated MVICs (3sec contraction - 2sec rest) and TES applied on the 1st, 5th, 10th and 15th contraction, (3) hand grip flexor strength (dominant hand). These tests were undertaken pre-post prolonged treadmill walking that elicited a 3% loss of weight. This bodyweight deficit was maintained overnight (16-18 hrs) and the tests were repeated the following morning (EXP). The strength/fatiguability tests were also undertaken without the dehydration protocol (control trial- CONT) within 1-3 weeks with the order of dehydration and control trials randomized. Results - There was no change in the force production of the dominant leg for any of the conditions ( $p > 0.05$ ) - The handgrip strength was lower during the experimental condition than the control ( $F(1, 8) = 11.5$ ,  $p < 0.05$ ) with no difference in the time of test ( $F(2, 16) = 1.1$ ,  $p = 0.35$ ). - The force produced of non-dominant leg during the EXP condition was lower than that during CONT ( $F(1, 8) = 7.25$ ,  $p < 0.05$ ), the pre test was higher than both post tests ( $F(2, 16) = 7.19$ ,  $p < 0.05$ ) and as trial progressed the subjects force decreased ( $F(2, 16) = 29.3$ ,  $p < 0.05$ ). Discussion This study has shown that there is no significant effect of moderate dehydration on maximum strength of skeletal muscle, yet there was a significant effect of dehydration in increasing muscle fatiguability. Increased fatiguability may be due to an impaired sodium-potassium pump or impaired intracellular calcium regulation. References Adolph, E. F. (1947). Physiology of man in the desert. New York, Interscience. Armstrong, L. E., D.L. Costill, and W. J. Fink (1985). 'Influence of diuretic-induced dehydration on competitive running performance' Med. sci. Sports Exercise 17: 456-461.

### A NOVEL FIELD TEST TO DETERMINE CRITICAL VELOCITY

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Introduction Hinckson and Hopkins (2005) provide the only previous investigation into the reliability of Critical Velocity (CrV) and Anaerobic Running Capacity (ARC). Their study used constant velocity, run to exhaustion trials in which reliability is often poor (Laursen et al., 2007). By contrast, constant distance trials have shown greater reliability (Laursen et al., 2007), although due to the limitations of the manual speed control measures on standard motorised treadmills, these are best performed in a field based setting. Therefore, the aim of this study was to establish the reliability of CrV and ARC using a constant distance trial in the field. Methods Ten trained male middle distance

runners (age: 22±4yrs; VO<sub>2</sub>max 69.1±4.2ml.kg<sup>-1</sup>.min<sup>-1</sup>), completed a familiarisation trial plus three separate experimental trials on a standard 400 m athletics track. Three distances (3600, 2400 and 1200 meters) were used within each trial to achieve finishing times for the runs in the region of 3, 7 and 12 minutes. Participants were instructed to cover the set distance in the fastest time possible. Participants rested for 30 minutes between efforts. Distances were kept in the same order for all repeat-testing trials. Data were modelled using the linear distance-time model, described by the equation:  $d = (CrV \times t) + ARC$ , where:  $d$  = distance run and  $t$  = running time. Results Reliability data yielded a mean group typical error, expressed as a coefficient of variation (CV%) of 2.0% (95% confidence limit (95% CL): 1.4-3.8%) for trials 2-1 and 1.3% (95% CL: 0.9-2.4%) for trials 3-2. There was no significant difference in CrV across trials ( $P < 0.05$ ) and trial comparisons 2-3 fell within the 95% CI of the trial 1-2 comparisons. Based upon a CrV of 4.7m.s<sup>-1</sup> the limits of agreement are  $\pm 0.2$  to 0.5m.s<sup>-1</sup> of the measure for trials 2-1 and  $\pm 0.1$  to  $\pm 0.3$ m.s<sup>-1</sup> for trials 3-2. ARC proved to be less reliable with a group CV% of 18.4% (95% confidence limit (95% CL): 13.5-39.9%) for trials 2-1 and 9.8% (95% CL: 7.0-19.6%) for trials 3-2. Discussion The results of this study demonstrate that a novel constant distance field trial reliably assesses CrV and produces reliability data lower than have previously been reported using constant velocity trials (Hinckson and Hopkins, 2005). Although the assessment of ARC is less reliable, CV% are similar to those reported previously during laboratory-based testing (Hinckson and Hopkins, 2005). References Hinckson EA, Hopkins WG. (2005). *Med Sci Sports Exerc*, 37, 696. Laursen PB, Francis GT, Abbiss CR, Newton MJ, Nosaka K. (2007). *Med Sci Sports Exerc*, 39, 1374.

## Poster presentations

### PP-PM27 Exercise and Health in Special Populations 2

#### EFFECT OF TIME OF DAY ON MFO AND FATMAX DURING EXERCISE IN OBESE AND NORMAL WEIGHT WOMEN

TABARI, E.

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**Introduction** Obesity has become a serious and growing public health problem. Previous ways to combat obesity have failed, and new approaches need to be taken (Wyatt, 2006). The biological clock regulates the expression and/or activity of enzymes and hormones involved in metabolism, and affect on substrate metabolism. Chwalibog et al. (2002) indicated that during day the major oxidative fuel is carbohydrate, while, during night changes in the energy status are accommodated by increasing fat oxidation. Therefore the purpose of this study was to determine the effect of time of day on maximal fat oxidation (MFO) and the exercise intensity at which the fat oxidation rate was maximal (Fatmax) during exercise in obese and normal weight women. **Material and methods** Twenty healthy, untrained (VO<sub>2</sub>max <50 ml/min/kg and less than three sessions per week of physical activity) women between the ages of 19 and 26 yr voluntarily participated in this study. Subjects include 10 obese (BMI >30 kg/m<sup>2</sup>) and 10 normal weight women (BMI 20-25 kg/m<sup>2</sup>). MFO measured during incremental running exercise test with 3 min stages on treadmill by indirect calorimetry method. Student's t-test and one-way ANOVA was used to analyses variables. **Results** In obese subjects, MFO (mg/min/kgFFM) in evening (8.54±1.5) was significantly higher than morning (8.01±1.2) ( $p \leq 0.05$ ). In addition, in normal weight subjects MFO was significantly higher in evening (8.9±1.9) than morning (7.51±1) ( $p \leq 0.05$ ). Fatmax occurred at exercise intensity around 44.6 ± 6% and 40.9 ± 4.4% VO<sub>2</sub>max in obese and 49.9 ± 5.1% and 43 ± 5.9% VO<sub>2</sub>max in normal weight groups in the evening and morning respectively, and it was significantly higher in evening than morning in both groups ( $p \leq 0.05$ ). We found that fat oxidation rates (mg/min/kgFFM) at 60%, 70% and 80 % VO<sub>2</sub>max in the morning and in the evening in normal weight group were significantly higher than obese group ( $p \leq 0.05$ ). **Conclusion** Our data suggest that Fatmax occurred around 44.6 ± 6% and 40.9 ± 4.4% VO<sub>2</sub>max in obese and 49.9 ± 5.1% and 43 ± 5.9% VO<sub>2</sub>max in normal weight groups in the evening and morning, respectively. Fat oxidation was similar in obese and normal weight women at exercise intensity lower than 60% VO<sub>2</sub>max and tended to be higher in normal weight than obese for exercise intensity higher than 60% VO<sub>2</sub>max. At all exercise intensity, fat oxidation rates were higher in the evening than morning. Thus we suggest that exercise in the evening with Fatmax intensity is better for weight loss purposes in obese and normal weight women. **References** Chwalibog, A, Thorbek, G. (2002). Energy expenditure and oxidation of carbohydrate and fat in humans during day and night. *Thermochimica Acta*, 394, 247–252. Wyatt, S.B., Winters, K.P., Dubbert, P.M. (2006). Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. *Am J Med Sci*, 331,166–174.

#### EVIDENCE FOR REDUCED NEUROMUSCULAR FUNCTION IN MEN WITH A HISTORY OF ANDROGEN DEPRIVATION THERAPY FOR PROSTATE CANCER

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**Introduction** Research indicates that men with a history of androgen deprivation therapy for the treatment of prostate cancer (PCa+ADT) experience reductions in muscular strength and non-osseous fat free mass. It remains unknown if the decrease in muscular strength is primarily related to losses in muscle quantity or if a decline in muscle quality is also apparent. This cross-sectional study compared muscular strength and non-osseous fat free mass and the relationship between these measures in men with ADT for the treatment of prostate cancer and asymptomatic matched men. **Methods** Nine subjects (63-83 yr) with a history of prostate cancer and ADT treatment for a minimum of 6 mo (PCa+ADT) and 11 asymptomatic matched eugonadal men (HM; 59-80 yr) were assessed for prostate specific antigen (PSA) and total testosterone (TT). Total body (TBLM) and right thigh non-osseous fat free mass (RTLTM) were assessed using dual-energy x-ray absorptiometry. Peak torque of the right knee extensors at 0°/s (ISO) and 60°/s (CON) were assessed and ISO and CON per unit-mass of RTLTM were also calculated. Data were analysed using a multivariate ANOVA with a bonferroni correction and linear regression analysis with significance set at  $P \leq 0.05$ . **Results** Age, height, mass, body mass index, and prostate specific antigen were comparable between groups ( $P > 0.05$ ) while TT was lower in PCa+ADT ( $P < 0.01$ ). TBLM and RTLTM were similar between groups ( $P \geq 0.075$ ); however, absolute ISO and CON as well as ISO and CON per unit of RTLTM were lower for PCa+ADT ( $P < 0.05$ ). Linear regression analysis revealed significant relationships between TBLM and ISO ( $r^2 = 0.48$ ;  $P < 0.01$ ), TBLM and CON ( $r^2 = 0.42$ ;  $P < 0.05$ ), and RTLTM and CON ( $r^2 = 0.48$ ;  $P > 0.05$ ) in HM; however, comparable relationships were not observed in PCa+ADT ( $P > 0.05$ ). **Conclusion** These data indicate that men receiving ADT for the treatment of prostate cancer for a minimum of 6 months experience reductions in muscular strength and non-osseous fat free mass. Furthermore, the reductions in muscular strength were associated with declines in muscular quality rather than quantitative changes in muscle mass alone. These findings suggest that muscular strength is associated with a decline in neuromuscular function possibly due to reduced neural drive, altered muscle architecture, and/or impaired contractile function. Further research is

needed to identify the specific neuromuscular mechanisms contributing to the accelerated loss in muscular strength associated with ADT+PCa and determine if exercise is an effective intervention for these deleterious changes.

### ENERGY EXPENDITURE DURING SPORTING ACTIVITIES IN TRANSPLANT RECIPIENTS

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**Introduction** Transplant recipients show a reduction in maximal exercise capacity and cardio-respiratory fitness that may be counteracted by physical and sporting activities (Nielsen et al. 2001). The aim of this study was to contribute to the debate about sporting activity and transplantation by presenting metabolic data collected "on the field". **Methods** The energy expenditure during some sporting activities (leisure and competitions) was measured by Sensewear Armband (Bodymedia, USA) in 48 males (age  $48 \pm 13$  yrs; BMI  $24.1 \pm 2.7$  kg.m<sup>-2</sup>) and 9 females (age  $42 \pm 13$  yrs; BMI  $24.0 \pm 3.0$  kg.m<sup>-2</sup>) transplanted patients (heart transplant n=3; liver n=12; bone marrow n=8 and kidney n=34), participating in various winter (alpine and cross country skiing) and summer (cycling, football, trak-&-field, trekking) sporting activities and competitions. Male and female patients had undergone transplantation  $9 \pm 6$  (range 1-23) years and  $9 \pm 4$  (range 2-16) years before the study. The immunosuppressive regimens were being provided according to the institutional standard protocols. Results Patients were involved in sporting activities at intensity higher than 3 METs from  $74 \pm 30$  (football) to  $455 \pm 97$  (trekking) minutes. During sporting activities the mean ( $\pm$ SD) energy expenditure was  $327 \pm 70$  kcal.h<sup>-1</sup> in males and  $266 \pm 35$  kcal.h<sup>-1</sup> in females ( $t=4.784$ ;  $P<0.001$ ). The higher energy expenditure was attained by male football players during a match ( $412 \pm 55$  kcal.h<sup>-1</sup>) and the lower energy expenditure was attained by females trak-&-field ( $259 \pm 38$  kcal.h<sup>-1</sup>). **Discussion** Transplants recipient who practice sports activities are able to express a normal exercise capacity. The levels of physical activity and of daily energy expenditure are able to reduce risk factors potentially modifiable for cardiovascular disease (obesity, sedentary lifestyle, glucose and fat dysmetabolism) in a population that remains at high risk for vascular events (vascular calcifications, medical history prior to transplantation, side effects of immunosuppressive therapy). These patients represent the upper limit of performance currently available for transplant patients and in any way can not be considered representative of the performance of all the transplant recipients population. However, data collected on patients who practice sports activities can help us to understand their potential performance and thus to promote physical activity for all the transplant patients. **References** Nielsen H, Lejeune TM, Lalaoui A, Squifflet JP, Pirson Y, Goffin E. (2001). Nephrol Dial Transplant, 16, 134-40.

### A SINGLE SESSION OF ENDURANCE OR RESISTANCE TYPE EXERCISE SUBSTANTIALLY REDUCES THE DAILY PREVALENCE OF HYPERGLYCEMIA IN TYPE 2 DIABETES PATIENTS.

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**Introduction:** Postprandial hyperglycemia represents a strong and independent risk factor for the development of cardiovascular complications in type 2 diabetes. Regular exercise forms an effective strategy to improve glycemic control. Although the acute effects of endurance type exercise on glycemic control have been well established, the effects of resistance type exercise on blood glucose homeostasis remain largely unexplored. The present study compares the impact of endurance versus resistance type exercise on subsequent 24 h blood glucose homeostasis in various type 2 diabetic subpopulations. **Methods:** Fifteen impaired glucose tolerant subjects (IGT), 15 type 2 diabetes patients treated with oral blood glucose lowering medication only (OGLM), and 15 type 2 diabetes patients using exogenous insulin (INS) were recruited to participate in a randomized crossover experiment. All subjects were studied on 3 occasions for 3 days under strict dietary standardization, but otherwise free-living conditions. During an experimental period, subjects performed either a 45 min resistance type exercise session (at 75% of 1-Repetition Maximum), a 45 min endurance type exercise session (at 50% Wmax), or no exercise at all. Glucose homeostasis was assessed over the subsequent 24 h period by ambulant continuous glucose monitoring. **Results:** Despite the continued use of glucose lowering medication and the consumption of a healthy diet, subjects experienced excessive hyperglycemia (blood glucose  $>10$  mmol/L) throughout a considerable part of the day. In fact, hyperglycemia was prevalent for as much as  $2:11 \pm 0:37$ ,  $9:01 \pm 1:39$  and  $8:16 \pm 1:44$  h:mm (over 24 h) in the IGT, OGLM and INS group, respectively. Overall, the prevalence of hyperglycemia was reduced by  $35 \pm 7$  and  $33 \pm 11\%$  over the 24 h period following a single session of resistance and endurance type exercise, respectively (main effect  $P<0.001$ ). No differences were observed between the glucose lowering effects of resistance versus endurance type exercise. **Conclusion:** A single session of resistance or endurance type exercise substantially reduces the prevalence of hyperglycemia throughout the day in glucose intolerant men, insulin treated, and non-insulin treated type 2 diabetes patients. Both resistance and endurance type exercise should be integrated in exercise intervention programs designed to prevent and treat type 2 diabetes.

### MAXIMAL FAT OXIDATION AT THE DIFFERENT EXERCISE INTENSITY IN OBESE AND NORMAL WEIGHT MEN IN THE MORNING AND EVENING

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**Introduction** Daily light-dark cycle governs rhythmic changes in the behavior and physiology of most species (Froy, 2010). The performances, substrate oxidation as well as the effects of physical exercise are known to depend on the time of a day when the exercise is performed (Yujiro et al. 2006). Also, human studies indicate that heart rate, Gastric emptying, gastro-intestinal enzyme activity, all peak at certain times during the day. Also body temperature, oxygen consumption (Weinert & Waterhouse, 2007) and catecholamine levels are peaked in the afternoon. We hypothesize that change in these variables can alter the substrate oxidation. Therefore, the objectives of the present study were to determine maximal fat oxidation (MFO) and the exercise intensity at which the fat oxidation rate was maximal (Fatmax) at a different exercise intensity in obese and normal weight men in the morning and evening. **Methods** MFO was measured in 12 normal weight (BMI 20-25 kg/m<sup>2</sup>; VO<sub>2</sub>max  $45.7 \pm 3.44$  ml/min/kg) and 10 obese (BMI  $>30$  kg/m<sup>2</sup>; VO<sub>2</sub>max  $37.2 \pm 3.6$  ml/min/kg) men during incremental running exercise test with 3 min stages on the treadmill (Achten et al. 2002). Breath-by-breath measurements were taken during exercise by using an open circuit gas analysis system (COSMED, Quark b2, s.r.l. Rome, Italy). **Results** We found that fat oxidation rates and energy expenditure in both groups in the evening were higher than morning; there were no significant differences in MFO between obese and normal groups. Furthermore, the fat oxidation rate in low intensity exercise ( $<60\%$  VO<sub>2</sub>max) was similar in obese and normal weight groups, but in high exercise intensities, in normal weight men were significantly higher than obese men. Energy expenditure at all exercise intensities in the evening was higher than morning in both groups. **Conclusion** Our data show that in

obese men, MFO in the evening was significantly higher than morning. In addition, in normal weight men MFO was significantly higher in the evening than morning. Fat oxidation rates were similar in obese and normal weight men at the exercise intensity lower than 60% VO<sub>2</sub>max and tended to be higher in normal weight than obese men for exercise intensity higher than 60% VO<sub>2</sub>max. Also, at all exercise intensities, fat oxidation rates were higher in the evening than morning. Thus we suggest that independent of exercise intensity and body fat mass, exercising in the evening is more effective on fat oxidation and decrease body fat mass; therefore, it is better for weight loss purposes in obese and normal weight men. References Achten, J., Gleeson, M., Jeukendrup, A. E. (2002). Determination of the exercise intensity that elicits maximal fat oxidation. *Med Sci Sports Exerc*, 34:1. 92-7. Froy, O. (2010). Metabolism and Circadian Rhythms—Implications for Obesity. *The Endocrine Society*, 30:1, 1-30. Yujiro, Y., Ken-ichi, H., Satoko, H., Nana, T., Toshihiko, M., and Sato, H. (2006). Effects of physical exercise on human circadian rhythms. *Sleep and Biological Rhythms*, 4: 199–206.

### PHYSICAL ACTIVITY ADVICE IN GERMAN PRIMARY HEALTH CARE: ANALYSES IN A COHORT OF COMMUNITY-DWELLING ELDERLY

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**Introduction** Previous studies repeatedly indicated that most elderly people fail existing physical activity (PA) recommendations. For inactive people in old age, a physician's advice seems to be an important requirement to take up PA. The primary health care setting might thus offer the chance to influence and to support older people to be regularly active. Currently, data concerning general practitioner (GP) advice on PA in Germany is missing. Therefore, the aim of this study was to evaluate the rate and characteristics of elderly patients receiving PA advice from their GP. **Methods** Within the 7-year follow-up telephone interviews of the getABI cohort (community-dwelling primary health care patients), participants were asked whether their GP had given them advice to be regularly physically active within the past 12 months. The interview also included socio-demographic variables, medical conditions, walking ability, history of falls and pain, number of GP visits, and amount of PA. **Logistic regression analysis** (unadjusted and adjusted for all covariables) was used to examine factors associated with receiving advice. Analyses comprised only complete cases with regard to the analysed variables. Results are expressed as odds ratios (OR) with 95% confidence intervals (95% CI). **Results** Out of 1,627 analysed patients (median age 77; range 72-93 years; 52.5% women), 534 (32.8%) stated that they had received advice to be regularly physically active. In the adjusted model, those more often receiving GP advice on PA were men (OR [95% CI] 1.34 [1.06-1.70]), those suffering from pain (1.43 [1.13-1.81]), coronary heart disease and/or myocardial infarction (1.56 [1.21-2.01]), diabetes mellitus (1.79 [1.39-2.30]) or arthritis (1.37 [1.08-1.73]), and those taking a high (>5) number of medications (1.41 [1.11-1.80]). **Discussion** The study revealed a relatively low rate of elderly primary care patients receiving GP advice on PA. GPs seemed to focus their advice on patients suffering from chronic medical conditions. There are likely many more patients who would benefit from advice. A number of barriers to GPs for counselling about physical activity have been reported: e.g. time constraints, lack of educational resources in PA counselling, preference of patients for drug treatment, and lack of reimbursement. Novel concepts are needed to overcome barriers to PA counselling in primary health care. The study was conducted within the research cooperation PRISCUS and funded by the German Federal Ministry of Education and Research (01ET0720).

### OVERWEIGHT AND UNDERWEIGHT DISTURBS NEUROMUSCULAR FUNCTION AND PROPRIOCEPTION

PASCHALIS, V.1,2, NIKOLAIDIS, M.G.1,2, THEODOROU, A.A.1,2, DELI, C.K.1,2, RASO, V.3, JAMURTAS, A.Z.1,2, GIAKAS, G.1,2, KOUTEDAKIS, Y.1,2,4

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**Introduction** Overweight is defined as an excessive fat accumulation due to imbalance of energy intake and energy expenditure (Suastika 2006) and is related to changes in body geometry and posture (de Souza et al. 2005). Regarding the underweight individuals, their deficient muscle mass results in musculoskeletal disorders (Mauch et al. 2008) which in turns may influence whole body physiology (Coin et al. 2000). Therefore, the aim of the present investigation was to compare proprioception of lean, overweight and underweight females at rest and after eccentric exercise. **Methods** Twelve lean, twelve overweight and eight underweight females performed an eccentric exercise session using their knee extensors of both lower extremities. Muscle damage and proprioception (position sense, reaction angle and force mismatch) were assessed in the dominant extremity up to 3 days post exercise. **Results** The results indicated that proprioception at rest of the lean individuals is superior to the other two groups. Additionally, a faster reaction angle in the overweight group and a slower reaction angle in the underweight group compared to the lean group was observed. After eccentric exercise, proprioception affected more in overweight and underweight groups compared to the lean group. **Discussion** Pre exercise position sense of the overweight participants was worse, compared to the lean, and this could be associated with over-increased body mass which may reduce control of postural stability (Brockett et al. 1997; Proske et al. 2004). However, the greater muscle damage of the overweight participants led them to produce greater disturbances in proprioception compared to their lean individuals after the exercise session. Regarding underweight participants, their reduced muscle mass (Mauch et al. 2008) and their limited strength output led them to worse pre exercise position sense as well as to greater disturbances in proprioception after eccentric exercise compared with their lean counterparts. **References** Brockett C, Warren N, Gregory JE, Morgan DL, Proske U. (1997). *Brain Res* 771:251-258. Coin A, Sergi G, Beninca P, Lupoli L, Cinti G, Ferrara L, Benedetti G, Tomasi G, Pisent C, Enzi G. (2000). *Osteoporos Int* 11:1043-1050. de Souza SA, Faintuch J, Valezi AC, Sant' Anna AF, Gama-Rodrigues JJ, de Batista Fonseca IC, Souza RB, Senhorini RC. (2005). *Obes Surg* 15, 1238-1242. Mauch M, Grau S, Krauss I, Maiwald C, Horstmann T. (2008). *Int J Obes (Lond)* 32:1068-1075. Proske U, Gregory JE, Morgan DL, Percival P, Weerakkody NS, Canny BJ. (2004). *Hum Mov Sci* 23:365-378. Suastika K. (2006). *Acta Med Indones* 38, 231-237.

### THE EFFECT OF BODY FAT PERCENTAGE ON MAXIMAL FAT OXIDATION RATES IN YOUNG WOMEN

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MIAMI UNIVERSITY

**THE EFFECT OF BODY FAT PERCENTAGE ON MAXIMAL FAT OXIDATION RATES IN YOUNG WOMEN** Blaize, A.N., Potteiger, J.A. Miami University (Oxford, Ohio, USA) **Introduction** Identification of the exercise intensity that elicits the highest rate of fat oxidation (i.e. fat use as a fuel) would allow for the development of more accurate exercise prescriptions in training programs targeted towards the promotion of fat loss and weight loss. There is little existing research that examines how body composition affects substrate oxidation rates in women; therefore, the purpose of this investigation was to examine how body fat percentage affects the maximal fat oxidation rates of women. **Methods** Fifteen female subjects, between the ages of 20-31 years had their body composition assessed using air displacement plethysmo-

graphy. Each subject completed a treadmill graded exercise test, which ended when the subjects respiratory exchange ratio (RER) reached 1.0. Heart rate (HR), RER, volume of oxygen consumed (VO<sub>2</sub>), and volume of carbon dioxide expired (VCO<sub>2</sub>) were recorded every minute using a Parvo Medics metabolic measurement cart. The rate of fat and carbohydrate oxidation was determined using stoichiometric equations and appropriate energy equivalents. Results One-way analysis of variance was used to examine the effect of body fat percentage (low vs. high) on FAT oxidation and CHO oxidation. No significant differences in FAT oxidation or CHO oxidation were found between the low-percent and high-percent groups. To determine if body fat percentage was related to substrate oxidation, Pearson correlation analyses were conducted. Body fat percentage was not significantly correlated to FAT or CHO oxidation. Discussion Past research has shown that women who are classified as obese have higher fat oxidation rates than women who were classified as normal weight (Schutz et al.). These research findings indicate that the greater the fat availability in the body, the higher the fat oxidation rate. The results of this study conflict with previous research. There were no significant differences in fat oxidation or carbohydrate oxidation between the low and high body fat percentage groups. Additionally, body fat percentage could not be correlated to substrate oxidation. These findings indicate that body fat percentage does not affect how women utilize fat during exercise, which could help in the creation of exercise interventions that prevent weight gain and/or promote weight loss in young women. Reference Schutz Y, Tremblay A, Weinsier RL and Nelson KM. Am J Clin Nutr 55: 670-674, 1992.

### ASSOCIATIONS BETWEEN INSULINE-LIKE GROWTH FACTOR-2 AND BMI IN HUNGARIAN ATHLETES

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Introduction Sportgenomics is a new and promising field in sport sciences. Hundreds of genes were identified in connection with sport performance. In international studies IGF2 Apal polymorphism shown to be associated with antropometric parameters like BMI or fat free body mass. IGF2 plays a role in mammalian growth, influencing foetal cell division and differentiation, possibly metabolic regulation and muscle regeneration. Method We examined 108 athletes (51 men, 57 women, mean of ages: 23,5 years) from different sports. DNA was extracted from blood samples using DNA isolating Kit. PCR detections were done with Agilent 2100 Bioanalyzer in GenolD Laboratory. Body weight was measured by using medical scale. BMI was counted as weight/ height<sup>2</sup>. Statistical analysis was done by Statistica 7 program, using ANOVA, the level of significance was determined at 5%. Results In the whole sample we had 8 (7,4%) A/A, 44 (40,7%) A/G, 56 (51,9%) G/G. Means of the parameters in the 3 genotype groups were the following: A/A height 1,71, weight 63,4, BMI 21,5, A/G height 1,78m, weight 73,5kg, BMI 18,1, GG height 1,76, weight 67,3, BMI 21,8. The analysis of variance showed significant difference between the 2nd and 3rd groups, A/G and G/G in BMI (p=0,008). We found no difference between the groups comparing body fat. Discussion The genotype frequencies were similar to the international results (10% A/A, 35% A/G, 55%). Weight and BMI values were also lower in A/A genotype groups compared to A/G, G/G groups. Though in this research we got statistically significant results, all sportgenomical studies should be extended for more genes, investigating complex gene patterns and involving more antropometric, biomechanical parameters. References O'Dell, SD, Day, INM Molecules in focus Insuline-like growth factor II (IGF-II). Int J Biochem Cell Biol 30(7):767-71, 1998. Schragger MA et al. Insulin-like growth factor-2 (IGF2) genotype, fat-free mass, and muscle performance across the adult life span. PresS. J Appl Pysiol (August 6, 2004). 10.1152/jappphysiol.00985.2003 Gaunt TR et al. Positive Associations between single nucleotid polymorphisms in the IGF2 gene region and body mass index in adult males. Hum Mol Genet 10(14):1491-501, 2001.

### EFFECTS OF RAPID WEIGHT LOSS AND WEIGHT REGAIN ON SLEEPING METABOLIC RATE, DIET-INDUCED THERMOGENESIS AND SUBSTRATE OXIDATION

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Introduction Athletes participating in sports with specific weight categories often compete at 5–10% below their habitual body weight (BW). Resting and sleeping metabolic rate (SMR) can be reduced in response to a loss of fat mass (FM) or fat-free mass (FFM) during rapid weight loss (1). It is unclear whether diet-induced thermogenesis (DIT) and substrate oxidation are also affected by rapid weight loss. Although prior studies suggested that regained weight is composed predominantly of FM (2), it is unknown what effects acute (~24 hour) weight regain after rapid weight loss has on SMR, DIT, and substrate oxidation. The present study examined the effect of rapid weight loss and weight regain on SMR, DIT and substrate oxidation. Method This study evaluated six healthy young male athletes who had experienced rapid weight loss (~5%BW) and weight regain. Each participant's body composition and metabolic rate were evaluated at three time points; 1 week before acute weight loss (baseline (BL)), the day after 7 days of weight loss (WL) and the day after acute weight regain (WR). The FM, FFM and total body water (TBW) were estimated by underwater weighing and 2H and 18O dilution methods. The SMR was measured in an indirect human calorimeter room (for five hours, 00:00 to 05:00). After an overnight fast, DIT was measured in the athletes for 2 hours after they ate the same meal in the chamber (07:00 to 09:00). Results Compared with BL, the BW, FM, FFM, and TBW were significantly decreased after weight loss (-4.2, -1.4, -2.8 and -1.9 kg, respectively). During the WG, FFM and TBW were regained (+2.7 and +2.2 kg, respectively) to a level not significantly different from BL. In contrast, FM was slightly increased during the WG period (+0.6 kg) but remained significantly lower than at BL. DIT (kcal) was not significantly changed. However, compared with BL, carbohydrate oxidation of the DIT component was significantly decreased at WL, and regained at WG (896, 432, 893 kcal/day, respectively). In contrast, lipid oxidation of the DIT component was significantly increased at WL (-194, 252, -219 kcal/day, respectively). Discussion During the WL period, DIT carbohydrate oxidation was inhibited while lipid oxidation was augmented. The FM was not regained to BL levels during the WG period, but LBM and TBW were rapidly increased over a 24-hour period. Although the underlying mechanism has not yet been elucidated, glycogen depletion followed by supercompensation, and the dehydration–rehydration process are possible mechanisms. References (1) Kukidome et al, Jpn J Phys Fitness Sports Med, 2007 (2) Dollo AG et al, Int J Obes Relat Metab Disord, 1996

### BODY COMPOSITION, MUSCLE STRENGTH AND FITNESS FOR PERITONEAL DIALYSIS PATIENTS WITH CHRONIC RENAL FAILURE

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Introduction It is common for patients with chronic renal failure (CRF) to have frequent complaints of low aerobic capacity, muscle weakness and chronic fatigue. The present body of evidence indicates that patient outcome is compromised if total Kt/V is below 1.7 (Lo, 2003;

Yao et al., 2001). An adequacy of weekly peritoneal creatinine clearance (CCr) above 60 L/1.73 m<sup>2</sup> is also suggested (Paniagua et al., 2002). The purpose of this study was to characterize body composition and muscle strength in Dialysis Peritoneal patients (DP) in both genders. We also pretend to analyze the values of these variables considering the cut-offs created for adequacy variables. Methods The study involved 34 patients with DP, 21 men (age: 52.10 ± 11.11 years old) and 13 female (age: 40.92 ± 14.28). Body composition was assessed by bioimpedance (TANITA TBF 300) and by dual-energy X-ray absorptiometry (DEXA Hologic QR). Muscle strength was measured with Isokinetic Dynamometer (Biodex). We measured spontaneous physical activity with an accelerometer (Actigraph GT1M Actilife-2009) for 7 days. The amount of dialysis was given by Kt/V and Clearance of Creatinine (CCr). Cut-offs for Kt/V (1,7) and for CCr (60L/SEM. /1,73m<sup>2</sup>) were consider in our study. Results Males showed higher values on Body Mass Index (BMI), Lean Mass (LM), and Bone Mineral Density (BMD) and lower values on Fat Mass (FM) as in the general population. The analysis of dialysis peritoneal adequacy with the other variables shows a higher values on BMD, FFM, and isokinetic strength on elbow extension movement with KT/V values under 1,7. Discussion Ours results did not differ about the usually gender differences on the BMI, FFM, BMD and FM. The significant differences between groups lower and upper the cut-off value for Kt/V on body composition and strength, contradict previous studies that refer that inclusive survival was significantly lower in patients with a Kt/V of <1.7 (Lo, 2003; Yao et al., 2001). These results could be influenced by the fact that our sample included more male than female subjects (mean ± SD of man and women Kt/V were respectively 1,7 ± 0,5 and 2,04 ± 0,7). Even the current knowledge suggest that the values of Kt/V should be higher than 1.7, we recommend that others variables as body composition and strength should be used as adequacy for DP patients once these variables are common related with better level of health. References 1 - Lo, W.K. (2003). *Perit Dial Int*, 23 (S2): S69 - S71. 2 - Yao Q, Lin AW, Qian JQ, Ren Q, Zhang DY, Ying H. (2001). *Hong Kong J Nephrol*; 3:79–83. 3 - Paniagua R, Amato D, Vonesh E, Correa–Rotter R, Ramos A, Moran J, et al. (2002). *J Am Soc Nephrol*; 13:1307–20.

## INVESTIGATIONS INTO BODY COMPOSITION AND VITAMIN D STATUS IN UK PROFESSIONAL JOCKEYS

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Wilson, G1, Fraser, W.D2, Drust, B1, Morton, J.P1 and Close, G.L1 1. Liverpool John Moores University, Liverpool, UK 2. University of Liverpool, Liverpool, UK Investigations into body composition and vitamin D status in UK professional jockeys Introduction - The nutritional practices of professional jockeys generally involve a low calorie diet, poor food choices and a reliance on sauna's to 'make weight' (Waldron-Lynch et al. 2010). Additionally, the common use of laxatives, appetite-suppressants, and forced vomiting has been reported (Leydon & Wall. 2002). However, there is a limited data available on the effects that such practices may have on body composition, vitamin D status and markers of ill-health in UK professional jockeys. Method - Eighteen professional UK based male flat jockeys were recruited for this study. All jockeys were required to visit the laboratory following an overnight fast to have a DXA scan for the assessment of body fat and bone mineral density, to give a venous blood sample for the assessment of vitamin D2 and D3 (25-OHD) using tandem mass spectrometry and to give a urine sample for the measurement of urine osmolality (UO). Data were compared with normative data using 1-sample T-tests. Results - Mean (SD) Age (years), Height (M) and Weight (Kg) for the 18 jockeys were 25 (3.7) 1.67 (0.05) and 56 (2.7) respectively. BMI (Kg/m<sup>2</sup>) was 20 (1.3) whilst mean body fat (%) was 13.5% (3.4). Mean urine osmolality (mOsmols/Kg H<sub>2</sub>O) was 820 (208). The mean BMD Z Score was -0.95 (0.49) significantly lower than normal (P<0.05) whilst 25-OHD (ng/ml) was 15.2 (12.7) significantly lower than normal (P<0.05). Discussion - Despite widespread reporting of dehydration techniques to 'make weight' the mean body fat was 13.5%, which is 3-5% higher than data reported in professional boxing (Morton et al. 2010). Mean BMD Z scores combined with low vitamin D concentrations suggests that the current dietary practices are having detrimental effects on bone health. Urine osmolality suggested severe dehydration. Conclusion - There is evidence that the dietary practices employed by UK professional jockeys tested here may be detrimental to optimal health and performance. With a combination of low vitamin D status, relatively high body fat and (self-report) lack of basic nutritional knowledge there is a need to educate these athletes on healthier ways to 'make weight' that could improve health and performance. References Leydon. M.A, & Wall. C. (2002). New Zealand jockeys' dietary habits and their potential impact on health. *International Journal of Sport Nutrition & Exercise Metabolism*. 12. 220-237. Morton. J.P, Robertson. C, Sutton. L, et al. (2010). Making Weight: A case study from professional boxing. *International Journal of Sports Nutrition & Exercise Metabolism*. 20. 1, 80-85 Waldron-Lynch. F, Murray. B.F, Brady. J.J, et al. (2010). High bone turnover in professional Irish jockeys. *Osteoporosis International*. 21. 3, 521-525.

## Poster presentations

### PP-PM28 Soccer 3

#### SELF-ASSESSED TACTICAL SKILLS OF ELITE YOUTH SOCCER PLAYERS WITH DIFFERENT ACADEMIC ACHIEVEMENT

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Self-assessed tactical skills of elite youth soccer players with different academic achievement Kannekens, R., Elferink-Gemser, M.T., Visscher, C. Center for Human Movement Sciences, University Medical Center Groningen, The Netherlands HAN University of Applied Sciences, Institute for Studies in Sports and Exercise, Nijmegen, The Netherlands Introduction A positive relationship has been established between sport performance and tactical skills (e.g., Kannekens et al., 2009; Williams et al., 1993) and between sport performance and academic achievement in elite youth athletes (e.g., Jonker et al., 2009; Umbach et al., 2006). Unknown, however, is whether elite youth athletes with different academic achievement score differently on tactical skills. Therefore, the aim of this study was to compare the self-assessed tactical skills of elite youth soccer players with different academic achievement. Methods The tactical skills inventory for sports (TACSIS; Elferink-Gemser et al., 2004) with questions related to declarative and procedural knowledge was used to measure self-assessed tactical skills of 93 elite youth soccer players (mean age 17.3±0.6) attending either pre-vocational (n=45) or pre-university (n=48) schools. Results Multivariate analyses of covariance with academic achievement as factor and field position and repeating class in school as covariates, revealed differences between elite youth soccer players attending pre-vocational and pre-university schools on the total construct of self-assessed tactical skills (p<.05) in favour of players at the pre-university schools. Discussion Pre-university students primarily learn to store knowledge pertaining to cognitive domains (Ministerie van OCW, 2008). In contrast, students attending pre-vocational schools primarily learn skills, which they have to apply in other situations (Ministerie van OCW, 2008). It is suggested that the

cognitive skills players acquire attending pre-university schools may help them or are consistent with declarative knowledge in sport situations (i.e., 'knowing what to do'). Regarding procedural knowledge (i.e., 'doing it'), no clear picture for its relation with academic achievement is derived from the results. References Elferink-Gemser, M.T., Visscher, C., Richart, H., Lemmink, K.A.P.M. (2004). Percept Mot Skills 99: 883-95 Jonker, L., Elferink-Gemser, M. T., & Visscher, C. (2009). High Ability Studies, 20, 55-64. Kannekens, R., Elferink-Gemser, M. T., & Visscher, C. (2009). J Sports Sci, 27, 807-812. Ministerie van Onderwijs, Cultuur en Wetenschappen (2008). Retrieved March 13, 2009, <http://www.minocw.nl/vo/235/Over-voortgezet-onderwijs.html> Umbach, P. D., Palmer, M. M., Kuh, G. D., & Hannah, S. J. (2006). Research Hig Educ, 47, 709-733. Williams, M., Davids, K., Burwitz, L., & Williams, J. (1993). Percept Mot Skills, 76, 579-593.

## EFFECTS OF AN ONE WEEK SOCCER-SPECIFIC HIGH INTENSITY INTERVAL TRAINING ON THE PERFORMANCE OF AMATEUR SOCCER PLAYERS

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Purpose: This study aimed to analyze the effects of a soccer-specific high intensity interval training micro-cycle (SS-HIIT) on performance parameters, on stress recovery balance and biochemical damage and inflammation markers respectively. Methods: A training group (TG) consisting of 8 amateur soccer players completed 11 training sessions within 6 days, whereas no exercise training was performed by subjects of a control group (CG) (n=8). A battery of exercise performance tests (maximal exercise test on a treadmill; Yo-Yo intermittent recovery test level1 (Yo-Yo IRI); Running Anaerobic Sprint Test (RAST) and a 20-meter sprint test) were performed before the intervention and following SS-HIIT respectively. Blood samples were drawn before, as well as 3 and 7 days following the loading period and creatine kinase activity; myoglobin, interleukine 6, leptin, adiponectin, troponin and NT-proBNP were analyzed. Additionally the stress-recovery balance questionnaire (RESTQ-sport) was completed. Training was performed twice daily and consisted of 4 repeated bouts over 4 minutes performed with 95% of the HFmax. interspersed by 3 minutes of low-intensity periods performed with 70% of the HFmax each. These exercise bouts were organized with soccer-specific small-sided-games. Results: The study showed sign. improvements with regard to performance at the anaerobic threshold (p=0,011), to the running performance (Yo-Yo Intermittent Recovery Test, p=0,000), to the average performance of the RAST (p=0,001) and to the RAST fatigue index (p=0,008) in the TG without any changes in CG. Sprinting time however did not change significantly. No sign. elevations of the biomarkers compared to baseline data could be detected following 3 and 7 days of recovery in both groups. RESTQ-sport questionnaire showed an increased physical strain of the participants of the TG immediately following the intervention. Conclusion: These results underline the effectiveness of repeated interval training performed in a block micro-cycle in enhancing soccer-specific performance. Although players demonstrate an increased stress immediately following this intervention, biochemical markers used for the diagnoses of overtraining are not elevated following 3 and 7 days of passive recovery. Based on these results it seems that a high intensity endurance micro-cycle with two training sessions a day over a week is well tolerated by amateur soccer players.

## EVALUATION OF PLAYERS' ACTIVITY DURING AMATEUR PRESEASON SOCCER PERIOD

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Introduction Despite the widespread use of the performance monitoring in soccer, more information is available for elite players with respect to no-professional ones. Thus, the purpose of this study was to provide a motion analysis of trainings (TR) and friendly matches (FM) of an amateur soccer team during the 2010 preseason. Methods Although 22 players took part at preseason only 8 of them (age 26.2±3.3 yrs) were continuously monitored during all TR and FM by means of GPS devices (SPI Pro X, 15 Hz). The variable studied was the percentage of time spent in each one of the following 6 speed categories: standing (ST; 0-0.6 km•h<sup>-1</sup>), walking (W; 0.7-7.1 km•h<sup>-1</sup>), jogging (J; 7.2-14.3 km•h<sup>-1</sup>), running (R; 14.4-19.7 km•h<sup>-1</sup>), high-speed running (HSR; 19.8-25.1 km•h<sup>-1</sup>), sprinting (SP; >25.2 km•h<sup>-1</sup>). The different components of TR were classified in 5 categories: Small-sided-games (SSG), Situational (SI) and Tactical (TA) drills, Training matches (TM), and TM with adapted rules (TMR). A MANOVA for repeated measures was applied for FM analysis, while a descriptive statistics were used for TR analysis. Results The FM analysis showed that players spent meanly 3.4±1.8%, 65.8±8.0%, 25.0±6.8%, 4.7±2.1%, 0.9±0.5% and 0.1±0.1% of time per match for ST, W, J, R, HSR and SP, respectively. The multivariate analysis of FM indicated main effects for matches (p=0.014) and for halves (p=0.018). The univariate tests showed matches differences for ST (p=0.006) and HSR (p=0.014), while half differences were for ST (p=0.003), W (p=0.029), J (p=0.038), and R (p=0.028). The TR analysis indicated as players spent meanly 6.8±8.4%, 63.5±10.1%, 25.4±10.3%, 3.6±2.1%, 0.6±0.6% and 0.1±0.2% of time per TR for ST, W, J, R, HSR and SP, respectively. In particular, the SI showed the highest and lowest values for ST (28.6±8.5%) and W (58.1±6.8%) respectively, while TA, SSG and TM was less than 1% for HSR and SP. Discussion The FM analysis highlighted that players spent a reduced time at high-intensity running (R, HSR and SP), which could be explained by the amateur level, the preseason period and the nature friendly of the matches. Comparing our data with those of elite level (Bradley et al., 2010) they are similar for high-intensity, while the fatigue occurrence (Mohr et al., 2003) could explain the higher time spent in ST and W, and lower time in J and R registered during the second half. The TR analysis confirmed that players spent more time at low-intensity (ST, W and J) than at high-intensity running, while TM were the most related to reproduce the FM demands. References Bradley PS, Di Mascio M, Peart D, Olsen P, Sheldon B (2010). J Strength Cond Res, 24(9), 2343-2351. Mohr M, Krstrup P, Bangsbo J (2003). J Sports Sci, 21, 519-528.

## THE NUTRITIONAL STATUS OF YOUNG ELITE SOCCER PLAYERS

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Introduction The condition of health and ability of athlete to compete both physically and mentally is influenced by the intake, absorption and utilization of nutrients and it is estimated through nutritional status (NS). Inadequate nutritional strategies can have negative impact on sports performance in endurance and energy demanding sport such is soccer. The aim of this study was to analyze NS of soccer players and correlate with blood, biochemical, anthropometric and ergospirometric parameters. Methods In this cross-sectional study 40 male elite soccer players completed 3-day dietary record at the beginning of training season. At the same time anthropometric measurement and ergospirometry test were conducted. Lipid status, hematological, biochemical, oxidative and anti-oxidative stress parameters were sampled from athletes as well. The fluid, energy, macronutrient and micronutrient intakes were calculated using COSMED FMed 2.0



software. Results Athletes had a mean age, height, weight, BMI and F% of  $16.7 \pm 0.7$  years,  $179.2 \pm 6.1$  cm,  $71.5 \pm 7.0$  kg,  $22.2 \pm 1.5$  and  $9.33 \pm 2.7$ , respectively. Daily energy intake (EI) was  $3042.9 \pm 905.9$  kcal which is significant lower ( $p < 0.001$ ) than the calculated values. EI was derived from carbohydrate, fat and protein by  $52\% \pm 8.2$ ,  $31.0\% \pm 5.5$  and  $17\% \pm 3.5$ . Fluid intake (ml) was very low  $1782.3 \pm 714.7$  and there is doubt about the validity of reported values. In terms of micronutrient intake, players had variation from DRI (%DRI) for Ca (71.6), Mg (94.8), Fe (134.5), K (71.2), Na (277.6), Vit.C (210.8), Vit.B6 (23.8) and Vit.B12 (61.1). Cholesterol (112.0) and saturated fatty (157.6) intake was above DRI. 22 players had iron deficiency without anemia ( $11.6 \pm 1.5$ ) that is already described in literature as a factor that can have impact on endurance. EI was positively correlated with Fe ( $p < 0.01$ ) and Ca ( $p < 0.05$ ) intake. F% demonstrate significant difference ( $p < 0.05$ ) for various soccer position in offense. The ANOVA showed that EI had significant effects on  $VO_{2max}$ . Discussion According to our and literature data, NS assessment of young soccer players suggests that they should increase EI together with a higher carbohydrate proportion. Research indicates that fluid and micronutrient intake is inadequate, so players should adopt dietary habits that ensure DRI. Interactions between EI and  $VO_{2max}$  clearly show that energy availability affects sports performance and this should be considered when training and nutritional strategies in soccer are planned. References 1. Caccialanza (2007). J Sports Sci, 6, 538-542 2. Maughan, R.J. (1997). Br J Sports Med, 31:45-47

## FOOTBALL, HEALTH AND HOMELESSNESS. THE COMPLEXITIES OF ENGAGING HOMELESS MEN IN REGULAR PHYSICAL ACTIVITY.

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Introduction: At present, there are over 6,000 single homeless men living in England (Department for Communities and Local Government, 2010). Single homeless people have, on average, worse health than the population as a whole (Bines, 1994). Participation in regular recreational football can significantly improve the health of men (Krustrup et al., 2010). This study explores the biological, psychological and social effects of engaging homeless men in regular physical activity through a Football in the Community programme. Methods: 15 homeless men (mean  $\pm$  SD: age  $24.4 \pm 3.5$  years, height  $175.9 \pm 4.8$  cm, mass  $74.0 \pm 14.2$  kg) engaged in a 12 week programme consisting of 4 hours of football training per week. Indices of health (body composition, blood pressure and resting heart rate) were measured pre and post the intervention. The 1st author adopted a practitioner-cum-researcher role and was immersed in the planning and delivery of the programme. Social and psychological issues were discussed with participants through informal client-researcher interactions and data was collated through field notes and personal reflections. Results: Total % body fat and total fat mass decreased from pre ( $19.20 \pm 3.96$  % and  $16 \pm 8.5$  kg respectively) to post testing ( $18.25 \pm 5.02$  % and  $15.4 \pm 9.1$  kg). Lean mass increased from  $64.5 \pm 21.5$  kg to  $65.5 \pm 20.9$  kg, whilst blood pressure and resting heart rate decreased from  $130/84 \pm 20$  and  $82 \pm 30$  bpm respectively to  $123/78 \pm 5$  and  $76 \pm 27$  bpm. However, although 100% of participants reported that the programme had vast appeal to them, adherence to the complete programme was poor ( $n=2$ ) due to the complexities and irregular lifestyles of this population. Issues with transport, lack of motivation and poor health were common explanations for irregular and non attendance. Discussion: Adherence to a regular physical activity programme can pose a challenge to homeless, single men. Further research is required to explore the barriers and realities that homeless men face when attempting to engage in physical activity in order to design a programme that is likely to accrue greater health benefits through higher levels of adherence. References: Bines, W. (1994) Health of single homeless people, Joseph Rowntree Foundation. Available at: <http://www.jrf.org.uk/publications/health-single-homeless-people>. Accessed on 04/02/10 Department for Communities and Local Government (2010). Statutory Homelessness: September Quarter 2010 England. Available at: <http://www.communities.gov.uk/documents/statistics/pdf/1791642.pdf>. Accessed on 04/02/10. Krustrup, P., Aagaard, P., Nybo, L., Petersen, J., Mohr, M. and Bangsbo, J. (2010) Recreational football as a health promoting activity: a topic review. Scandinavian Journal of Medicine and Science in Sports 20 (1), 1-13.

## RELATIONSHIP BETWEEN JUMP AND SPRINT ABILITY IN FOOTBALL PLAYERS OF DIFFERENT AGE

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Introduction The relationship between jump and sprint ability has been widely assessed, analyzing different jump types, and different sprint distances (Stolen et al., 2005). Lately, sprint distances of 5m and 30m have been widely used in football testing, so, the objective of the present study is to report reference values and to analyze the correlation of squat jump (SJ) and countermovement jump (CMJ) with sprint ability using such distances in three base categories of a Spanish professional football team. Methods A total of 102 players have been assessed from three categories: U15 (age:  $14.02 \pm 0.273$ ;  $N=36$ ), U16 (age:  $15.45 \pm 0.505$ ;  $N=37$ ), U18 (age:  $17.55 \pm 0.801$ ;  $N=39$ ), excluding the goalies. Training load was controlled during the two days prior to testing (two days before: light training, day before: no training). Jump ability (SJ, CMJ) was assessed by using a contact mat, and sprint ability (5m, 30m) by using three pairs of photo cells positioned at 0.5m from ground level. Both systems were connected to a laptop to collect data. All testing was performed in-season and when the coach deemed the players were at their best performance level. Data (mean $\pm$ SD), and correlation studies are presented. Results The values obtained for jump ability were the following for U15, U16, and U18: SJ ( $33.7 \pm 4.5$ cm,  $34.9 \pm 4.3$ ,  $38.6 \pm 3.3$ cm, respectively;  $p < 0.05$ ), and CMJ ( $37.1 \pm 4.5$ cm,  $37.1 \pm 4.9$ cm and  $42.5 \pm 4.1$ cm, respectively;  $p < 0.05$ ). With regards to sprint ability, the values obtained were: for 5m sprint ( $1.004 \pm 0.0481$ sec,  $0.984 \pm 0.501$ sec, and  $0.939 \pm 0.047$ sec, respectively;  $p < 0.05$ ), and for 30m sprint ( $4.454 \pm 0.36$ sec,  $4.285 \pm 0.213$ sec, and  $4.191 \pm 0.116$ sec, respectively;  $p < 0.05$ ). The correlation found between the 5m sprint and the jump testing was  $r = -0.566$  ( $p < 0.05$ ) for SJ and  $r = -0.551$  ( $p < 0.05$ ) for CMJ. Furthermore, the correlation found between the 30m sprint and the jump testing was  $r = -0.634$  ( $p < 0.05$ ) for SJ and  $r = -0.617$  ( $p < 0.05$ ) for CMJ. It was observed that, when analyzing each category separately, the correlation, although statistically significant in all categories, was stronger as we move up; therefore, correlation tends to be lower in U15 and greater in U18. Discussion The values presented show the evolution of jump and sprint ability, improving from the inferior category to the superior ones. The observed sprint values are in agreement with those reported in the literature while jump values are inferior and, thus, improvable. Moderate correlations were found between jump ability and sprint, increasing as players move up from one category to the following; from the results it can be derived that there is possibly greater influence of coordinative factors in the lower categories, losing influence as strength becomes more important over the years. References Stolen T, Chamari K, Castagna C, Wisloff U. (2005). Sports Med, 35, 501-536.

## 5 WEEK OF REPEATED SPRINT TRAINING CAUSE MODERATE EFFECT ON YO-YO IR1 AND 35M SPRINT TIME IN ADULT AMATEUR SOCCER PLAYERS

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Introduction Research indicates that the ability to perform high intensity running is important in soccer. Hence, it has been suggested that athletes in soccer can benefit from the inclusion of speed-endurance and high-intensity training (Iaia and Bangsbo 2010). Therefore, the aim of this study was to investigate the effect of repeated sprint training on repeated sprint ability (RSA) and Yo-Yo IR1 on adult amateur soccer players. Methods Fourteen male amateur soccer players (age  $22.7 \pm 3.1$  yrs, mass  $77.2 \pm 8.6$  kg, and height  $181 \pm 0.06$  cm) from Norwegian national level four, were tested in RSA (7x35m) and Yo-Yo IR1. These tests were conducted on two separated days. Further, the subjects were divided into one repeated sprint group (RS) and one contrast group (CG), both training twice weekly during team practices. The RS training consisted of 4 sets x 7 x 35m sprints with start every 30th second interspersed with 3 min active recovery between sets. The CG training consisted of four sets of 3.5 min. running with a ball in a specific "dribbling track", with 3 min. active recovery between sets. Differences between pre- to post-test were calculated using paired t-test. Possible between group differences in performance were tested by unpaired t test. Differences were considered significant at  $p < 0.05$  and results are presently expressed as mean  $\pm$  standard deviations (SD). Also, Cohen's d was calculated (Rosnow and Rosenthal 1996) to determine the effectiveness of the repeated sprint and contrast training. Results No significant changes were found in RSA, maximal speed or Yo-Yo IR1. However, improved (not significant) Yo-Yo IR1 performance was observed within both RSG ( $\sim 10\%$ , from  $1444 \pm 562$  to  $1590 \pm 342$  m) and CG ( $\sim 5\%$ , from  $1710 \pm 505$  to  $1800 \pm 512$  m). Based on the scale developed by Batterham and Hopkins (2006) we found a moderate effect on Yo-Yo IR1 ( $d = 0.34$ ) and 35m sprint time ( $d = 0.20$ ) and a trivial effect on mean 35m repeated sprint time ( $d = 0.06$ ) within the RSG. The contrast training within CG gave a moderate effect on 10m ( $d = 0.27$ ) and 35m ( $d = 0.59$ ) sprint time, as well as on mean 35m repeated sprint time ( $d = 0.40$ ), while only trivial effect on Yo-Yo IR1 ( $d = 0.19$ ). Discussion Present results indicate that 5 weeks of twice weekly repeated sprint training cause a moderate effect on Yo-Yo IR1 and 35m sprint performance. Although present changes were not found to be statistical significant, a 10% improvement in Yo-Yo IR1 performance could indicate an improved ability to perform high-intensity running in soccer matches. However, we speculate that to gain significant improvements, present players would need a longer period of systematic repeated sprint training as this was a new form of physical training for them. References Batterham, A. M. and Hopkins, W. G. (2006). *Int J sports Physiol Perform*, 1(1): 50-57 Iaia, F. M. and Bangsbo, J. (2010). *Scand J Med Sci Sports*, 20 (2): 11-23. Rosnow, R. L. and Rosenthal, R (1996). *Psychological Methods*, 1(4): 331-340.

## CHANGES IN HORMONAL CONCENTRATIONS AND BLOOD BIOCHEMISTRY OVER THE PRESEASON AND FIRST COMPETITIVE SOCCER MESOCYCLE IN STARTERS AND NON-STARTERS

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CHANGES IN HORMONAL CONCENTRATIONS AND BLOOD BIOCHEMISTRY OVER THE PRESEASON AND FIRST COMPETITIVE SOCCER MESOCYCLE IN STARTERS AND NON-STARTERS Kostas Patras<sup>1,3</sup>, Thomas Giannitopoulos<sup>3</sup>, Spyridon Siaravas<sup>3</sup>, Aggelos Evaggelou<sup>2</sup>, Anastasios D. Georgoulis<sup>1</sup>. 1Orthopaedic Sports Medicine Center, School of Medicine, University of Ioannina, Greece 2Laboratory of Physiology, School of Medicine, University of Ioannina, Greece 3F.C PAS Giannena 1966 INTRODUCTION: Soccer is a sport that is characterized by the application of a complex training nature thought out the season [1]. The ability of the bodily systems to adapt to composite stresses is influenced by the interaction between training and competition [1, 2]. Therefore the potential greater competitive responsibilities being placed on the regular starters in soccer may have a greater impact on the hormonal and biochemical response. The present study examined whether differences existed between starters (S) and non-starters (NS) professional soccer players over the course of the pre-season and first competitive mesocycle. METHODS: Twenty-one professional soccer players participated in the study. Blood samples were collected before the initiation of the preseason mesocycle (July, PRE), before the first competitive game (September, END-PRE) and at the end of the first competitive mesocycle (October, MESO 1). Samples were analyzed for haematocrit (HCT), haemoglobin (HGB), creatine kinase (CK), ferritin (FER), free testosterone (Free T) and cortisol (C). Players were divided as S (n=10) having played >75% of the total game time during MESO 1 (7 games) and as NS (n=11) having played <25% of the total game time. A two way ANOVA (group as between and time interval as within factor) with Tukey post-hoc analyses was used for statistical analysis. RESULTS: HCT was higher for both groups at MESO 1 and END-PRE than PRE ( $p < 0.001$ ), HCT was higher for both groups at MESO 1 and END-PRE than PRE ( $p < 0.001$ ), CK was lower for both groups at MESO 1 than END-PRE and PRE ( $p < 0.01$ ), FER was lower for both groups at MESO 1 and END-PRE than PRE ( $p < 0.001$ ), Free T was higher for both groups at MESO 1 than END-PRE and PRE ( $p < 0.001$ ) and C remained unchanged for both groups from PRE to MESO 1. DISCUSSION: The first seasonal competitive mesocycle does not induce significant differences in the hormonal and biochemical response of S soccer players compared to NS. Both groups adapt to the training loads by increasing Free T levels [3]. Additional stress from competitive games is not translated into an exacerbated C response [3]. Although increases in both HCT, HGB are observable after the end of the preparatory period, they occur in conjunction with reduced iron stores which may indicate that these positive changes will plateau or even decrease in the long term. REFERENCES 1. Ekblom B. *Sports Med* 3:50-60, 1986. 2. Kirkendall DT. *Phys Sportsmed* 12:53-59, 1985. 3. Viru A and Viru M. Biochemical monitoring of sport training, 2001.

## RELATIONSHIP BETWEEN THE EXPERIENCED IMPACT OF FATIGUE AND PHYSICAL AND NERVOUS SYSTEM CHARACTERISTICS IN FOOTBALL PLAYERS

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RELATIONSHIP BETWEEN THE EXPERIENCED IMPACT OF FATIGUE AND PHYSICAL AND NERVOUS SYSTEM CHARACTERISTICS IN FOOTBALL PLAYERS Olm, T., Baskin, K., Herde, K. Tallinn University (Estonia) Introduction The aim of the study is to find out which characteristics of physical and cognitive abilities are related to athletes' experienced impact of fatigue on their technical skills and will to fight. Methods The subjects were 21 male football players of the best club of Estonia (FC Flora). Their average age was  $20.5 \pm 2.8$  years. The test battery included anthropometric measurements, electro-, echo- and polycardiography, and incremental treadmill test to volitional exhaustion. Blood lactate concentration, maximum oxygen uptake, the anaerobic threshold were recorded. Anticipation speed and correctness, and ability to concentrate were assessed using the software WinPsycho 2000 (Thomson 2001). Before the treadmill test the athletes estimated how substantial is the impact of fatigue on their: a. technical skills; b. will to fight, giving grades from 0 to 3. The mean values of the indices and Pearson product moment correlation coefficients between physical indices, nervous system indices and the grades of the

experienced impact of fatigue were calculated. Results Most anthropometric indices, body fat, echocardiographic indices and indices characterizing anaerobic and aerobic metabolism have statistically significant correlations between themselves. But there are no correlations between them and the nervous system indices, except for the anaerobic threshold which has significant correlations with anticipation speeds. Anticipation speed, measured before and after treadmill test, alone has substantial correlations with athletes' esteem grade points of athletes. Discussion From the correlation analysis for all 42 average indices we can see that there is considerable variability in the relationships between the indices according to the different systems. The indices of physical abilities, while having numerous significant mutual correlations, have low correlations with the indices of the nervous system. In our earlier work (Olm et al., 2003) we observed tendencies towards correlations between the latter and the anaerobic metabolic indices. Here we found positive correlation between the anaerobic threshold and the anticipation speed. As anticipation speed has crucial importance for the perception of moving objects and is very sensitive to fatigue, it is understandable that these indices are related to players' subjective estimations of the impact of fatigue. Conclusions As football performance can be divided into many multidimensional performance characteristics (Elferink-Gemser, et al., 2004) the current results showed that complex investigations can be useful for identifying the players' performance level. References Thomson K.(2001).FEPSAK Bulletin,Vol 13, 2-7. Olm T, Thomson K, Baskin K, Herde K.(2003).Proc.8th Ann congr ECSS,224. Elferink-Gemser M. (2004). J Sports Sci, 22,1053-1063.

### SEASONAL CHANGES IN ANTHROPOMETRY, PERFORMANCE, HORMONAL STATUS AND MUSCLE DAMAGE OF ELITE AUSTRALIAN RULES FOOTBALL PLAYERS

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SEASONAL CHANGES IN ANTHROPOMETRY, PERFORMANCE, HORMONAL STATUS AND MUSCLE DAMAGE OF ELITE AUSTRALIAN RULES FOOTBALL PLAYERS Bilsborough, J.C. 1,2), Greenway, K. 3) Opar, D. 3) Cordy, J.2) Coutts, A.J. 1,2) 1) Elite Performance Unit, Carlton Football Club, Australia, 2) University of Technology Sydney (UTS), Australia, 3) Royal Melbourne Institute of Technology, Bundoora, Australia. Keywords: Introduction Australian Football (AF) players typically complete two distinct phases of training during the season, the preseason (PS) and the inseason (IS). The PS phase typically consists of higher load training where physiological and technical/tactical skills are developed. During the IS, training loads are lower as the focus of training is to recover players for the regular weekly competitions. At present, the seasonal changes in anthropometry, hormonal status and performance are not well known. Therefore the purpose of this study was to examine the seasonal changes in these parameters in professional AF players. Methods Forty seven professional AF players were assessed for anthropometry (body mass (BM), lean mass (LM) and body fat (BF)) with a pencil beam DEXA (Lunar DPX-IQ, GE) five times during the 2010 season (start-PS, mid-PS, start-IS, mid-IS, end-IS). Salivary testosterone (S-Test), cortisol (S-Cort), blood creatine kinase (CK) and physical performance characteristics (bench press, bench pull, BM jump squat) were also taken at these times. A one-way ANOVA was used to detect differences between tests. Pearson's correlations were determined. Significance was set at  $P < 0.05$ . Results BF decreased during the PS ( $P < 0.01$ ) but was maintained through the IS. Since BM was unchanged during the season, %LM was increased during the PS ( $P < 0.01$ ) and remained constant thereafter. Compared to the start-PS, the S-Test was lower at mid-PS until the end of IS ( $P < 0.01$ ). S-Cort was reduced from the beginning of PS to the end-IS ( $P < 0.01$ ). T-C remained constant throughout the PS but was reduced at mid-IS ( $P < 0.01$ ). CK was higher at the end of PS and declined during the IS ( $P < 0.01$ ). Upper body strength increased during the PS and was maintained during the IS. Peak distance and peak velocity from BM squat jumps increased during the PS and decreased during the IS ( $P < 0.001$ ). Changes in LM were related to changes in upper body strength performance ( $r = 0.23-0.35$ ,  $P < 0.05$ ). Discussion These findings show that the training program for this team was effective for maintaining LM and strength/power characteristics during the PS. However the reductions in jump performance during the preseason may be due to the lower training dose or accumulated fatigue during the season. Although the hormonal and muscle damage markers changed during the season they were not related to changes in physical performance. Future studies should examine factors influencing these seasonal changes and to assist scientists manage training during the AF season.

### SEASONAL BIRTH EFFECT AND PHYSICAL FITNESS OF SUCCESSFUL YOUNG SOCCER PLAYERS

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Introduction It is commonly accepted the idea that physical fitness, particularly speed, resistance and strength has a great influence in sports performance. The purpose of this study was to show how seasonal birth effect influence physical fitness variables and the performance level of young elite soccer players, disregarding the effect of bone age. Methods A total of 133 under-15 young soccer players were studied. Aerobic capacity, speed, reactive strength and soccer-specific evaluations were measured. The aerobic capacity was evaluated through the Yo-Yo Intermittent Test (Bangsbo, 2002). The speed was evaluated through the Linear 30-m Speed Test (time in 10-m and 30-m). The reactive strength was measured through the Squat Jump and the Countermovement Jump. Soccer-specific performance was obtained according to the success level achieved by each soccer player: Level 1, representing those who were dismissed from the club (27.8%); Level 2, a player that stayed on the club but was never called to a youth selection (28.6%); Level 3, a player that is called to the district selection (23.3%) and; Level 4, a player of youth international level (20.3%). Maturity (bone age) was evaluated through Tanner-Whitehouse III Method (TW III). The 4 groups were compared with ANCOVA using the SPSS for windows (v.18.0). Permissions from parents and from the boys (self assent) were obtained before data collection. Results The athletes that achieve a higher degree of success in soccer are the ones that obtain better scores in the speed (1-2;1-3;1-4) and in resistance (1-4) tests (all,  $p < .05$ ) and it should also be noted that most of the athletes are born during the first semester of the year (77.4%). The results showed some differences between the studied groups (trimesters) even after removing the bone age effect. The athletes born in the first and second trimester are significantly faster than the athletes born in the others (1-3;1-4;2-3;2-4). In addition, the athletes born in the first trimester performed worse in Squat Jump test, although the results were only significant between the first and second trimester (1-2) as result of the number of subjects included in other groups. Discussion Soccer coaches reveal a tendency to choose athletes with superior aerobic capacity and faster, which demonstrates that they do not choose athletes only because of their technical skills. They make a more global analysis where they include fitness, in particular speed, as part of their perception of success in the game. The results above show the relevance of the seasonal birth effect in physical fitness tests particularly in speed even after removing the bone age effect. References Bangsbo J (2002). Entrenamiento de la condición física en el fútbol. Barcelona: Editorial Paidotribo.

## OPINION FROM ELITE YOUNG SOCCER ON CARDIOVASCULAR HEALTH ISSUE

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Opinion from elite young soccer on Cardiovascular Health issue Mema,F .1, Kuriu ,A.1,Martiri,A.1,Qeleshi, A.1, 1: UNIVERSITY OF SPORT OF TIRANA Introduction: Participation in physical activity during childhood may have an indirect effect on risk-factors for cardiovascular disease, by helping children to prevent excess weight gain or helping overweight children to lose weight (Department of Health, 2004). Although chronic diseases are infrequent in youth, risk factors are present and track from childhood to adult life. (Goran, M.I., et. al 1999, Rolland-Cachera, M.F., et. al 1999) .This modest study try to see what's the opinions of young profesionist soccer on this debate topic .They are so young and training so hard but are they aware about Cardiovascular Health etc? Objectives: To objectively see and investigate the cardiovascular problem and they opinion among young soccer from best Albanian team U 17 and U19. Subjects: This study engages 125 young between 17 and 19 years old that participate in five football teams: S.K.Trana, Patizani, Dinamo, Shkendia including in national championship football under 17 and 19 years old. Methodology: questionnaire assessment cardiovascular has been applied. (Poul M.Insel and Walton T .Roth 1988). Results: Data from questionnaire according to scale show: In U 17 at moderate level 19.5 %, superior level 27.5 %, optimal level 53 % In U19 at moderate level 36 %, superior level 28%, optimal level 36 % Discussion: This study show a interesting data analyzed and compared with transformation socio-economic status that our country is going throw, changing mentality hand by hand with our way of thinking. The young soccer 17 years old for five team seem to have better data than U 19 and in general for both ages values are optimistic and significant showing that actually we have a awareness and understanding in the most of them about Cardiovascular Health issue. References- Goran, M.I., & Malina, R.M. (1999). Fat distribution during childhood and adolescence: implications for later health outcomes. *Am J Hum Biol*, 11, 187-188 - Rolland-Cachera, M.F., Bellisle, F., Deheeger, M., Pequignot, F., & Sempe, M. (1990). Influence of body fat distribution during childhood on body fat distribution in adulthood: a two-decade follow-up study. *Int J Obes Relat Metab Disord*, 14, 473-481.

## Poster presentations

### PP-PM29 Children and Ageing

#### A MATHEMATICAL MODEL OF THE RELATIVE AGE EFFECT

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A MATHEMATICAL MODEL OF THE RELATIVE AGE EFFECT (RAE) Werninger, L., Lames, M. TUM (Munich, Germany) Introduction There is some debate on the methodological treatment of the RAE. To test its significance a Chi-Square test or the Kolmogorov-Smirnov test are frequently used. Moreover, Augste and Lames (2011) suggest characterizing the strength of a RAE by the median of the birth days in the corresponding sample. This paper suggests a mathematical model for a RAE and provides two indices that characterize the underlying selection process leading to the respective RAE. STA (Selection Threshold Applied) is an estimate for the percentage of the population eligible to the sample, and MLA (Maturity Level Applied) is the corresponding biological age expressed in years ahead of the maturation level of the population. Method The probability of being selected is assumed to be proportional to having a certain maturity level or biological age at time of selection. Biological age may be assumed to be normally distributed with chronological age as mean value and a standard deviation spop that is typical for the population the sample is drawn from (Sherar et al., 2007). From these assumptions one may calculate the probability of having a certain biological age x. The probability of being selected is considered to be proportional to this biological age. As the sample is composed of athletes born at the kth of n time intervals the probability distribution selection probabilities can be calculated dependent on x. MLA is the x-value that gives the best approximation of the sample's empirical distribution. STA is the probability of having MLA as biological age. Results The model was applied to four different samples in youth football of different selection level and sample size. RMSE as goodness-of-fit indicator varied from 0.49% in the largest (national training camps, n=22,238) to 3.25% in the smallest (U17 first league team, n=26) sample. Correlations between observed and expected values ranged from 0.917 to 0.986. Processes employed to select German national youth team players are characterized by a MLA of 2.58 years ahead of population that corresponds to 0.5% of the population being eligible. Discussion Modeling the RAE based only on the assumption that a biological threshold is applied has turned out to be successful in terms of conceptual considerations and the goodness of fit results in different samples. Although problems of prediction grow with decreasing sample size even results for small samples give a valid description of the underlying selection process. References Augste, C., Lames, M. (2011). *J Sports Sci*, (subm.). Sherar, L. B., Baxter-Jones, A. D., Faulkner, R. A., Russell, K. W. (2007). *J Sports Sci*, 25(8), 879-886.

#### SCALING OF AEROBIC FITNESS IN 9-11 YEAR OLD LIVERPOOL CHILDREN

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Objective: How aerobic fitness (VO2 peak) data is scaled to partition out the influence of body size is important to our understanding of current and secular trends in youth fitness. The ideal method is to scale VO2 peak to a direct quantification of the metabolically active muscle mass during the fitness test (Tolfrey et al., 2006). The aim of this study was to investigate the appropriateness of using lean mass of both legs as a scaling variable for VO2 peak compared to total lean body mass and total body mass. Methods: 126 girls (age mean 10.2, SD 0.9) and 87 boys (age mean 10.4, SD 0.9) provided acceptable VO2 peak scores from an incremental treadmill protocol to volitional exhaustion. Dual-energy x-ray absorptiometry measured total lean mass of the body and the sum of both legs. We used allometric regression models of the form  $\log \text{VO2 peak} = \log a + b (\log \text{body size})$ , adjusted for biological sex and maturity offset (years from peak height velocity; PHV). Three models were compared, each using a different index of body size; total body mass, total lean body mass, lean mass of both legs. We assessed goodness of fit using the Akaike Information Criterion (AIC) with Akaike weights for each model computed from the derived AIC values. Results: The Akaike weight for the model using the lean mass of both legs as the index of body size was 0.91; this is the probability that this model is the best from the set of candidate models. The Akaike weight for the next best model (total lean body mass) was 0.09. The size exponent (b) for lean leg mass was 0.59 (95% CI, 0.48 to 0.71). Both sex and maturity offset contributed substantially to the model. After controlling for body size and maturity offset the VO2 peak in boys was 19% higher than

in girls [95% CI, 13 to 26%]. After controlling for body size and sex a 1-year increase in maturity offset (closer to PHV) was associated with a 5% higher VO<sub>2</sub> peak [95% CI, 2 to 8%]. Conclusion: The model using the lean mass of both legs was more than ten times as likely to be the best model as that using total lean body mass. The model using total body mass as the indicator of body size was very unlikely. Compared to surrogate markers of metabolically active muscle mass during a fitness test, such as total body mass, lean mass of both legs appears a more appropriate scaling variable for VO<sub>2</sub> peak in children. References: Tolfrey et al. (2006) J Appl Physiol 100 1851-1856

#### **A STUDY OF STRESS RELATED TO URINARY INCONTINENCE IN HIGH SCHOOL AND UNIVERSITY-AGE FEMALE ATHLETES IN JAPAN**

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**A STUDY OF STRESS RELATED TO URINARY INCONTINENCE IN HIGH SCHOOL AND UNIVERSITY-AGE FEMALE ATHLETES IN JAPAN** YAMAMOTO Saho, TANAKA Shigehiro Introduction The occurrence of urinary incontinence is not so rare in female athletes, however there have not been clear reports of the urinary incontinence in female athletes in Japan. Therefore, we investigated the prevalence of urinary incontinence and urge incontinence in younger female athletes in Japan. Methods We studied the prevalence of urinary incontinence in high school and university-age female athletes in Japan aged 15-22 (n=245) by questionnaire (response rate 100%). Statistical analyses of the results included the test and chi-square test. Results of  $P < .05$  was considered significant. Results The prevalence of stress urinary incontinence (SUI) and urge incontinence was reported by 53 of the 245 participants. The athletes who experiencing SUI and urge incontinence were heavier and older than non-SUI athletes. Activities which were most likely to provoke SUI included jumping (37%), running (37%), high-impact activities (16%). The age the participants reported first noticing SUI and urge incontinence was during a sports related activity: 24% (elementary school), 22% (junior high school) and 7% (high school). The time of SUI people spent exercising was significantly longer than that of non-SUI people. There were no significant findings between the effort to prevent SUI and the outcome of SUI prevention. Discussion As for weight, one of the risk factor of SUI is being overweight. Intra-abdominal pressure and pressure in the bladder rise with weight gain, then these factors may the chance of increase SUI (Yasuhiro. S et al., 2005). Concerning age, the cause may possibly be the insufficient of estrogen. However, as this study is intended to analyze high school and university-age participants, it is unlikely that estrogen is the root of SUI. University-age participants have more opportunity to exercise than high-school age participants. This difference is thought to be a significant factor between SUI and non-SUI. The previous studies, in which non-Japanese elite athletes were surveyed about when they first noted incontinence, reported 40% in high school and 17% in junior high school (Nygaard I. E et al., 1994). This leads us to the fact that the younger female athletes are, the more likely the risk of SUI they have. Studies concluded that not all of female athletes with SUI were willing to treat SUI. References Yasuhiro, S., Midori, M., Hiromitsu, M. (2005). Risk Factors of Stress Urinary Incontinence. Sanfujinka Chiryo, 91, 392-393. Nygaard I. E., Thompson F. L., Svengalis S. L., Albright J. P. (1994). Urinary incontinence in elite nulliparous athletes. Obstetrics and Gynecology, 84(2), 183-187.

#### **CAN A 6 WEEK SCHOOL BASED ACTIVE PLAY INTERVENTION INCREASE MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY AND DECREASE SEDENTARY BEHAVIOUR?**

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**Introduction** There is concern that preschool children are not physically active enough to benefit health, yet few interventions have attempted to increase physical activity (PA) in this population. This study aimed to investigate the effectiveness of a 6-week school based Active Play intervention on children's moderate-to-vigorous physical activity (MVPA) levels and sedentary behaviour. **Methods** Participants (n=240; 52% male, Mage = 4.4 ± 0.6 years) were recruited from 12 schools in one large city in England and were randomly assigned to an intervention or comparison group. Intervention schools received one Active Play session (~30 min) per week for 6-weeks from a trained Active Play deliverer. Comparison schools received the Active Play resource pack, which was delivered by the class teacher during curriculum time. PA was measured by uniaxial accelerometer (GT1M Actigraph) for 7 consecutive days using a 5 second epoch before and after the intervention. Data were analysed using age specific cut points (Sirard et al. 2005). For inclusion in the analyses, participants were required to have worn the monitors on 3 days (including one weekday day). A mixed between-within subject's analysis of variance assessed the effectiveness of the two different groups on children's MVPA and sedentary behaviour. **Results** At baseline, preschoolers spent 6.9% (average: 42.3 minutes) of the day in MVPA while 81.5% (average: 642.5 minutes) was time spent sedentary. There was no significant interaction between intervention type and time for weekday MVPA ( $p=0.7$ ) and sedentary behaviour ( $p=0.8$ ). Weekend sedentary behaviour decreased in both groups (average decrease: 31.2 minutes) although this decrease was not significant ( $p=0.6$ ). **Discussion** Low levels of PA at baseline emphasises the need for interventions to increase PA engagement among this population. However, the Active Play intervention did not significantly increase MVPA or decrease sedentary time, possibly because there may not have been an adequate dose of activity. In addition, Bronfenbrenner's Ecological Model (Bronfenbrenner 1989) proposes that for a preschooler the two main influencing factors are parents and teachers; the absence of involving parents may have contributed to the lack of behaviour change. Future interventions focusing on preschool children should aim to include the home environment and run over a longer period of time. **References** Sirard, J.R. et al. (2005) Calibration and evaluation of an objective measure of physical activity in preschool children. Journal of Physical Activity and Health, 3, 357-435. Bronfenbrenner, U. (1989) Ecological systems theory. Annals of Child Development, 6, 187-249.

#### **THE EFFECTS OF A 12 MONTH GROUP-RANDOMISED TRIAL ON FUNDAMENTAL MOVEMENT SKILLS, PHYSICAL ACTIVITY, AND PERCENT BODY FAT IN PRIMARY SCHOOL CHILDREN: THE A-CLASS PROJECT.**

FOWEATHER, L., MCWHANNELL, N., RIDGERS, N.D., GRAVES, L.E.F., HENAGHAN, J., HEPPLER, J., STRATTON, G.

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The effects of a 12 month group-randomised trial on fundamental movement skills, physical activity, and percent body fat in primary school children: The A-CLASS Project. Fowweather, L.1, McWhannell, N.2, Ridgers, N.D.3, Graves, L.E.F.1, Henaghan, J.1, Hepples, J.1, & Stratton, G.1 1. Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, UK, 2. Department of Sport and Exercise Sciences, University of Chester, UK, 3. School of Exercise and Nutrition Sciences, Deakin University, Australia. **Background:** Physical activity interventions conducted in UK children are sparse. This study evaluated the effectiveness of a 12 month intervention to increase physical

activity, prevent excess body fat gain, and improve fundamental movement skills among 9-10 year old children. Methods: 152 children (58% response; 41% male), average age 9 years 8 months, were recruited from 8 primary schools in areas of high deprivation. Children were randomised by school to one of four conditions: a bi-weekly high-intensity physical activity after-school club (HIPA; n=36); a bi-weekly multi-skill (fundamental movement skill) after-school club (FMS; n=37); a behaviour-modification programme (PASS; n=45); or a control-comparison (CON; n=34). Outcome measures were assessed at baseline, 9 months and 12 months (post-test) and included 8 fundamental movement skills, measured using video-analysis and process-orientated measures; percent total body fat, determined by means of dual-energy x-ray absorptiometry; and moderate-to-vigorous physical activity (MVPA), assessed by accelerometers over 7 days. Intervention effects were calculated using ANCOVA techniques, with baseline scores as the covariate. Findings were checked for both practical relevance and statistical significance. Results: Fundamental movement skills: At post-test, compared with controls, children in the FMS group significantly improved competence in locomotor (adjusted mean difference (AMD) = 2.52; 90% CI: 1.65 to 3.38,  $P < 0.01$ ) and object-control skills (AMD=3.14; 2.08 to 4.19,  $P < 0.01$ ), whilst HIPA also enhanced competence in locomotor skills (AMD=1.28; 0.35 to 2.19,  $P = 0.024$ ). Body fat: After adjusting for changes in maturation, no intervention effects on percent total body fat were observed compared to controls. Physical activity: No group differences were found for MVPA, which increased from baseline to mid-test but fell sharply at post test in all conditions. Discussion: Multi-skill after-school clubs can improve fundamental movement skills, though skill competence gains were not associated with increased participation in physical activity or lower percent body fat. A subsequent follow up study is warranted to assess long term impact. After-school clubs and behaviour-modification programmes may need to be combined, or supplemented by other intervention strategies (e.g. nutrition), to facilitate positive changes in body composition and increased participation in habitual physical activity.

### A CLUSTER-ANALYTIC CLASSIFICATION OF CHILDREN'S PHYSICAL ACTIVITY: THE CHANGE! PROJECT

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Introduction: Physical activity is a major public health concern as trends show inadequate levels of physical activity for health and rising levels of obesity. A research priority is understanding key explanatory variables underpinning children's physical activity participation. Despite this, there are few studies identifying "clusters" of children based on their physical activity classification levels. This study used cluster analysis in identifying physical activity patterns of children, examining whether different physical activity clusters differ on key explanatory variables. Methods: Two hundred and eighty-nine children (54.7% girls) aged 10-11 years old from 12 primary schools in North-West England completed the Children's Physical Self-Perception Profile, items of Enjoyment, items of Self-Efficacy, and wore a physical activity monitor (GT1M ActiGraph) for seven consecutive days. Sample-specific cut points were generated using a ROC analysis approach in a sub-study based on the recommendations of Welk (2005). Anthropometric measures were completed to estimate maturity status. Cluster analysis was performed to identify homogeneous groups of children based on similar time spent in sedentary, light physical activity (LPA), moderate physical activity (MPA), moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA). Multivariate analyses of variance were then performed to examine differences between clusters on psychological variables and gender. Results: Cluster analysis yielded a four-cluster solution, reflecting low activity, average activity, moderate activity and vigorous activity groupings. There were significant differences in physical activity classifications between all clusters ( $p < .001$ ). There were significant gender differences between the clusters, with the more active clusters consisting of more boys. In addition, clusters of higher activity were associated with higher ratings of self-perception. When controlling for maturity, physical activity differences remained yet all other significant differences between clusters were removed. Discussion: Children who spend more time in MPA and VPA have higher self-perceptions for sport competence, physical condition, body attractiveness, perceived strength, physical self-worth and global self-esteem, but not for enjoyment or self-esteem. Notably, these results also indicate maturity status may differentially influence boys' and girls' physical self-perceptions. References Welk, G.J. (2005). *Med Sci Sports Exerc*, 37, S501-S511.

### REVISITING SOME METHODOLOGICAL APPROACHES OF THE USE OF GPS IN MEASURING THE FREE-LIVING PHYSICAL ACTIVITY OF YOUNG PEOPLE

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Previous literature has recommended specific guidelines with regard to how many days of testing are necessary to provide an accurate reflection of an individual's 'average day' when measuring free-living physical activity (PA) levels (Tudor-Locke et al., 2005). However, whilst technological advancements have led to methodological development in measuring young people's PA levels, this has not transcended into updating the traditional guidelines. Trost et al (2000) has been widely supported in stating that when objectively measuring PA levels, a minimum of four days including weekend and weekdays are necessary. The recent technological development in the global positioning system (GPS) has led researchers to combine the use of GPS with more traditional tools to objectively measure PA levels. However, whilst guidelines regarding the number of days necessary for PA measurement with traditional objective tools such as pedometers and accelerometers are continually supported, no research has specifically addressed this issue with regard to the use of GPS. This has led to the majority of studies adopting a four day testing policy when utilising GPS to measure PA. Recent reviews have highlighted the potential in utilising GPS effectively as a measure of PA (Maddison and Mhurchu, 2009). Hence, the current study attempts to investigate whether the traditional method of 4 days testing is the most appropriate for measuring PA with GPS. This study explores the possibility of measuring young people's free-living PA over a whole week (instead of a four day period) to ascertain whether this helps eliminate some of the drawbacks of utilising GPS. The study reviews recent research literature and investigates different methodological procedures for measuring PA using GPS combined with heart-rate monitoring. A total of 50 adolescents (22 M, 28 F) wore GPS and heart rate devices over a period of 7 days. 16 participants wore the devices for 7 consecutive days, with 34 participants wearing the devices consecutively for four days (Monday to Thursday) before having a short break (several days) after which the devices were worn over a weekend period (Friday to Sunday). Statistical procedures were performed to reveal significant differences between various methods of measuring PA. This entailed testing for participant reactivity, variance in daily moderate-to-vigorous PA, and analysing the pattern of participant compliance over the 7 day testing period. Gender and school type differences were also analysed. The results of the study draw several insightful conclusions which should be considered by future researchers measuring PA with GPS.

## ENERGY EXPENDITURE MEASUREMENTS UNDER CONTROLLED CONDITIONS AND IN THE FIELD - COMPARISON OF OVERWEIGHT AND NORMAL WEIGHT WOMEN USING INDIRECT CALORIMETRY AND ACTIVITY MONITORS

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Introduction Physical Activity (PA) is an important factor to remain physical and mental health. Activity monitors are widely used to detect physical activity (PA) and quantify energy expenditure (EE) (Garatachea, 2010). For developing strategies against the worldwide increase of physical inactivity and its related health problems, accurate EE measurements are essential. Therefore physical activities of daily living (PADL) have been measured in normal weight (NW) and overweight (OW) women using accelerometer and indirect calorimetry. Methods 35 women (age=41±13) were divided in two groups (NW: n=19, BMI=21±2; OW: n=16, BMI=29±3) and completed PADL (15min of Resting Metabolic Rate (RMR), computer work, vacuuming, stair stepping, cycling and 6min walking), wearing the multisensor device SenseWear Armband (SW), a triaxial accelerometer (RT3) and the portable ergospirometry system Oxycon Mobile (OM). Additionally participants wore SW at home (SWH). Results EE measurements of SW and RT3 are significant ( $p<0.01$ ) compared to OM for both groups for walking, stair stepping and cycling. SW is not significant in RMR and vacuuming compared to OM, whereas RT3 shows significant results for vacuuming in both groups. EE differences of both sensors compared to OM increase with higher levels of PA. Comparing OW vs. NW, OW showed higher EE in RMR (7%), walking (12%) and stair stepping (20%). Analysis of SWH over 24 hrs showed less PA ( $p<0.01$ ) in OW (501 kcal/d) compared to NW (active EE 897 kcal/d). Discussion Activity monitors are helpful to detect the quantity of physical activity. SW, as multi-sensor device, measures more accurate than RT3, which shows a lack of accuracy in activities with less vertical or horizontal acceleration (Jacobi, 2007). Overweight women showed greater EE in activities with moderate intensity than normal weights (LeCheminant 2010). When referring EE results to nutrition analysis, using accelerometer in health care programs to reduce body weight and increase PA requires careful interpretation due to possible under- or overestimated EE by accelerometer. References LeCheminant J et al. (2009). *Eur J Appl Physiol*, 106, 675-682. Garatachea N et al. (2010). *Nutr. Hosp*, 25 (2), 224-230. Jacobi D et al. (2007). *Obesity*, 15 (4), 950-956.

## THE EFFECT OF STRUCTURED AND LIFESTYLE PHYSICAL ACTIVITY INTERVENTIONS ON BODY FAT IN 9-11 YEAR OLD CHILDREN.

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The effect of structured and lifestyle physical activity interventions on body fat in 9-11 year old children. McWhannell, N.1,2, Henaghan, J.2, Fowweather, L.2,3, Reilly, T.3, Stratton, G.2,3. 1: UC (Chester, England), 2: REACH (Liverpool, England), 3: LJMU (Liverpool, England). Introduction Increasing the physical activity (PA) levels of children is a key objective in health promotion strategies. Physical activity intervention studies attempting to reduce body fat have had limited success and have been less than robust methodologically. This study implemented different structured exercise interventions alongside a lifestyle intervention and compared changes in body fat and habitual PA over a 12 month period. Methods 144 children (girl n=86, boy n=58), from 8 randomly selected schools participated in the 12 month study, 2 schools were randomly allocated into 1 of 4 groups: high-intensity (HIPA), skill development (FMS), lifestyle (PASS) and control (CONT) groups. The HIPA and FMS groups participated in an after-school club (2x60 min.week-1), the PASS group attended a weekly classroom session (40 min) delivered by a lifestyle coach. The CONT group received health information. Dual-energy x-ray absorptiometry (DXA) was used to measure body fat mass (kg) and percent body fat (%) and habitual PA levels were quantified using accelerometer at baseline and 12 months. ANCOVA, with baseline scores and maturity offset values as the covariates, was used to evaluate the effect of the intervention on body fat. ANCOVA, with baseline habitual PA as a covariate was used to evaluate the effect of the intervention on PA. Results The CONT group displayed the greatest increase in fat mass, percent body fat and percent trunk fat over the 12 month intervention. All intervention groups changes in fat mass were significantly less than changes observed by CONT group (all  $P<0.05$ ), with the HIPA group showing the least change ( $P=0.03$ ). No significant changes were found in % body fat. The FMS group displayed the least change in % trunk fat ( $P=0.03$ ). Neither group displayed a significant change in time spent in PA compared to CONT group. Discussion All treatment groups showed significantly smaller increases in fat mass compared to CONT group. On the basis that the HIPA group gained fat at a slower rate than other groups, the HIPA intervention had most effect on minimising the fat mass accumulation. This finding supports the consensus that time spent in vigorous PA is associated with lower levels of body fat (Gutin et al., 2008; Ruiz et al., 2006). Neither intervention increased PA levels. A 60 min programme of structured PA (HIPA and FMS) performed twice weekly stimulated a significant effect on minimising the accumulation of body fat in 9-11 year old children. References Gutin, B., Yin, Z., Johnson, M. and Barbeau, P. (2008). *Int J Pediatr Obes*, 3, 3-9 Ruiz, J.R., Rizzo, N.S., Hurtig-Wennlof, A., Ortega, F.B., Warnberg, J. and Sjostrom, M. (2006). *Am J Clin Nutr*, 84, 299-303.

## ARE RURAL CHILDREN REALLY HEALTHIER? CASE OF CROATIA.

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Are rural children really healthier? Case of Croatia. Novak Dario (Faculty of Kinesiology, University of Zagreb), Podnar Hrvoje (Faculty of Kinesiology, University of Zagreb) INTRODUCTION This study aims to determine health status of 5th to 8th grade pupils through registering health-related indicators and compares physical fitness level of students from urban areas and their peers from rural domain. METHODS Subjects were school children enrolled in grades 5th to 8th. Sample consisted of 9685 students, 4924 girls and 4761 boys from urban and rural areas of Croatia. A battery of fifteen tests was applied for the evaluation of motor abilities. Coordination, agility, flexibility, explosive and dynamic strength were estimated each with three tests. The differences between the children's physical fitness profiles from urban and rural areas were determined using Anova. A series of t-tests for independent samples were made to compare additionally the subjects. Statistical significance was set to  $p < 0.05$ . RESULTS The results suggest that there are differences in children's health-related physical fitness profiles depending on the rural-urban characteristics. Namely, urban male students had better results in tests for the assessment of agility, flexibility, explosive and repetitive strength than the rural male students, while the urban female students are more successful in tests of agility, flexibility and explosive strength than their peers from rural areas who performed better in flexibility and repetitive strength tests. DISCUSSION AND CONCLUSION Although former researches have shown that students from urban environment hold lower level of kinanthropology characteristics (Pena et al., 2003; Tsimeas et al., 2005; Ozdirenc et al., 2005; Felton et al., 2002) it is to assume that induction of mechanization and lower need for physical work on farms, while maintaining the nutritional habits that involve traditional, high calorie meals, also because of richer offer of organized sport events and programmes in the cities, they change men-

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### ETHNIC DIFFERENCES IN PARENTAL ATTITUDES AND BELIEFS ABOUT CHILDHOOD OBESITY

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Introduction Childhood obesity in the UK is a serious public health concern, particularly in ethnic groups where prevalence is higher (Department of Health, 2010). It is important to understand ethnic differences in parental attitudes to childhood obesity so that interventions can be tailored appropriately to the needs of ethnic groups (NICE, 2006). The aim of this study was to examine how parental attitudes and beliefs about the causes of overweight in childhood varied with ethnic background. Methodology A self-report questionnaire was designed to explore parental attitudes surrounding childhood weight and beliefs about the causes of overweight in childhood. Eight hundred and eight parents of children aged 4 to 16 years who self-identified their ethnic background as White British (n=603, 75%), Black Somali (n=43, 5%), Chinese (n=41, 5%), Black African (n=40, 5%), South Asian (n=28, 3%), Asian British (n=27, 3%) or Yemeni (n=26, 3%) completed the questionnaire. Differences in parental attitude were analysed using Chi-Squared and significance was set at  $p \leq 0.05$ . Results There were significant ethnic differences in parental attitudes and beliefs about overweight in childhood. Black Somali parents (64%) were more likely than South Asian (19%) and Yemeni (20%) parents to view overweight children as healthy ( $X^2(12, n=780)=25.17, p<0.05$ ). Eighty-six percent of White British, 83% of Chinese and 81% of Asian British parents believed both dietary and physical inactivity factors played a role in the development of overweight in childhood, compared to only 38% of Yemeni parents ( $X^2(6, n=803)=62.95, p<0.001$ ), who attributed overweight in childhood to dietary but not physical activity causes (50%). Conclusion Parental attitudes and beliefs about overweight in childhood were significantly associated with ethnic background. It is important to draw on these differences in the design of and recruitment to childhood obesity interventions aimed at ethnic minority groups. References Department of Health. The National Children Measurement Programme: England 2009/10 School Year. England, December 2010. Available at <http://www.ic.nhs.uk/ncmp> NICE Clinical Guideline 43. Obesity: Guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children. December 2006. Available at [www.nice.org.uk](http://www.nice.org.uk)

### AGING AS A NATURAL PROCESS AND VALUABLE HUMAN RESOURCE

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Aging as a natural process and valuable human resource Kapedani,K.1,Fortuzi,I .1,Qeleshi, A.1, 1: UNIVERSITY OF SPORT OF TIRANA Introduction: This study explore the understanding of aging .Using questionnaires for some groups of the population also need specific questionnaires that are related to their habits and surroundings (Montoye H .J .at al1996 ; Kohl H.W,at al 2000) and in mean time questionnaires, either self-reported or interviewer-based are commonly used ( Sallis J.F.at al 2000; Sirard JR at al 2001). Our study tries to light inside thoughts and memories of young generation (students) about aging facing with trendy and tendency changes that go throw to mentality and transitory society . Objectives: To objectively investigate the understanding problem of aging in our student, the avant-garde of our society. Subjects: This study engages 510 student 19 years old -boys at University of Tirana including 4 Faculty Methodology: Questionnaire assessment for understanding and debating of aging has been applied. (Poul M.Insel and Walton T .Roth 1988). Results: Data from questionnaire , according to scale , show: Faculty of economic - Marginal level 0 %(boys % girls %) , moderate level 43 %(boys 5 % girls 38%), superior level 49 % (boys 6 % girls 43 %), optimal level 8 %(5 boys 3 % girls Faculty of Jurisprudence - Marginal level 14%(boys 2% girls 12%) , moderate level 38%(boys10 % girls28 %), superior level 42 % (boys 10 % girls 32%), optimal level 6%( boys 2 % girls4%) F of History & Philology - Marginal level 12.5 %(boys 2.5% girls 10%) , moderate level 45%(boys 2.5% girls 42.5 %), superior level 35 %(boys10 % girls 25%),optimal level 7.5 %( boys 0% girls 7.5%) F of Foreign Language - Marginal level 7 %(boys 2% girls 5 %) , moderate level 42%(boys0 % girls 42%), superior level 44% (boys 7% girls 37%), optimal level 7%( boys0 % girls 7 %). Discussion: This study demonstrates a significant awareness about aging among students 19 years old of four faculty ,specially Faculty of Economy with data superior level 49 % (boys 6 % girls 43 %), optimal level 8 %(5 boys 3 % girls, where according to scale these levels consider old age as e stage in life ,consider aging as a natural process ,feels older people as a valuable human resources that can make significant contributions . References: - Montoye H.J, Kemper HCG, Saris WHM, Washburn RA. Measuring Physical Activity and Energy Expenditure. Cham-paign: Human Kinetics, 1996:1-191. - Kohl HW, Fulton JE, and Caspersen CJ. Assessment of Physical Activity among Children and Adoles-cents: A Review and Synthesis. Preventive Medicine 2000;31:54-76. - Sallis J.F and Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res.Q.Exerc.Sport 2000;71:S1-14. 37- Sirard JR and Pate RR. Physical activity assessment in children and adolescents. Sports Med. 2001;31:439-54.

## Poster presentations

### PP-PM30 Sports Medicine: Spine and Shoulder

#### EFFECTS OF COMPENSATORY STRENGTH TRAINING PROGRAM ON SHOULDER ROTATOR CUFF BALANCE AND MUSCULAR FATIGUE IN YOUNG SWIMMERS

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Introduction The purpose of this study was to evaluate de effects of 16 week compensatory strength training program in shoulder rotators balance and muscular fatigue in young swimmers. Methods A total of 40 male swimmers were assessed and randomly divided in two



groups: experimental group (n=20; age: 14.65±0.67 years old, height: 173.48±6.87 cm, body mass: 63.15±5.68 kg) and control group (n=20; age: 14.60±0.60 years old, height: 170.79±6.48 cm, body mass: 61.73±4.68 kg). Experimental subjects participated in a 16 week shoulder strength program with Thera-Band® elastic bands (3 times a week). The external rotator /internal rotators ratio (ER/IR) and fatigue ratio were measured in both groups at baseline and after 16 weeks. Concentric action at 60°/s (3 reps) and 180°/s (20 reps) were measured, in a seated position, with the shoulder at 90° of abduction and elbow flexion, using an isokinetic dynamometer (Biodex System 3). The muscular fatigue protocol consisted in 20 maximal-effort repetitions of ER and IR at 180°/s. Anova with repeated measures was used to determine significant main effects in unilateral ER/IR ratios and fatigue ratios. The level of significance was set at 0.05. Results Considering ER/IR ratio, a compensatory strength training programme induces significant differences in both shoulders at 60°/s (Dominant: P=0.001; Non dominant: P=0.001). At 180°/s we just found significant effects on the Dominant shoulder ER/IR ratio (P=0.002). With respect to fatigue ratios, we found no differences between groups from baseline and 16 weeks. Discussion Our results show that 16 weeks of compensatory strength training improve ER/IR ratio, nevertheless, were not enough to improve fatigue ratios, representing the rotators shoulder muscular resistance. This results support earlier research (Malliou et al., 2004) that showed that the unilateral shoulder strength ratios increases substantially after a period of a strength training program. Since the ratios describe the quality of muscular balance/imbalance (Ellenbecker & Davies, 2004), we can conclude that a 16 week compensatory shoulder strength training program using Thera-Band® elastic bands, reduces muscular imbalances in rotator cuff of competitive young swimmers. These results highlight the useful of this kind of compensatory program to prevent shoulder injuries. References 1. Malliou, P.C. Giannakopoulos, K. Beneka, A.G. Giotsidou, A. and Godolias, G. (2004). Br. J. Sports Med. 38(6),766-772. 2. Ellenbecker, TS, and Davies, GJ. (2000). J Athl Train. 35(3), 338-350.

### EFFECTS OF LOCALIZED AND GENERAL FATIGUE ON POSTURAL CONTROL IN MALE TEAM HANDBALL ATHLETES

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Introduction: In team sports, muscular fatigue and sensorimotor impairments have been identified as factors contributing to an increased injury risk (Hawkins & Fuller, 1999; Plisky et al., 2006). However, little is known to what extent exercise-induced fatigue influences sensorimotor mechanisms. This study determined the effects of general and localized fatigue on static and dynamic postural control in team handball athletes. Methods: Nineteen healthy male youth handball players (age: 16.8±0.6 years; height: 179.9±6.9 cm; mass: 73.5±10.8 kg, first and second division) performed (1) a treadmill fatigue protocol and (2) fatiguing single-leg step up exercises in two sessions separated by one week. Before and immediately after the fatiguing exercise, center of pressure (COP) sway velocity during a single-leg stance on a force plate and maximum reach distances of the star excursion balance test (SEBT) were used to assess static and dynamic stability during upright standing. A two respectively three factorial linear mixed model, was specified for each of the main outcomes. The experimental factors 'fatigue', 'protocol' and 'eyes condition' were included as fixed factors nested in the individual's factor. Results: COP sway velocity increased significantly ( $p<.05$ ) following general (+47%) and localized fatigue (+10%). No fatigue effects were found for the SEBT. No association was identified between COP sway velocity and SEBT mean reach distance. Discussion: In conclusion, the increase in COP sway velocity following general and localized muscle fatigue suggests, that both fatigue dimensions change neuromuscular/sensorimotor control mechanisms and may influence the injury risk in team handball athletes. Further research is needed to clarify the impact of fatigue on dynamic balance. References: Hawkins RD, Fuller CW (1999). Br J Sports Med 1999, 33(3), 196-203. Plisky PJ, Rauh MJ, Kaminski TW, Underwood FB (2006). J Orthop Sports Phys Ther 36(12), 911-919.

### THE FACTORS RELATED TO LOW BACK PAIN IN JAPANESE ELITE JUNIOR DIVERS- ANALYSIS OF PHYSICAL AND TECHNICAL CHARACTERISTICS-

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During Competitive diving, divers jump up from 1-3m springboards or 5-10m platforms and dive into the water. The impact forces are very large in the water entry phase, and therefore, microtraumatic injuries are common because of tremendous physical stress placed on a diver. This study aimed, 1) to describe the prevalence of injuries during a 6-year period and 2) to extract possible risk factors related to low back pain (LBP) from physical and technical characteristics, in Japanese elite junior divers. One hundred and seventeen (61 males, 56 females) elite junior divers in Japan were included in this study. LBP that the divers experienced were assessed by questionnaires, interviews, and physical examinations during national training camps. Morphological data, physical fitness, and diving skills were evaluated. The factors related to LBP were extracted with logistic-regression analysis using the forward selection method (likelihood ratio). In total, 114 reports of pain were recorded. 39.4% of pain occurred in the lumbar lesion (forty-nine reports), and most occurred in the water entry phase. Shoulder flexibility and age were recognized as factors related with the LBP in male elite junior divers, while only age was a factor in female elite junior divers. Our results suggested that shoulder flexibility is important to prevent LBP in the elite male junior divers, since divers require full shoulder flexion in the water entry phase. Limited shoulder flexibility could cause lumbar hyper-extension when adjusting the angle of water entry. The major findings of this study were: 1) Among all types of injuries, there was high prevalence of low back pain (39.4%) in elite junior divers in Japan. 2) Most injuries occurred in the water entry phase. 3) Shoulder flexibility and age were related to low back pain among the males. 4) Age was related to low back pain among the females.

### BENEFICIAL EFFECTS OF AEROBIC TRAINING IN ADOLESCENT PATIENTS WITH MODERATE IDIOPATHIC SCOLIOSIS

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BENEFICIAL EFFECTS OF AEROBIC TRAINING IN ADOLESCENT PATIENTS WITH MODERATE IDIOPATHIC SCOLIOSIS Villar Aura J.1, Gomez-Cabrera MC2, Romagnoli M. 1,3. 1Department of Sports, Catholic University of Valencia, Spain, 2Department of Physiology University of Valencia, School of Medicine, Spain. 3Department of Physical Education and Sports, University of Valencia, Valencia, Spain. INTRODUCTION Several studies have shown the decrease in the capacity to produce aerobic work in young subjects with mild to moderate AIS (when scoliosis exceeds 25°) [1,2]. These abnormalities may lead to an increase in the energy required for walking or performing other physical activities [3]. However the frequency and the relevance of the restricted work capacity is uncertain and a matter of controversy. MATERIALS AND METHODS 6 weeks of aerobic training in AIS girls that suffer from mild scoliotic curvatures (n=6) and healthy controls (n=6) in different biochemical, anthropometric and cardio respiratory parameters. The groups performing a cycling training program

were subjected to a training program of 3 sessions per week during a period of 6 weeks with an approximate duration of 1 hour per session (table 2). The training intensity was increased from 65% to 85% VO<sub>2</sub>max. All the girls trained every day with a Pulsometer 810R Cardio Polar. RESULTS The maximal power output and the power output achieved at the anaerobic threshold, during the maximal exercise test, were significantly increased in both experimental groups. The training program caused significant changes in body composition (i.e. a decrease in body fat %) only in the scoliotic group. Regarding the cardio respiratory measurements, VO<sub>2</sub>max was increased by 17% in AIS group and by 10% in the healthy group. DISCUSSION We measured in our study the degree of the curve according to Cobb and we did not find any significant modification after 6 weeks of training in a cycle ergometer. Our results suggest that physical activity should be encouraged in scoliotic girls with mild curvatures. BIBLIOGRAPHY 1. Barrios C, Perez-Encinas C, Maruenda JI, Laguia M (2005) Significant ventilatory functional restriction in adolescents with mild or moderate scoliosis during maximal exercise tolerance test. *Spine* (Phila Pa 1976) 30:1610-1615 2. DiRocco PJ, Vaccaro P (1988) Cardiopulmonary functioning in adolescent patients with mild idiopathic scoliosis. *Arch Phys Med Rehabil* 69:198-201 3. Shneerson JM, Madgwick R (1979) The effect of physical training on exercise ability in adolescent idiopathic scoliosis. *Acta Orthop Scand* 50:303-306

## **MEDIUM-TERM EVALUATION THROUGH RASTERSTEREOGRAPHY OF DORSAL AND LUMBAR SPINE OF VARSITY ATHLETES WITH DIFFERENT TYPES OF LOAD**

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**Introduction** There is a lack of information about modifications of the spine due to the practice of different sport disciplines in non-professional population. Therefore, aim of this study was to investigate about the contribution of different sport disciplines on spine modification in a sample of adult varsity athletes across a six-month sport season. **Methods** 44 varsity athletes (24.5 ± 3 years) were divided into two groups according to the typology of the Sport Team they belonged to: 22 athletes formed the symmetric sports group (S) (track and field running, n=14; cycling, n=8 respectively) and the others 22 formed the asymmetric sports (tennis, n=19; fence, n=3 respectively) group (A). Participants' spine was evaluated through Formetric® 3D (Diers, Germany) rasterstereographic analysis at the beginning (BE), in the middle (MID, after 3 months) and at the end (END, after 6 months) of a sport season. The following parameters were measured and recorded in Average 4D modality: trunk length, trunk imbalance, pelvic tilt, pelvic torsion, kiphotic angle, lordotic angle, pelvic inclination, pelvic dimples inclination, rotation correction (pelvis), kiphotic apex, inflection point ITL, lordotic apex, inflection point ILS, cervical fleche, lumbar fleche, pelvic ante-retroversion, right surface rotation, left surface rotation, trunk torsion, right lateral deviation, left lateral deviation. **Results** Results showed that Intervention factor (BE vs END) had a significant main effect on dimples distance (P<0.05) and on pelvic inclination (BE vs END, P=0.05). Left lateral deviation was also affected by the Intervention factor (BE vs END and MID vs END, P<0.01 and P<0.01 respectively). **Discussion** No statistical differences were found for Sport Typology factor for all the parameters, maybe due to the non-professional technical level of the sample; however, previous studies did not find clinically significant differences even in high-level athletes (Sward, 1992). Instead, referring to Intervention effect on dimples distance, it could be hypothesized that a six-month sport season led an increase of the parameter through pelvic mass hypertrophy. Pelvic inclination, which is related to dimples distance, showed statistical difference in line with that parameter. About left lateral deviation, no modulation was found for Sport Typology: for all athletes, Intervention had an increasing effect suggesting that a deviation can occur independently from the sport load. Asymmetric versus symmetric sport load showed neither statistically significant nor clinically significant differences in a non-professional sample of adult athletes. **References** Sward L. (1992). *Sports Medicine*, 13, 357-364.

## **HUMAN BALANCE EVALUATION IN SUBJECTS WITH CERVICAL INJURIES COMPARED TO HEALTHY SUBJECTS: RESULTS OF A PILOT STUDY.**

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**Introduction** It is very important that forensic medicine properly calculates the biological damage not only through the disturbance indicated by the patient, but more accurately through instrumental diagnosis. Our aim was to verify through posturography the qualitative and quantitative alterations of postural stability in subjects with cervical trauma, compared to the control group. **Methods** We analysed 78 subjects, selecting 42 volunteers and distinguishing a control group of 22 normal men (NM) and a group of 20 men (WM) with a positive anamnesis of whiplash injury for six months. Through a force platform, we recorded the Centre of Pressure (CoP) movements of these groups, both with their eyes open, and closed. The data was used to compare between the two groups, with both open and closed eyes. **Results** During the closed eyes test, those subjects with cervical injuries, displayed a significant increase in anterior-posterior oscillation velocity (p<0.05) compared to the control group, with a significant reduction (p<0.01) of ratio between Shifting Length (SL) of CoP on the polygon support and total envelop area (EA, mm<sup>2</sup>) of CoP movements in the polygon support (SL/EA-ratio, mm<sup>-1</sup>). During the closed eyes test, subjects with cervical injury showed a significant anterior shifting of the mean position of CoP compared to the other group performing the open eyes test. **Discussion** Our results suggest that posturographic tests can be used to assess and confirm human body imbalance in subjects with whiplash injury. Further studies with more subjects from both sexes are necessary to confirm this pilot study. **References** Endo K, Suzuki H, Yamamoto K: Consciously postural sway and cervical vertigo after whiplash injury. *Spine*. 2008, 33(16):E539-42. Pomara F, Bianco A, Petrucci M, Vaccarino F, Bellafiore M, Battaglia G, Palma A: Whiplash injure and human body balance: a force platform analysis. *Minerva Medicolegale* 2010 Marzo;130(1):1-5. Sjostrom H, Allum JH, Carpenter MG, et al: Trunk sway measures of postural stability during clinical balance tests in patients with chronic whiplash injury symptoms. *Spine* 2003, 28:1725-34.

## **THE PREVENTION OF BASKETBALL PLAYERS IN VERTEBRAL PAIN <15-16 YEARS>**

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**The prevention of basketball players in vertebral pain (15-16 years)** **Introduction** In many sports there are combinations of linear and angular movements and in particularly in basketball player movements are carried out on vertical planes, horizontal, in space and time. Some investigations on the lumbar pains among basketball players, show that 60% suffer from periodic or recurrent back pain. **Materials and methods** Before the start of the season 2009-2010, 18 basketball players were undergo a sport medical examination to ascertain their competitive state of health. Before the first training session, the players have compiled one questionnaire containing general news and after the posturologist has completed an evaluation form for each posture. After consideration of responses received, we found that

most of the players complained intermittent back discomfort or pain, especially in the lumbar spine. We subjected the players to 5 test (20 m race, standing long jump, jumping 5 times, Ergojump, tapping). After 2 months another postural control and we proposed to the players the 5 initial tests. During this time, the players have been training continuously on rigid floors and on different types of parquet. After 5 months, the players repeated the 5 test, were subjected to another postural examination and completed a final questionnaire. Results From the results: for 6 players the work was very effective, for 7 fairly effective and for 5 extremely useful. The posturologist, after the final postural examination, showed that the work done during the activation phase has produced undoubted benefits and found that some of the pain had disappeared and that many had trouble at the lumbar spine were weakened or even disappeared. Test results have provided encouraging data, as 13 players have performed better in all tests, 4 players were stable in the results, only one player negative results. Compared to the beginning, the 5 players that early work is not too much pain or discomfort, have maintained the same situation and also improved the executive technique, while those who accused pain at the beginning of work, 6 improved, 5 had a good improvement and 7 do not feel any more pain. Conclusions The exercises to try to reduce the pain were carried out at the start of training with the trainer, so that players could start work in the gym with increasing intensity, with no more pain in the spine. The work, done over 5 months, has raised awareness further players to pay more attention to 'what does' the body during training and competition and to behave accordingly. The tests were useful indicators on the initial, intermediate and final motor situation of the players, note that some key individuals with and without the ball, since the beginning has been made technically better. References B. Toso, Back School, Milano, 2005

## CHANGES IN ROMAND COS OF THE CERVICAL SPINE BY RELAXATION, STRETCHING AND NEURAC-TRAINING

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Introduction Selective neuromuscular reeducation is the basic principle underlying specific training aimed to gain muscular stability and flexibility. Referring to PhysioAustria (2009) sport medicine and sport physical therapy offer a variety of training approaches. However, most of these studies are not evidence based. The research study on hand aims to evaluate a typical training with application for soldiers having high and fasten load on the cervical spine. Method The training program consisted of 3 phases, each 4 weeks in length and a daily training of 10min. Phase 1 included progressive muscle relaxation training (Jacobson, 1990), in order to improve the range of motion (ROM) of the head. Phase 2 followed up with stretching techniques (Evjenth, 1991). Phase 3 aimed at the progression in local joint stability and dynamic stability (Kirkesola, 2010). To rate stability in this context the measurement parameter was the centre of stability (COS). It was defined as the difference of head alignment between participants' subjective middle position and the neutral zero position. 3D-ROM and 3D-COS were measured by XSens™ before and after each phase. The normative values for ROM are depicted as the following: axial rotation left-right (ROT): 140°, extension-flexion (EXFL): 120°, lateral flexion left-right (LAFL): 90°. Male soldiers (mean age 22±2.7 years) of the 1.MilFü2 of HUAk at Enns had to undergo medical examinations to ensure their fitness and health. Results Comparing the ratios and Pearson correlations of beginning and end there are no significant mean differences of ROM between TG (n=18, ROT: 1.02±0.09, 1.06±0.09, r=0.47; EXFL: 0.78±0.13, 0.78±0.12 r=0.55; LAFL: 0.4±0.22, 0.4±0.19, r=0.48) and CG (n=15, ROT: 1.04±0.13, 1.08±0.13, r=0.64; EXFL: 0.71±0.11, 0.68±0.17, r=0.5; LAFL: 0.4±0.14, 0.39±0.12, r=0.51). At the beginning there is a high deficit to the norm in EXFL and also in LAFL, but remains to the end. COS shows a similar pattern for the differences between the beginning and end: TG (ROT: 8.77°±4.21°, 3.62°±11.78°, p=0.19; EXFL: -0.17°±5.27°, -6.09°±5.26°, p=0.13; LAFL: -1.99°±2.07°, p=0.3), CG (ROT: 7.09°±7.71°, p=0.11; EXFL: 0.6°±14.58°, p=0.24; LAFL: -1.59°±3.28°, p=0.19). Discussion However, there are no significant differences between TG and CG. At this stage the training program's preventative goal to gain muscular stability and flexibility cannot be effectively illustrated. Furthermore, it needs to be reconsidered, whether the measurement of COS or the parameter itself allows the accurate display of stability. References Evjenth, O. (1991). Auto Stretching. Oslo: Alfa Rehab Verlag. Jacobson, E. (1990). Entspannung als Therapie. Progressive Relaxation in Theorie und Praxis. Oslo: Alfa Rehab Verlag. Kirkesola, G. (2010). Neurac – a new treatment method for long-term musculoskeletal pain. J Fysioterapeuten 2009;76 (12), 16-25. Physioaustria (2010). Internet (30.10.2010) <http://www.physioaustria.at/ueber-physio-austria/berufsbild-physiotherapie/kernstandards/kernstandards>

## INCIDENCE OF SCOLIOSIS AND BACK PAIN IN YOUNG TENNIS PLAYERS: A TRASVERSAL STUDY

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INCIDENCE OF SCOLIOSIS AND BACK PAIN IN YOUNG TENNIS PLAYERS: A TRASVERSAL STUDY Mondoni M.1, Negrini S.1, Casolo F.1, Ajani A.1, Bottini L., Vantellino E. Department of Motor Science - Università Cattolica del Sacro Cuore di Milano INTRODUCTION AND OBJECTIVES The purpose of this research is to identify whether the incidence of scoliosis and low back pain (LBP) is most common in young tennis players compared to persons who do not practice this sport. MATERIALS AND METHODS The groups tested (mean age 12-16 years) are the group of players, comprising 50 males and 50 females and the control group (100 males and 100 females), consisting of persons who do not practice courts, for a total of 300 subjects. All subjects were given a questionnaire to fill out anonymously, comprised of 68 questions, whose purpose is to gather data on physical activity and back pain. Were also carried out surveys of the spine to assess the incidence of scoliosis through two instruments: the plumb line and scoliometro (ATR). RESULTS Comparing the ATR measurements, shows that for females, the average is 2.8 in the control group and 3.2 in the Bunnell group of players, whereas in males the average is 2.6 in the control group and 2.8 in the group of players. What has been noted is that a greater number of players present for values of 3 and 4, greater incidence than the control group, but the difference is not aimed at statistical significance, because this is the group of players by 56% (females) and 54% (males). By analyzing the most significant application of the questionnaire, when asked if they had never had back pain, there is no substantial difference between the two groups also are mostly those who have never had. In females, the prevalence of low back pain is greater in the control group compared to the group of players, even if not tending to statistical significance. The male tennis players said they had suffered from back pain than the control group, in fact 77% of the control group and 66% of the players responded 'never' to the question. Comparing males and females, both in the control group is that of tennis, there is a statistical significance from the point of view: the episodes of low back pain are greater in females than males. CONCLUSIONS The study shows that the practice of competitive tennis (boys and girls) does not lead to an increased incidence of scoliosis compared with the control group. From our results, it appears that males and females in the group of players, records of slight asymmetries compared to the control group, but without statistical significance from the point of view. The results of the research shows that females belonging to the control group suffer more back pain than women's tennis team, while, in the case, the male tennis players suffer somewhat higher percentage of back pain than the group of control, but the data are not significant from statistical point of view. REFERENCES Thesis of Elisa Vantellino, Milan, 2010

## EVALUATION OF THE OUTER AND INNER SHOULDER ROTATOR MUSCLES OF SWIMMING ATHLETES

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Introduction: Muscle imbalance has been identified as a common occurrence induced by training (1). Repetitive swimming movements may stress the shoulder joint and swimmers frequently develop rotator cuff tendonitis (2). Objective: To assess the force of the inner (IR) and outer shoulder rotators (OR) of elite swimmers. Methods: Fifteen elite swimmers of the swimming team of the University of Ribeirão Preto, SP, Brazil, aged 18 to 27 years were evaluated. The following data were obtained: age, main swimming style, time of practice (years) and anthropometric data: body mass (kg), height (cm), and body mass index (kg/m<sup>2</sup>). An isometric dynamometer was used to determine the force of the shoulder IR and OR. Data were analyzed statistically by the t-test for paired samples and by Pearson correlation (r), which analyzed the ratio of IR and OR strength of the left and right shoulders of the swimmers. Analysis was performed using the SPSS software, version 16.0. Results: The mean age of the 15 athletes was  $20.5 \pm 2.4$  years, mean weight was  $76.6 \pm 4.7$  kg, and mean height was  $183 \pm 4.9$  cm. The main swimming styles were crawl and butterfly and the time of practice was  $9.28 \pm 4.08$  years. Comparison of the IR/OR strength ratio of the right and left shoulder showed a significant difference. Regarding rotator strength, the swimmers presented a lower IR and OR strength of the left shoulder compared to the right shoulder ( $p < 0.05$ ). We observed that the OR ratio was higher than that of the IR ( $p < 0.05$ ). Conclusion: We conclude that swimming causes changes in OR and IR strength, which may become worse as the swimmers become older and require physical training outside the water to improve their performance. We believe that these results can be used for comparison with data to be obtained in future studies, thus helping the technical committee for the prescription of exercises focusing on the prevention of injuries and on sport performance. 1. COOK E.E., GRAY V.L., SAVINAR-NOGUE E., et al. – Shoulder antagonistic strength ratios: a comparison between college-level baseball pitchers and non-pitchers. J Orthop Sports Phys Ther 8:451-61, 1987. 2. RUPP, S.; BERNINGER, K.; HOPF, T. Shoulder problems in high level swimmers-impingement, anterior instability, muscular imbalance? International Journal of Sports Medicine. v. 8, p. 557-62, 1995.

## Poster presentations

### PP-PM31 Basketball/Team Sports

#### THE CORRELATION BETWEEN ANTHROPOMETRIC CHARACTERISTICS OF IRANIAN BASKETBALL WOMEN CHAMPIONS WITH THEIR PERFORMANCE IN COMPETITIONS

ADELI, B.

I.R.IRAN BASKETBALL FEDERATION

Mostafail Sabz Persian and Thinking House B.Aadeli, F.Haadavi Belgheis Adeli: I.R.IRAN Coach, Farideh Hadavi: Professor Associate of IAU Introduction In Basketball, the Performance level of champions in a particular sport and achieving athletic success are the subjects to which coaches and athletes have special attention. Assessing players' performances (positive / negative) are rated according to particular position standard indices of (FIBA).Hence, anthropometric parameters take on great importance as some major factors in champions' performance level. Those are focused on: Determining body size (BS), assessing body composition (BC), measuring somatotype(ST) (ISAK level I). Therefore, the aim of this study was to find the Correlation between anthropometric characteristics of Iranian Basketball women champions with their Performance in Competitions. Methods Statistical population for this study included Iranian basketball women champions who were the members of teams participating in national Premier league (2005-2006). According to I.R.IRAN reports, this group consisted of 65 women, using simple random sampling, 21 individuals (guard, forward, center). Through using anthropometric kit; variables of the participations composed of reliability coefficient,  $r = 94$ , and concurrent validity coefficient,  $r = 1$ . Descriptive statistical methods and Pearson correlation were used to data analysis. For comparing a group of anthropometric and performance variables, multiple regression method in alpha 0.05 was employed. All data collected by using SPSS version 16 were analyzed. Results The following paragraph indicates clearly some of these results: ST with positive performance ( $P = 0.62$ )  $F(4,16) = 0.68$   $R^2 = 0.14$   $R = 0.38$  ST with positive performance ( $P = 0.62$ )  $F(4,16) = 0.68$   $R^2 = 0.14$   $R = 0.38$  Results showed that there was no significant relationship between women champions' ST with certain position ( $p < 0.05$ ). Discussion Statistical description of present research findings indicates that ST,BS and BC in the positions (G,F,C) are different. Furthermore, the anthropometric characteristics have considerable effects on players' various performance in different positions through the competition. Results obtained from recent study are consistent with Heath Carter (1990) which indicated players' performance in different positions was affected by ST, BS and BC. General Results of this study may show that ST of players with their positive and negative performances in various positions is inconsistent. Moreover, there is a significant relationship between player's BS and BC with positive and negative performance in the various positions. References: Bloomfield J, (2003), Biom in sport Oliver D,(2004), Basketball on paper Brassey's sine,age,81-85 International Society for the advancement of Kinanthropometry (ISAK)(2001) Carter J. & Heath B.(1990) SD & A P.P. 83,176,201,208,211

#### RELATIVE AGE EFFECT OF GERMAN BASKETBALL TALENTS – PHYSICAL AND ANTHROPOMETRIC DIFFERENCES BETWEEN FIRST HALF AND SECOND HALF OF THE YEAR BORN PLAYERS

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The aim of our project "Basketball-Talents" is to evaluate and optimize the U16 German Basketball Talent Program. To analyze the output of the talent system, a multidimensional performance assessment was developed: physical condition testing, psychological diagnostic, a sociological questionnaire, regular training documentation and a questionnaire for coaches to evaluate tactical and technical skills. The present study is focused on RAE in combination with results of physical condition testing. Our first question was if there is a RAE in German competitive basketball at all and if this phenomenon is reflected in the anthropometric data and the data of physical condition testing. The physical conditioning testing of 1009 male and 613 female players included: body height (bh), body weight (bw), range of arms (ra), 20 m sprint time (20 m), 5 m sprint time (5 m), 20 m agility-run (20 ar), 20 m agility dribbling (20 ad), jump & reach (jr), standing jump (sj), chest pass (cp), mid distance shot precision (sp) and the multistage fitness test (mf). The chi-square test of the birthdates of regional selected players (U12-U16) divided into born in first half (FH) and second half of the year (SH) showed a significant effect ( $p < 0.05$ )

for boys (65% to 35%) and girls (58% to 42%). A MANOVA (factors: age and half year) showed a main effect (half year) for the anthropometric data of male players (bh, bw, ra): body height and the chest pass. For the female players, there was no main effect (half year) or interaction effect for the physical test performance. In tendency, FH showed better results than SH. The first result of our study is that there is a significant RAE in the German talent program. A player is more likely to be nominated for a regional selection team if she/he is FH than SH. The FH-male players are significantly taller than SH, up to 6cm in early years (U12-1 158,0  $\pm$  8,3 vs. U-12-2 151,7  $\pm$  8,0), which might be an important advantage in playing basketball. Female players in U12 are up to 5 cm taller (U12-1 157,6  $\pm$  7,2 vs. U12-2 152,9  $\pm$  6,8). Surprisingly there aren't many significant effects for conditioning testing even if the FH show better results than SH in tendency. One conclusion might be that SH (and maybe retarded) are not getting the same access to the developing system (better and more training, minutes per game, responsibility) than FH. In U16 the differences in anthropometry and conditioning results between FH and SH are adapting. But in the selection of U16 there are still more FH than SH (male: 68,5%/female: 57,6%). FH still have a profit from their advantage of early years. They are probably more experienced and supported (training, playing time, responsibility) than SH.

## EVALUATION OF PEAK POWER PREDICTION EQUATIONS IN ADOLESCENT BASKETBALL PLAYERS

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**Introduction** The ability to generate power is key to successful performance in many sports. Vertical jump height has been widely used in the assessment of power within field settings due to the cost and inaccessibility of force platforms outside the laboratory (Canavan and Vescovi, 2004). Prediction equations have been developed to estimate power from jump height but the validity of these equations is questionable, and research examining the soundness of prediction equations in different athletic groups is needed (Duncan, Lyons and Nevill, 2008). This study sought to evaluate peak power prediction equations in adolescent basketball players. **Method** Following ethical approval and informed consent, 62 elite adolescent male basketball players ( $M = 16.82 \pm 0.86$  years) performed three maximal counter movement jumps (CMJ) on a force platform (Kistler, Amherst, New York). Peak power (PPactual) was compared to peak power estimated (PPest) from four previously validated regression equations (Harman et al., Sayers squat jump (SSJ), Sayers CMJ (SCMJ) and Canavan and Vescovi (CV)). Pearson product moment correlations were used to determine the relationship between PPest and PPactual. Repeated measures ANOVA was used to examine any differences (bias) between PPest and PPactual. Results Significant relationships were evident between PPest and PPactual from all four equations (all,  $P < 0.001$ ). The coefficient of determination for all four equations ranged from 48-67%. Repeated measures ANOVA showed a significant main effect ( $P < 0.001$ ). Bonferroni post hoc tests revealed that SSJ significantly underestimated power ( $P < 0.001$ ) compared to PPactual. While there were no significant differences between PPactual and Harman et al, SCMJ, and CV equations ( $P > 0.001$ ), the Harman et al equation showed the least bias (mean difference = -2.07 Watts) compared to PPactual. Discussion Results indicate that not all of the regression equations used to estimate peak power from CMJ height are appropriate to use for this cohort supporting prior claims (Duncan et al., 2008). Current results support conclusions made previously that the Harman et al equation is valid for predicting CMJ power despite being originally developed using a SJ (Sayers et al. 1999). Therefore, it can be suggested that the Harman et al. equation is best suited in this cohort as the values for PPest and PPactual were not significantly different and the discrepancy between values for PPest and PPactual was less than the other equations investigated. References Canavan PK, Vescovi JD (2004) Med Sci Sports Exerc, 36, 1589-1593. Duncan M, Lyons M, Nevill AM (2008) J Strength Cond Res, 22, 1379-1381. Harman EA, et al (1991) J App Sports Sci Res, 5, 116-120. Sayers SP, et al (1999) Med Sci Sports Exerc, 31, 572-577.

## PROFILE CHARACTERISTICS OF CRITICAL MOMENTS ON BASKETBALL: GAME BALANCE AND GAME RHYTHM EFFECTS

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**Introduction** Ferreira (2009) has defined the situational profile of the basketball critical moments (CM) for balanced and unbalanced games on professional Portuguese basketball. However, no studies are available about the influence of game rhythm on the game criticality conditions. This study aimed to replicate the characteristics and profile determination of basketball CM, analyzing the game balance and the game rhythm effects. **Methods** Point's difference of sixty-four basketball games from the European Under-20 Championship – Division B – were reconstructed ball possession by ball possession. Each game was analyzed according the Dynamical of Coach's Thought Approach (Ferreira; 2010). CM were defined as independent objects and categorized by quarter, local in quarter, intensity, nature and the phase transition involved. Game balance was defined by a dichotomist division: balanced games, less 10 point of difference on the final score; the unbalanced games, 10 or more points between teams (Ferreira, 2009). Game rhythm was determined by the games' number of ball possessions. Using a statistical cluster analysis, game rhythm was divided into three groups: slow, moderate and fast games. Descriptive statistics were used to compare the games by balance and rhythm. An Homogeneity Analysis (HOMALS) was used to determine the specific associations among the categories in which the CM episodes were classified. Results Balanced games showed a higher number of CM during the 4th quarter than the unbalanced games ( $t=1,969$   $df=46$ ;  $p \leq 0,05$ ). The categories nature ( $\chi^2=9,549$ ;  $df=2$   $N=92$ ;  $p \leq 0,05$ ) and phase transitions ( $\chi^2=19,249$   $df=2$   $N=92$ ;  $p \leq 0,05$ ) also demonstrated significant differences on 4th quarter when balanced and unbalanced games were compared. No differences were found for the influence of game rhythm on CM characteristics. The Cronbach's Alpha average obtained on the profiling model for 4th quarter (0,70 for both dimensions) was consistent to explain the data variance of balance and unbalance games. **Discussion** These results confirm what Ferreira (2009) defined as the criticality context of 4th quarter on the balanced basketball games. The CM profile of balanced and unbalanced games emphasized the disadvantage recovering episodes with transitions from the Transition State to Alarm State and also from the Misbalance to Transition State. Fast and moderate rhythm games highlighted the beginning of the 3rd quarter as a preferential moment for critical occurrences. Ferreira, A.P.; Sampaio, J.; Volossovitch, A.; Gomes, F. (2009). 3rd International Workshop International Society of Performance Analysis of Sport, 55, University of Lincoln, 55. Ferreira, A.P., Volossovitch, A., Gomes, F., Infante, J. (2010). Int J Sport Psychol 41(4), 68-69.

## PHYSICAL, TECHNICAL FITNESS & BODY COMPOSITION PROFILE IN YOUTH BASKETBALL AGED 7-17 YEARS

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**Introduction** In long-term athletes development (Balyi & Williams, 2009) body composition of a basketball players and their physical, technical fitness are vital factors for managing training process (Matulaitis et al., 2010). The aim of the research was to compose physical and technical fitness normative profile for youth basketball players' (7 to 17 years). **Methods** Subjects: Basketball players aged 7-17 years

(from 30 to 172 in every age category, overall – 1051 subjects) took part in the study. Indices of body size (height, body mass), physical (speed – 20 m, leg muscle power – squat jump [SJ] and counter movement jump [CMJ]), technical fitness (dribbling, movement in defense, free throws, 1 minute shooting) were tested using well known methods of basketball (Matulaitis et al., 2010). Cross sectional analysis between age groups were assessed using independent sample t-test with unequal variance. Statistical significance was set at  $P < 0.05$ . The SPSS 17.0 for Windows software was used to form the range scale of body size, physical and technical fitness (excellent 80–100%; very good 60–79%; good 40–59%; average 20–39%; poor 0–19%). Results The greatest changes ( $P < 0.05$ ) in height were assessed in the years of 13th (5.1%) and 15th (5.2%) compared to previous years. The greatest changes ( $P < 0.05$ ) in body mass were assessed in the years of 11th (13.8%) and 15th (13.2%) compared to previous years. The power of leg muscles (SJ) increased the most ( $P < 0.05$ ) in 12th (12%) years, but CMJ in 15th (11.1%). Speed increased ( $P < 0.05$ ) in the years of 15th (6.1%). The indices of technical fitness increased ( $P < 0.05$ ) in such a way: 1 minute shooting (11th – 23.2%), dribbling (13th – 7.2%), movement and free throw (15th – 13.5% and 19.7% respectively). Discussion Genotypic and phenotypic factors might have influenced those results (Malina et al., 2004). Different changes in height and body mass of 11 and 12 year-old players might be affected by the juncture of pre-puberty and puberty (Malina et al., 2004). Increasing of SJ and CMJ, as well as technical fitness might be valuable factor for basketball coaches in order to design right training programs for improving specific fitness features for players (Balyi, 2001). References Balyi, I. (2001). Sport system building and long-term athlete development in Canada. In Coaches Report. The Official Publication of the Canadian Professional Coaches Association, 8 (1), 25–28. Balyi I., Williams C. (2009). Coaching the young developing performer, 17–21. Leeds: Coachwise. Malina, R. M., Bouchard, C., Bar-Or, O. (2004). Growth, Maturation, and Physical Activity. Champaign, IL: Human Kinetics. Matulaitis K, Skarbalis A, Pūkėnas K, Balčiūnas M. (2010). Ugdymas. Kūno kultūra. Sportas, 2 (77), 55–62.

## PERSONALISED ENDURANCE TESTING IN TOP LEVEL BASKETBALL PLAYERS

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**Introduction** After more than 25 years designing specific endurance tests for basketball players and having applied them in different basketball teams (Spanish under-20 national team, young-player teams, ACB-1st div, LEB1-2nd div, LEB2-3rd div and EBA-4th div of Spanish leagues, NCAA Division I and High School of USA leagues), it is evident the need for a dynamic personalization of endurance testing. The aim of this study was to analyze the evolution of the endurance capacity, measured with personalized tests, in five professional basketball players during two consecutive seasons (LEB1 2nd division and ACB 1st division of the Spanish leagues). **Methods** One test with specific offense and defense actions for interior players (centers and power forwards) and another test with specific offense and defense actions for exterior players (point guards and forwards) in which the player had to perform the sequence of specific actions as many times as possible during four 2-minute effort periods alternated with 30-second rest periods were used to measure the endurance capacity during the first season (LEB1 2nd division). One test with specific offense and defense actions for each players (AO, FL, JP, JC, JS) consisting on eight 1.5-minute effort periods alternated with 30-second rest periods were used to measure the endurance capacity during the second season (ACB 1st division). The number of actions performed (each period and total), recovery heart rate (each 30-second rest period and at 1, 2 and 3 minutes of end) and performance index (number of actions/heart rate for each period and total) were evaluated and the test was performed six times (at beginning and end of pre-season and after three mesocycles of each season). **Results** Total number of actions and recovery heart rate at 1-minute in tests 1,2,3,4,5 and 6 are, respectively, for player AO: 225/135, 238/148, 245/136, 357/146, 370/147 and 389/144, for player FL: 216/164, 236/145, 248/153, 346/157, 372/152 and 399/153, for player JP: 220/146, 231/153, 240/149, 345/143, 365/149 and 403/161, for player JC: 236/147, 242/150, 248/156, 349/158, 364/148 and 402/140, and for player JS: 223/158, 212/135, 225/144, 330/142, 339/137 and 391/141. **Discussion** The type of endurance testing proposed, with options to personalize the type of actions and the duration and number of effort-rest periods, is useful for making effective analysis of the evolution of the endurance capacity of each player, if also other factors, such as specific training and minutes played during competition, are considered. In addition, the specific information on the endurance capacity is relevant for planning the special endurance-strength training and for effective guidance of training process. **References** Ribera-Nebot D. (1991). Endurance testing in basketball for point guards, forwards and centers. Barcelona University Report. Ribera-Nebot D. (2005). Evaluating Conditioning Capacities of Basketball Players. International Basketball Clinic - Lithuanian Basketball Coaches Association, Vilnius.

## PHYSICAL FITNESS COMPONENTS ASSOCIATED WITH LINE DRILL PERFORMANCE IN ADOLESCENT BASKETBALL PLAYERS

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**Introduction** Basketball entails repeated episodes of short, intense activity involving rapid changes in direction (Abdelkrim, El Fazaa and El Ati, 2007). The line drill test (LD) is proposed as a viable and appropriate field test for anaerobic performance (Seminick, 1990) due to its high reliability and acceptable validity in adolescent basketball players (Carvalho et al., 2010). The analysis of factors that influence performance in the LD has practical implications for coaches and sports scientists. This study sought to determine the components of fitness associated with performance in the LD in adolescent basketball players. **Method** Following ethical approval and informed consent, 46 elite adolescent male basketball players ( $M = 16.82 \pm 0.86$  years) took part in LDs, lateral quickness test (LQT), aerobic capacity test (VO<sub>2</sub>max estimated via 20m shuttle run), back and leg strength test (Takei Instruments Ltd), upper body strength test (Concept II Dyno), vertical jump test with measures of jump height, actual peak power (PPactual) and peak power relative to body mass (PPrel) using a force platform (Kistler, Amherst, New York). Pearson product moment correlations were used to determine the relationship between the fitness variables and LD. Multiple-regression analysis (backward stepwise;  $p$  to enter  $< 0.05$ ,  $p$  to remove  $> 0.1$ ) was conducted to determine which combination of measured characteristics could predict LD performance. **Results** Significant relationships were evident between LDs and all fitness variables (all,  $P < 0.001$ ). Multiple-regression analysis indicated that together lateral agility, aerobic capacity and PPrel could account for approximately 73.9% of the variance in LDs ( $p < .001$ ), according to the following regression formula: LD performance =  $25.291 - 0.082$  (PPrel) +  $0.795$  (LQT) –  $0.058$  (aerobic capacity). **Discussion** Performance in the LD is predicted best by a combination of factors which include PPrel, LQT and aerobic capacity rather than by any single component of fitness. As previously mentioned the LD is recommended as an appropriate field test for measuring anaerobic performance in adolescent basketball players (Carvalho et al., 2010). The results imply that aerobic capacity has a significant contribution to performance of the LD, disagreeing with previous research, which suggests the LD is an anaerobic test (Seminick, 1990). Therefore, it can be suggested that training which results in improvements in any of these factors may result in improved performance in LD. **References** Abdelkrim NB, El Fazaa S, El Ati J (2007) Br J Sports Med, 41, 69-75.

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## RELATIONSHIP OF PLAYERS TO BIRTHPLACE AND BIRTHDATE AMONG JAPAN BASEBALL LEAGUE

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Relationship of players to birthplace and birthdate among Japan baseball league Naomasa Sakamoto, Knnihiro Sakamoto, , Preventive medicine, Hyogo College of Medicine (Hyogo, Japan) Introduction : There were many reports that the birth condition especially temperature or nutrient as social environment effected to the personality and physical activity in adults, and there were reports that chronic disease might be connected with the birthdate. In this study, Japan baseball league players were analyzed on birthplace and birthdate. Method: baseball players of Central and Pacific league were analyzed on birthplace and birthdate in 780 persons using Nippon Professional Baseball Players guide 2010. Nippon sports Kikaku Shupannsha(Tokyo). The median age of players were 26 years old and the distribution of age was 19-41 years old. The birthplace was analyzed by 47 prefecture unit(Pre.). And the birthdate was analyzed by the month. The analyses was down using the odds ratio and chi-square test. Results: The distribution of blood type of the players were A type 0.374, B type 0.236, O type 0.313, AB type 0.077 as same pattern with Japanese. The median value of frequent of players per Pre. was 20 persons. Correlation coefficient(r) between the numbers of players and the populations of Pre. was 0.811. Odds ratios of the players to the populations of Pre. were high to 3.039 of Wakayama Pre. and 2.356 of Fukui Pre., and were low to 0.215 of Aomori and 0.216 of Nagano Pre.. Thus, relatively warmer south part of Japan showed relatively high frequent appearance of players, and the heavy snowed region showed low appearance of players in north part of Japan. The relation of tax rate per person per Pre. to the frequent appearance of players was analyzed. The r between numbers of players and tax amount of Pre. was 0.556. The odds ratios of players to the tax amount of Pre. were high to 2.437 of wakayama Pre., 2.034 of kyoto Pre. and 2.020 of Nara Pre., and were low to 0.171 of Aomori Pre. and 0.219 of Nagano Pre.. The distribution of birthdate of players was high in June and July. The r between birthdates of players and monthly birth rates of the population was 0.479. Odds ratios of birthdate to monthly birth rate were high to 1.561 for June and 1.512 for July, and was low to 0.475 of February and to 0.513 of March. Thus, there were tendency to concentrate the birthdate on summer season in players. Discussion: The birthplaces of professional baseball players were distributed frequently in the prefectures of relatively moderate temperature and economy rich area in Kinnki district located in middle part of Japan, The birthdate of players seemed to accumulate to June and July, and a few in February. Reference: Jean C, Dany JM, Joseph B, Bruce A.(2006) J Sports Sci,24:1065-1073 Baker J, Cote S, Abernethy B,(2003) J App sport Psy, 15:12-25 Shimura M, Nakamura I, Miura T.(1977) Acta Psychist Scand, 55:225-232

## EVALUATION OF PERIPHERAL VASCULAR IMPAIRMENT IN THE FINGERS OF BASEBALL PLAYERS BY USING A LASER DOPPLER BLOOD PERFUSION IMAGER

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Introduction Digital vessel trauma from repetitive impact on the fingers and hand is a concern for baseball players (Sugawara, 1986). Laser Doppler blood perfusion imaging (LDBPI) is a technique employing two-dimensional horizontal scanning of the blood flow in a specific tissue without the necessity for surface contact (Wärdell, 1993). The LDBPI method may have the benefit of detecting vasospastic abnormalities and occlusion of the digital artery, which generally appear with an inhomogeneous reaction to cold. This study aimed to examine whether LDBPI is useful for detecting peripheral vascular impairment in baseball players exposed to repetitive impact due to catching a ball. The changes in finger skin blood flow in response to a cold water immersion test were evaluated using LDBPI in baseball players suffering from disturbances of finger peripheral circulation and in healthy players without the symptoms. Subjects and Methods The subjects were 10 male university baseball players (age, 18-21 years) suffering from peripheral vascular impairment of the index finger on the catching side and 22 healthy players of a similar age as controls. A cold provocation test was carried out by immersing a subject's hand on his catching side into cold water at a temperature of 10°C for 10 minutes. Repeated image scanning of skin blood flow on the palm was performed every 2 min before, during, and after cold water immersion using a PIM-3 LDBPI (PERIMED, Sweden). The mean blood perfusion values in the finger area were calculated on each color-coded image. The finger skin temperature was recorded using an electrode thermistor attached to the skin on the dorsal side of the index finger. Results The cold provocation test showed that the finger skin temperature was not significantly different between the symptomatic players and controls. However, mean blood perfusion values were significantly different between the controls and the symptomatic players at almost every measurement point. The difference in the responses of skin blood perfusion under the condition of cold provocation between the symptomatic players and controls were clearly demonstrated in color-coded images. Discussion These findings suggest that the LDBPI technique employing multiple point recording and spatial mapping is an important quantitative tool for studying changes in finger skin blood perfusion after cold water immersion. Thus, this method can be used for the assessment of peripheral circulatory function in baseball players.

## ACUTE INFLUENCE OF MONOCULAR VISION ON SPECIFIC SKILLS IN HANDBALL – A PILOT STUDY

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Introduction: The quality of vision in high-performance sport is a basic requirement to react on steady changing game situations. The visual system is an essential condition for performances in sports with differences in binocular and monocular visual function (left and right). Numerous athletes have on-sided visual impairments, very often they remain undetected. The present study examines the influence of on-sided visual impairments on game skills in Handball. Methods: 11 physical education students took part in our study (age: 21.91±1.13 years; 9 male and 2 female, Visus L: 1.59±0.24; R: 1.64±0.22). Every subject performed four handball-specific tests on one experimental day, catching quotas in ten levels 20km/h -84km/h quantity 0-10 (1), pass quality in terms of precision in points-based system 0-5(2.1) and speed in km/h (2.2), slalom dribbling in sec(3) and depth perception in cm(4). The test were conducted in crossover-design without distraction of the visual function (BI) and only monocular right (MOR) or monocular left (MOL) seeing. Results: In catching quotas we found a significant impairment between BI and MOR(p=0.023)and BI and MOL(p=0.181) (1)BI:5.18±1.41;MOR:3.64±1.69;MOL:3.27±2.41(p=0.014).In the testsituation, which analyses the pass quality and precision we found no changes (2.1) BI:39.18±5.49; MOR:36.18±8.37;MOL:37.27±3.52(p=0.284)(2.2)BI:63.93±5.6;MOR:63.25±5.76;MOL:63.13±5.34(p=0.579).There were no changes in slalom dribbling time for all testsituations (3) BI:7.47±0.50; MOR:7.73±3.55;MOL:7.59±0.50(p=0.331).In

depth perception we found a significant impairment in BI and MOR ( $p=0.074$ ) and BI and MOI ( $p=0.02$ ) (4) BI:  $1.81 \pm 1.77$ ; MOR:  $11.09 \pm 10.24$ ; MOI:  $18.36 \pm 13.92$  ( $p=0.009$ ). Discussion: The reduction of the monocular visual function leads in our study to a deterioration on game skills in handball especially on standard game situations in mid-tempo, this shows especially test no. 1 and test no. 4, which represent essential parts of the handball game. Undetected visual impairments will lead, with a high probability, to a significant loss of performance, because our results show how the visual function and our tested game skills get significant worse if the subject is monocular. Unanswered is the question of compensation and possibilities of specific training. Prospectively it is still to examine if a monocular practice leads to an optimization of binocular visual performances in sports. Literature: Olivier, I., Weeks, D.-J., Lyons, J., Ricker, K.-L., Elliot, D. (1998). Monocular and binocular vision in one-hand ball catching: Interocular integration. *Journal of motor behavior*, 30 (4), 343-351. Ypsilanti, A., Hatzitaki, V., Graviou, G. (2009). Lateralized effects on hand and eye on anticipatory postural adjustments in visually guided aiming movements. *Neuroscience Letters*, 462 (2), 121-124.

## INSTRUMENTS FOR FATIGUE'S CONTROL IN HANDBALL TEAM PLAYERS IN ECOLOGICAL SITUATIONS: CMJ AND 10 M SPRINT TIME.

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Introduction In handball team, the possession or not of the ball it determines the own player's behaviors, existing a constant relation offensive - defense that takes place during the game. This correlation implies that the actions players realize are characterized by rapid direction changes, accelerations, sprints, jumps and throws, all of them performed to high intensity and opposite to an opponent what implies that the handball team players develop high degrees of fatigue specially in muscles' legs (Ronglan, Raastad and Borgesen, 2006). Therefore the aim of this study is acquiring more specific knowledge regarding development of fatigue following real handball matches. Such sport specific knowledge may facilitate the adjustment of more adequate training and competition procedures within elite handball. Methods Sixteen male players from Spanish First Division (age  $25.6 \pm 4.4$  yr, body mass  $86.3 \pm 7.9$  kg, height  $184.4 \pm 14.6$  cm; body fat  $12.7 \pm 8.2\%$ ) participated in this study. They realized 5 counter-movement jumps (CMJ) and 10 m. sprint test just after finishing the warming and before the celebration of match, these measures were repeated at the half and the end of match. Results We analyse CMJ height and 10 m. sprint time losses during four official matches. There were significant differences between CMJ height loss ( $p < 0.001$ ) before and after match and between 10 m sprint time loss ( $p < 0.005$ ) before and after match. Furthermore, these differences also were found between first and second half of the match. Discussion During the match development the players are fatiguing measured like CMJ height loss and the increase in time to travel 10 m. During the measurements realized at half time of and at the end of match, being this reduction even more accused in the last measurement. Therefore, it is possible to conclude that the use of the CMJ and 10 m. sprint time are valid and reliable tools for estimating the neuromuscular fatigue produced (Jiménez-Reyes, 2010). References Jiménez-Reyes, P. (2010). Relation between strength, power, training load and specific performance, in national and international sprinter. Tesis Doctoral. Universidad Pablo de Olavide. Sevilla. Ronglan LT, Raastad T, Borgesen, A. (2006). Neuromuscular fatigue and recovery in elite female handball players. *Scandinavian Journal of Medicine and Science Sports*. 16, 267-273.

## Poster presentations

### PP-PM32 Reproductive Hormones

## THE EFFECTS OF MENSTRUAL CYCLE PHASE ON THE DEVELOPMENT OF PEAK TORQUE UNDER ISOKINETIC CONDITIONS

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Introduction: It is widely recognised that during the menstrual cycle there are decrements in athletic performance. However the association between menstrual cycle phase and the rate of force development is less well understood. Therefore the purpose of this study was to examine the effects of menstrual cycle phase on the development of peak torque across a range of isokinetic speeds. Methods: Following local Institutional ethics approval 17 well trained female participants agreed to participate. 11 of the participants formed the non-oral contraceptive group (n-OC) (age  $20.7 \pm 1.4$  yrs, mass  $59.2 \pm 6.9$  kg, height  $166.8 \pm 7.1$  cm) and reported a regular menstrual cycle. The remaining 6 participants formed the oral contraceptive control group (OC) (age  $20.3 \pm 0.5$  yrs, mass  $60.5 \pm 4.2$  kg, height  $164.8 \pm 4.8$  cm). Concentric strength of the knee flexors and extensors were assessed using an isokinetic dynamometer at speeds of 60 °/s, 120 °/s, 180 °/s and 240 °/s with the participant completing 5 repetitions at each speed separated by a recovery period of 180 s. The participants completed this protocol on four occasions which corresponded to menstruation (MEN), mid-follicular (mFOL), mid-luteal (mLUT) and immediately pre-menstrual (pMEN). Also recorded from the non-OC group at the onset of each visit to the laboratory were progesterone and 17β-oestradiol via enzyme immunoassay. Results: There was a significant decrease in peak torque production (Nm) of the extensors for non-OC at 120 °/s ( $P = 0.0207$ ) (MEN) and of the flexors at 60 °/s ( $P = 0.0116$ ) (MEN) and 120 °/s ( $P = 0.0282$ ) (MEN). There was no significant difference for peak torque development across menstrual cycle phase for the OC group ( $p > 0.05$ ). Re-analysis of the data using test order instead of menstrual phase indicated that there was no learning effect on peak torque production of the knee flexors or extensors in both the non-OC and OC groups ( $p > 0.05$ ). There was a significant increase in progesterone (pg/ml) during mLUT compared to MEN and mFOL ( $P = 0.0010$ ) and a significant decrease in oestrogen during MEN compared to mLUT ( $P = 0.0207$ ). Discussion: The decrease in peak torque production at 60 and 120 °/s would appear to be associated with decreased oestrogen concentrations. The data suggests that it is the amount of force produced by the muscle fibres rather than fibre recruitment patterns that are affected by stage of menstruation as evidenced by no change in peak torque at 180 and 240 °/s. Oestrogen receptors have been shown in skeletal muscle suggesting that oestrogen could have a direct effect on force production. Furthermore high oestrogen levels have been associated with increased availability of ATP and PCr.



### COMPARISON BETWEEN YOUNG AND POSTMENOPAUSAL WOMEN FOR CHANGES IN MARKER OF MUSCLE DAMAGE FOLLOWING TWO DIFFERENT VELOCITIES OF ECCENTRIC EXERCISE

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**Introduction** It is known that unaccustomed eccentric exercise induces muscle damage (Lavender and Nosaka, 2006). Some parameters could influence in this process, such as age (Dedrick and Clarkson, 1990) or contraction velocity (Chapman et al., 2006). This study investigated if different velocities of eccentric exercise could interfere in the magnitude of losses and repair of isometric strength (IS) in postmenopausal women when compared to young women. Isometric strength is the best marker for muscle damage (Warren et al., 1999), therefore, one can infer that greater losses of IS indicates greater muscle damage. We hypothesize that fast eccentric actions should promote greater losses in IS for both groups, with greater muscle damage for the postmenopausal group. **Methods** 19 young and 18 postmenopausal (PM) women volunteered for the study, divided into 4 groups, 2 of fast velocity ( $210^{\circ} \text{ s}^{-1}$ ): young fast (YF,  $n=10$ ) and postmenopausal fast (PMF,  $n=10$ ); and 2 of slow velocity ( $30^{\circ} \text{ s}^{-1}$ ): young slow (YS,  $n=9$ ) and postmenopausal slow (PMS,  $n=8$ ). The groups performed 5 sets of 6 maximal isokinetic eccentric actions (Biodex System 4 Pro, Medical Systems, USA) of elbow flexors in the non-dominant arm. The maximal isometric muscle strength (IS) was assessed before the session of eccentric exercise (Pre), immediately after (Post), and 24, 48, and 72h after the protocol. **Results** No significant difference was found at IS nor between ages or velocities. However, IS values were different in YS, YF and PMS throughout the moments. Pre values were significantly higher from: 24h ( $p < 0.044$ ) and 48h ( $p < 0.005$ ) for YS; 24h ( $p < 0.003$ ) and 72h ( $p < 0.024$ ) for YF; Post ( $p < 0.001$ ), 24h ( $p < 0.017$ ), 48h ( $p < 0.001$ ) and 72h ( $p < 0.001$ ) for PMS. No significant difference was found in PMF. **Discussion** It is known that estrogen could possibly attenuate muscle damage (Kendall and Eston, 2002). Despite the PM state of the group, and thus the reduced protection of estrogen, no changes were observed in the IS values between ages. What concerns velocity, we expected that fast velocity would promote greater muscle damage in men (Chapman et al., 2006). In the present study the velocity did not affect IS. **In conclusion**, for women, we found no influence of age or velocity in this marker of muscle damage. **References** Chapman D, Newton M, Sacco P, Nosaka K. (2006) *Int J Sports Med*, 27(8), 591-598. Dedrick ME, Clarkson PM. (1990) *Eur J Appl Physiol Occup Physiol*, 60(3), 183-186. Kendall B, Eston R. (2002) *Sports Med*, 32(2), 103-123. Lavender AP, Nosaka K. (2006) *Eur J Appl Physiol*, 97(5), 619-626. Warren GL, Lowe DA, Armstrong RB. (1999) *Sports Med*, 27(1), 43-59.

### EFFECTS OF QUASI FOLLICULAR AND QUASI LUTEAL PHASE-BASED STRENGTH TRAINING ON MUSCLE CELL PARAMETERS IN SUBJECTS WITH ORAL CONTRACEPTION

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**Purpose:** The modern monophasic oral contraceptive (OC) administration consistently suppresses circulating endogenous sex steroid hormone concentrations in OC users. OC provide the women with fixed doses of estrogen and progestogen over 21 days (consumption phase), followed by a 7 days break (withdrawal phase). These hormone concentrations might be important influence factors on strength capacity. The aim of this study was to investigate effects of quasi follicular phase-based (qFT) in comparison to quasi luteal phase-based strength training (qLT) on cellular parameters such as muscle fiber composition, diameter and cell nuclei to fiber ratio of skeletal muscle. **Methods:** Six healthy untrained or moderately trained women (age:  $22.8 \pm 3.0$  yrs, height:  $164.5 \pm 5.09$  cm, weight:  $65.0 \pm 10.0$  kg) using OC completed a strength training program of the m. quadriceps femoris for each leg on the leg press for 3 menstrual cycles (12 weeks). The subjects trained (4 time a week) one leg mainly in quasi follicular phase (qFO) and the other leg mainly in quasi luteal phase (qLU). Muscle fiber composition (F%no: relative fiber number, F%area: relative fiber area), muscle fiber diameter (Fdm) and cell nuclei to fiber ratio (N/F) were determined in skeletal muscle biopsy samples of both legs (m. vastus lateralis) prior to and after 3 months of strength training using histochemical analysis (ATPase and HE staining). **Results:** F%area of type II increased after 3 months strength training of qFT ( $+7.0\% \pm 10.9$ ) and qLT ( $+6.7\% \pm 13.3$ ). Mean value of F%no of type II increased by  $7.0\% \pm 7.5$  after qFT and by  $1.0\% \pm 11.0$  after qLT. Moreover, Fdm showed increases in type II after both qFT ( $+5.1 \pm 8.8\mu\text{m}$ ) and qLT ( $+6.6 \pm 7.8\mu\text{m}$ ). N/F ratio increased after qFT ( $+0.6 \pm 0.7$ ) and decreased after qLT ( $-0.1 \pm 0.6$ ). **Conclusions:** In a small sample of 6 subjects we were not able to demonstrate any relevant differences between the two training modes concerning adaptation of skeletal muscle. This finding will have to confirm in larger sample, which might be explainable by the artificially constant hormone levels in OC users. The confirmation of this finding would suggest that untrained or moderately trained OC users could perform strength training independently from phases of menstrual cycle. **Acknowledgement** The study was supported by the Federal Institute of Sport Science Bonn, Germany (BISp: IIA1-070106/09-10).

### TRAINING STATUS AND SKIN MICROVASCULAR VASODILATION IN ADOLESCENT FEMALES

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**Introduction** Detrimental vascular changes begin in youth and are seminally characterised by endothelial dysfunction. Therefore, the procurement of systemically intact endothelial function from a young age is pivotal in the prevention of atherosclerotic morbidity. We have previously reported superior endothelial vasodilatory responsiveness of the skin microcirculation in the limbs of trained versus untrained male adolescents (Roche et al., 2010). However, no study has exclusively investigated the vasodilatory responsiveness of the skin microcirculation in healthy young females in relation to training status. **Methods** 14 trained and 9 inactive females ( $\text{VO}_{2\text{peak}}$ :  $43.7 \pm 3.4$ ;  $35.3 \pm 4.2$  mL/kg/min,  $p < 0.01$  respectively), matched for maturity status (age:  $15.0 \pm 0.8$  yrs; tanner stage:  $3.8 \pm 0.98$ ; mass:  $55.7 \pm 7.8$  kg; stature  $160.7 \pm 4.6$  cm), had their skin microcirculation interrogated via laser Doppler flowmetry (Periflux 5000) on the forearm and dorsal foot. Maximal skin blood flow (SkBFmax) was attained by heating the skin to 44 degrees using integrated probe heaters, whilst peak forearm post-occlusive reactive hyperaemia (PORH) was determined as the highest blood flux value following the rapid deflation of a cuff (50mmHg above systolic blood pressure for 3 mins). Peak  $\text{VO}_2$  was assessed through a maximal treadmill test to volitional exhaustion. Between group comparisons were made using independent t-tests. Maximal cutaneous vascular conductance, during the thermal plateau (CVCmax), was calculated as  $\text{SkBFmax}/\text{MAP}$  (mean arterial pressure). **Results** SkBFmax was significantly higher in the skin of the dorsal foot of trained girls (trained:  $293.9 \pm 139.7$ , inactive:  $186.6 \pm 75.4$  PU,  $p < 0.05$ ). Likewise foot CVCmax was significantly higher in the trained versus inactive girls (trained:  $3.8 \pm 1.45$ , inactive:  $2.8 \pm 1.8$  PU/mmHg,  $p < 0.05$ ). In the forearm, SkBFmax, CVCmax and PORH did not vary significantly between groups (SkBFmax trained:  $267.4 \pm 139.5$ , inactive:  $211.4 \pm 124.5$  PU; CVCmax trained:  $3.4 \pm 1.7$ , inactive:  $2.8 \pm 1.8$  PU/mmHg; PORH trained:  $55.3 \pm 46.7$ , inactive:  $34.6 \pm 19.4$  PU). **Discussion** We have demonstrated that in healthy adolescent girls,

regular physical training that is sufficient to elevate  $\text{VO}_{2\text{peak}}$  is associated with superior maximal endothelial vasodilation and cutaneous vascular conductance, at least in dorsal foot skin microcirculatory tissue. This has implications regarding the remedial role of physical activity from a primary prevention stand-point in healthy young females. References Roche, D.M., Rowland, T., Garrard, M., Marwood, S., Unnithan, V. (2010). *Eur J Appl Physiol*, 108, 1201-1208.

### EFFECTS OF MENSTRUAL CYCLE PHASE AND EXERCISE TRAINING TYPE ON CENTRAL ARTERIAL COMPLIANCE IN YOUNG WOMEN

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[Introduction] Decreased central (e.g., carotid and aorta) arterial compliance with aging is an independent risk factor for mortality and morbidity of cardiovascular diseases. Though estradiol and progesterone, major ovarian hormones, have potentials for changing arterial compliance, the effects of their natural fluctuations during the menstrual cycle are not fully understood. Meanwhile, in young men, regular aerobic exercise increases arterial compliance, but it is decreased by resistance training (Otsuki et al., 2007). However, little data related to the exercise training type on arterial compliance are available in young women. In this study, we determined whether carotid arterial compliance is affected by menstrual cycle phases (study 1) and/or regular exercise training (aerobic or resistance training) (study 2). [Methods] Study 1; Ten eumenorrheic sedentary healthy women (mean age: 20.7 yrs.) were studied. We investigated variations in blood pressure (carotid and brachial), carotid arterial compliance (simultaneous ultrasound and applanation tonometry) and serum estradiol and progesterone concentrations at the five different crucial hormonal time points during the menstrual cycle (menstrual: M, follicular: F, ovulatory: O, early luteal EL, late luteal: LL). Study 2; we determined the relation between the exercise training type and the carotid arterial compliance in healthy young women: 26 healthy young women who were sedentary (CO, n=9), endurance-trained (ET, n=9), and resistance-trained (RT, n=8) groups. [Results] Study 1; Carotid arterial compliance varied cyclically, with significant increase from M and F to O phase, and sharp falls in the EL and LL phase ( $F=5.590$ ,  $p<0.05$ ). The fluctuation in carotid arterial compliance was synchronized with the changes in the balance of blood estradiol and progesterone concentrations. Study 2; No significant difference was found in the carotid arterial compliance among the ET, RT, and CO groups. [Conclusion] These results suggest that it is necessary to consider the menstrual cycle phase rather than exercise training status when interpreting arterial elasticity in young women. [Reference] Otsuki T, Maeda S, Iemitsu M, Saito Y, Tanimura Y, Ajisaka R, Miyauchi T (2007). *Am J Physiol Heart Circ Physiol* 292, H786-91.

### THE EFFECT OF EXERCISE AND/OR TESTECTOMY ON CONCENTRATIONS OF ADIPONECTIN AND TESTOSTERONE IN BOTH BLOOD AND ADIPOSE TISSUE

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INTRODUCTION and PURPOSE There is little evidence that the effect of exercise and/or testectomy on production and secretion of adiponectin from adipocyte. The purpose of this study was to investigate the effect of exercise and/or testectomy on concentrations of adiponectin and testosterone in both blood and adipose tissue. MATERIALS and METHODS Male Wistar rats were used in this study (12-week-old at the end of experiment). The rats were randomly assigned to either the 3 weeks voluntary wheel running exercise (Ex-) or sedentary control (Co-) groups. Both groups had testectomy (-Tx) and sham (-Sh) operation groups. All rats subjected to these operations at 8-week-old, and took one week of recovery and acclimatization period. The cages of exercise group attached freely accessible running wheels with digital revolution counters, but access to the wheel was prohibited during the recovery and acclimatization period. The rats were provided with water and standard chow food ad libitum. At the end of experimental period, blood and fat tissue samples were collected and analyzed using enzyme immunoassay methods. RESULT and DISCUSSION Testectomy provided remarkable decreases in blood testosterone concentrations in both Co-Tx and Ex-Tx groups. Compared to Co-Sh group, Co-Tx group exhibited the significant increase in blood adiponectin concentration and the tendency to decrease in adiponectin and testosterone concentrations in adipose tissue. Ex-Sh group did not show any significant changes in these parameters. Compared to Co-Tx group, Ex-Tx group exhibited the decrease in blood adiponectin concentration and the tendency to increase in adiponectin and testosterone concentrations in adipose tissue. These findings may indicate that testosterone in adipose tissue negatively regulate adiponectin secretion from adipocyte.

### SEX DIFFERENCES IN ELECTROMECHANICAL DELAY OF THE HAMSTRINGS DURING ECCENTRIC MUSCLE ACTIONS

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UNIVERSITY OF GLOUCESTERSHIRE

SEX DIFFERENCES IN ELECTROMECHANICAL DELAY OF THE HAMSTRINGS DURING ECCENTRIC MUSCLE ACTIONS De Ste Croix, M., El Nagar, Y. and James, D. University Of Gloucestershire, Department of Sport and Exercise, Gloucester, UK Introduction Increased relative risk of non-contact ACL injury has been attributed to numerous biomechanical, anatomical and neuromuscular factors. One of the proposed reasons for an greater incidence of non-contact ACL injury in females is a reduced capacity for neuromuscular functioning to stabilise the knee joint effectively (Hewett et al. 2007). Therefore the purpose of this study was to examine sex differences in the electromechanical delay (EMD) of the hamstring muscles during eccentric muscle actions. Methods One hundred and ten participants (55 males and 55 females) provided written informed consent to participate in the study. Prone isokinetic eccentric torque of the hamstrings was determined at 60, 120, 240°/s with the hip flexed at 0°. Range of movement of the knee joint was 90°. Surface electromyography was simultaneously recorded from the semitendinosus (ST), semimembranosus (SM) and biceps femoris (BF) of the dominant limb using an 8-channel DelSys EMG telemetry system. The biodex square wave synchronization pulse was configured with the EMG software via a trigger system so that EMG and torque data were completely time aligned. EMG data were collected at a sampling frequency of 1024 Hz and included a common mode rejection ratio of <80 dB and an amplifier gain of 1000. Raw EMG data was band pass filtered at 20 – 450 Hz. EMD was determined as the time delay between the onset of muscle activation (change in activation of +15  $\mu\text{V}$ ) and onset of torque production (9.6Nm) according to the procedures described by Zou et al (1995). A 2 (sex) X 3 (muscle group) X 3 (movement velocity) ANOVA was performed with subsequent post hoc analysis using bonferroni correction. Results There were no significant differences between the EMD of the 3 muscles examined at any of the movement velocities ( $p>0.05$ ). EMD for all muscles significantly increased with increasing movement velocity ( $p<0.05$ ). Irrespective of muscle examined or movement velocity no sex differences were found ( $p>0.05$ ). Discussion During eccentric hamstring muscle actions there are no differences in the delay time of the 3 muscles examined indicating these 3 hamstring muscles activate at a similar rate. Irrespective of sex, as movement velocity increases the delay time also increases indicating a reduced

capacity to stabilise the knee during fast velocity movements with potential for increased risk of injury. We found no significant sex differences in EMD irrespective of movement velocity or muscle examined, suggesting that females do not have impaired neuromuscular performance of the hamstring compared with males during eccentric hamstring muscle actions. References Hewett, T., Shultz, S., and Griffin, L. (2007) Understanding and preventing non-contact ACL injuries. *Human Kinetics*

### **MENSTRUAL CYCLE PHASE AND ORAL CONTRACEPTIVE USE: NO EFFECT ON ENDURANCE PERFORMANCE IN ROWERS**

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**MENSTRUAL CYCLE PHASE AND ORAL CONTRACEPTIVE USE: NO EFFECT ON ENDURANCE PERFORMANCE IN ROWERS** Vaiksaar, S.I, Jürimäe, J.I, Mäestu, J.I, Purge, P.I, Jürimäe, T.I 1: UT (Tartu, Estonia). Introduction Oestrogen and progesterone fluctuate predictably across the menstrual cycle (MC) in normally cycling eumenorrhoeic women (Oosthuyse & Bosch, 2010). The oral contraceptive (OC) use may provide a more stable environment to evaluate the effect of reproductive hormones on physiological variables and exercise performance in women (Rechichi et al., 2009). The aim of this study was to examine whether variables commonly used in aerobic exercise testing to predict performance over 2000 m distance are influenced by MC phase and OC use in female rowers. Methods Twenty-four eumenorrhoeic female rowers distinguished on the basis of both menstrual status and athleticism participated in this study and were divided into competitive cyclic athletes (CCA; n=8), recreationally trained cyclic athletes (RCA; n=7) and recreationally trained athletes taking oral contraceptive (OC) pills (ROC; n=9). Rowers performed two incremental tests on a rowing ergometer during two different phases of the MC: the follicular phase (FP) and the luteal phase (LP). The study variables were power output (Pa), heart rate (HR), oxygen consumption (VO<sub>2</sub>), carbon dioxide production (VCO<sub>2</sub>), minute ventilation (VE), the mean respiratory exchange ratio (RER), and ventilatory equivalents of O<sub>2</sub> (VE/VO<sub>2</sub>) and CO<sub>2</sub> (VE/VCO<sub>2</sub>), which were measured at maximal and at the aerobic-anaerobic transition intensities. In addition, maximal blood lactate (La) values after the test were obtained. Results When comparing Pa, VO<sub>2</sub>, HR and La values, no significant differences ( $p>0.05$ ) between FP and LP at maximal load and at threshold intensity were found in all three groups of studied rowers. However, we observed higher values ( $p<0.05$ ) for VE/VCO<sub>2</sub> at both intensities in LP compared with FP in ROC group. Discussion Similarly to other studies, no effect of MC phase on P<sub>max</sub>, VO<sub>2max</sub> and HR<sub>max</sub> values were found in highly active women with normal MC (Forsyth & Reilly, 2005). Although the glycogen-sparing effect of oestrogen in the LP may cause a decrease in La production in muscle during exercise (Forsyth & Reilly, 2005), MC phase did not affect aerobic-anaerobic transition intensity at least in more trained athletes. However, some cyclical variations in ventilatory response should be considered when interpreting physiological test results in OC users. Therefore, normally menstruating rowers and rowers taking OC pills should not be concerned about the timing of their MC with regard to optimized sport-specific endurance performance. References De Souza, MJ, Maguire, MS, Rubin, KR, Maresh, CM. (1990). *Med Sci Sports Exerc* 22: 575-580. Forsyth, JJ, Reilly, T. (2005). *Med Sci Sports Exerc* 37: 2046-2053. Rechichi C, Dawson B, Goodman C. (2009). *Int J Sports Physiol Perform*, 4: 151-162. Oosthuyse T, Bosch AN. (2010). *Sports Med* 40(3): 207-227.

### **PET OWNERSHIP AND MATERNAL ACTIVITY DURING PREGNANCY**

WESTGARTH, C.I, LIU, J.2, HERON, J.3, NESS, A.3, BUNDRED, B.I, GASKELL, R.I, COYNE, K.I, GERMAN, A.I, MCCUNE, A.A, DAWSON, S.I

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**PET OWNERSHIP AND MATERNAL ACTIVITY DURING PREGNANCY** Westgarth, C.I, Liu, J.2, Heron, J.3, Ness, A.3, Bundred, B.I, Gaskell, R.I, Coyne, K.I, German, A.I, McCune, A.A, Dawson, S.I 1: University of Liverpool (Liverpool, UK), 2: University of South Carolina (Columbia, USA), 3: University of Bristol (Bristol, UK), 4: WALTHAM Centre for Pet Nutrition (Melton Mowbray, UK) Introduction Maternal obesity has adverse outcomes for both mothers and their offspring, which have led to recent guidance that clinicians should advise pregnant women to manage their weight and to exercise (Sayburn, 2010). The objective of this study was to examine whether pregnant women that own pets, in particular dogs, were more active and less likely to be obese, than those who did not. Methods Data came from a cross sectional analysis of 14,273 pregnant women enrolled in the Avon Longitudinal Study of Parents and Children (ALSPAC) in the UK. The main outcome measures were self reporting of strenuous (enough to work up a sweat) activity (hours per week) at 18 weeks of gestation, types and hours spent in leisure-time physical activities, and maternal overweight defined as pre-pregnancy BMI = or above 25 and obese BMI = or above 30. The assumption was made that pre-pregnancy BMI was a proxy for weight status during pregnancy. Pet ownership was self reported at 8 weeks gestation. Logistic regression models were used, with adjustment for confounding factors known to be associated with pet ownership, activity and weight status. Results There was evidence for a positive relationship between participation in activity at least once a week and dog ownership (OR=1.27, 95% CI=1.11-1.44,  $P<0.001$ ). Dog owners were 50% more likely to achieve the recommended 3 hours activity per week, equivalent to 30 minutes per day, most days of the week (OR=1.53, 95% CI=1.35-1.72,  $P<0.001$ ). Dog owners were more likely to participate in brisk walking activity than those who did not have a dog, (compared to none; 2-6 hrs per week OR=1.43, 95% CI=1.23 to 1.67; 7+ hrs per week OR=1.80, 1.43 to 95% CI=2.27). No association was found between dog ownership and participating in other types of activities such as jogging, keep fit classes or swimming. There was no evidence of an association between dog ownership and weight status pre-pregnancy. Discussion Pregnant women who own dogs were more likely to be active, particularly through brisk walking but were no less likely to be obese (based on pre-pregnancy BMI). Walking is considered a low risk exercise and it is a readily available and economical. Although the effect sizes were modest, encouraging people to walk their dogs might help to increase activity levels in pregnant women. Further work needs to examine the motivation and barriers to owning and walking dogs in pregnancy. References Sayburn, A. (2010) Challenge pregnant women to manage their weight, NICE says. *British Medical Journal*, 341(c4107).

### **LIFESTYLE AND HOMA INDEX IN POST-MENOPAUSE**

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**Introduction** Menopause is characterised by both hormonal and metabolic changes linked with an increased risk of cardiovascular disease. Insulin resistance increases the cardiovascular risk, and it has been shown linked to a negative lifestyle, including poor movement and bad dietary habits. To better know whether movement and diet are negatively affected by the same problems (i.e. qualitative, quantitative or distributive problems) or not, the aim of our study was to individualize the influencing factors of the onset of insulin resistance in post-menopausal women without counselling on diet and daily movement. **Methods** Eighty-four post-menopausal women were

enrolled in the study, the 47 of them ( $57.34 \pm 4.78$  yrs) without history of diabetes mellitus, cardiovascular diseases, hormone-replacement therapy, controlled diet and physical exercise program participation were used for the analysis. Body composition was assessed by electrical bioimpedance technique, while the SenseWear Pro3 Armband measured daily physical activity characteristics. The device gives information about mean values of daily energy expenditure, intensity of daily physical activities (METs m/die), daily steps (STEPS m/die) and both time (TPA m/die) and energy spent (PAEE m/die) on physical activities with intensities  $> 3$  METs. A dietician estimated dietary habits and calories intake from three-day dietary records. The sum of kcal intake with breakfast, morning snack and lunch (FIRST%) gave information about energy intake of the first part of the day as percentage of daily energy intake. The sum of kcal intake with afternoon and evening snacks, and dinner (SECOND%) gave information about energy intake of the second part of the day. Maximal stress test was performed to assess maximal aerobic capacity (Max METs). Blood was collected to measure plasma glycaemia and insulin. HOMA index was calculated to assess insulin-resistance. Results Pearson's correlation showed the HOMA index positively correlated with body weight, BMI, waist circumference (WC), waist to hip ratio, percentage fat mass, SECOND% and dinner energy intake, expressed as percentage of daily energy intake. On the contrary, METs m/die, STEPS m/die, PAEE m/die, TPA m/die and FIRST% have been found inversely correlated with HOMA index. Linear regression, performed in stepwise modality ( $F=11.637$ ,  $p<0.001$ ), indicated WC ( $p=0.010$ ), SECOND% ( $p=0.005$ ) and STEPS m/die ( $p=0.005$ ) as predictive variables of HOMA index. Discussion Visceral adiposity, quantity of daily physical activity and the way to share daily energy intake between first and second part of the day are useful to predict insulin resistance of postmenopausal women, and suggest useful fields of intervention to promote health and to prevent cardio-metabolic diseases.

### **NO RELATIONSHIP BETWEEN TESTOSTERONE OR MACRONUTRIENT INTAKE WITH MUSCLE STRENGTH AND SIZE CHANGES DURING 12 WEEKS OF ELBOW FLEXOR STRENGTH TRAINING**

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**Introduction** There is considerable individual variability in the muscle strength and size adaptations to resistance training (RT) that may be influenced by testosterone and dietary intake of protein and fat. This study investigated the relationship between macronutrient intake and basal testosterone with changes in muscle strength and size over 12 weeks of elbow flexor RT. **Methods** Thirty-three untrained healthy males (18-30 yr) took part in 12 weeks of RT; 2-3 sets each of unilateral and bilateral elbow flexor curls at 8-10 repetition maximum (RM) 3 x per week. They were randomly assigned to a protein (PRO; 20g protein, 7g carbohydrate (CHO), 250ml H<sub>2</sub>O; n=17) or placebo (PLA; 7g CHO, 250 ml H<sub>2</sub>O; n=16) drink taken immediately before and after each RT session. Pre and post RT muscle strength (isometric elbow flexion strength (IEFS) at 120°, 1RM) and size (elbow flexor volume (FVOL), anatomical cross-sectional area (ACSA) of the biceps brachii, brachialis and brachioradialis muscles, determined from magnetic resonance imaging (MRI)) measurements were made of the dominant arm. Participants completed a 3-day weighed food intake during the 5th week of RT. Total testosterone (TT) and sex hormone binding globulin (SHBG) from fasted, early morning blood samples pre and post RT were measured by ELISAs and used to calculate free testosterone (FT). Pearson's correlation coefficient was used to assess bivariate relationships (critical p value  $<0.05$ ). **Results** RT increased IEFS (263 to 298 N;  $13.4 \pm 9\%$ ); 1RM (12.8 to 17.8 kg;  $49.3 \pm 19.7\%$ ); FVOL (401 to 463 cm<sup>3</sup>;  $15.7 \pm 6.1\%$ ); ACSA (28 – 32 cm<sup>2</sup>;  $16.3 \pm 5.7\%$ ) respectively ( $p<0.01$ ). Training adaptations were not influenced by PLA or PRO supplementation. Therefore, both groups were subsequently considered together for further analysis. Testosterone fractions were unaffected by the RT (TT, FT:  $p>0.18$ ) and therefore the mean was used for subsequent analysis. There were no associations between TT and FT and changes in measures of muscle strength and size after RT (IEF, 1RM, FVOL, ACSA:  $R<0.15$ ,  $P>0.43$ ). No relationships were found between macronutrient intake expressed as g.kg<sup>-1</sup> or % energy intake and changes in muscle strength and size (protein, SFA, PUFA, MUFA;  $R<0.09$ ,  $P>0.07$ ). There were also no correlations between TT or FT with PUFA, SFA, MFA and protein intake (all:  $R<0.09$ ,  $P>0.4$ ). **Discussion** In the current study, serum testosterone and macronutrient intake did not influence the muscle strength and size gains that occurred with RT in healthy young men. Other factors, including as local paracrine hormones and genetics, may be more important in explaining the individual responses to RT. **Acknowledgement** This study was sponsored by GlaxoSmithKline Nutritional Healthcare.

### **EFFECTS OF AEROBIC EXERCISE ON URINARY ESTROGENS AND PROGESTAGENS IN POSTMENOPAUSAL WOMEN.**

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**Introduction.** Important hormonal changes happen during the menopause. These hormonal alterations could be responsible for the increased morbidity that characterizes this period of life (Santoro et al. 1996). The physical activity could have an important regulating effect on female hormonal metabolism during the menopause (Stoddard et al, 2007) **Methods.** Twenty sedentary postmenopausal women (age  $52.27 \pm 3.80$  years) participated in this study. Each participant completed a 6 months supervised exercise training program (60-70% of the maximal heart rate, 60 min/day, 3 days/week) based on aerobic dance. Anthropometric tests and assessment of VO<sub>2</sub>max were carried out and urine samples were taken before and after the exercise program. The following hormones and metabolites were measured by gas chromatography/mass spectrometry: Testosterone, estradiol, estrone, estriol, progesterone, pregnanediol and pregnanetriol. **Results.** Postmenopausal women improved their VO<sub>2</sub>max and also they increased significantly their urinary excretion of progesterone metabolites (pregnanediol and pregnanetriol) after aerobic exercise training. However, urinary levels of estrone, estradiol, progesterone, testosterone and estriol did not change significantly. **Discussion.** The adrenal gland is converted into an important source of progesterone production in postmenopausal women (Sablík et al. 2008), so the increase in urinary excretion of pregnanediol and pregnanetriol would indicate an activation of the suprarenal gland produced by the exercise program. In addition, it may be that there is an adaptive effect of exercise on pregnanetriol and pregnanediol changes and that moderate physical activity does not act on these metabolites in the same way as estrogens. This increase in progesterone would have a beneficial effect on the health of postmenopausal women. **References.** Sablik Z, Samborska-Sablík A, Goch JH. (2008) Concentrations of adrenal steroids and sex hormones in postmenopausal women suffering from coronary artery disease. *Pol Merkuri Lekarski* 25: 326-329. Santoro N, Brown JR, Adel T, Skurnick JH. (1996) Characterization of reproductive hormonal dynamics in the perimenopause. *J Clin Endocrinol Metab.* 81 (4): 1495-1501. Stoddard JL, Dent CW, Shames L, and Bernstein L. (2007) Exercise training effects on premenstrual distress and ovarian steroid hormones. *Eur J Appl Physiol* 99: 27-37.

## Poster presentations

## PP-PM33 Thermoregulation

**STUDIES OF PHYSIOLOGICAL RESPONSES OF THERMOREGULATORY, HORMONAL, AND IMMUNE IN TRACK AND FIELD AND SWIMMING ATHLETES WITH SPINAL CORD INJURY IN HOT AND COLD ENVIRONMENTS**

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[Introduction] The purpose of this study was to clarify the influences of exercise-related stress on thermoregulatory, hormonal, and immune responses in hot/cold environments in track and field and swimming athletes with spinal cord injury. The subjects consisted of 5 male wheelchair long-distance athletes with spinal cord injury (wheelchair long-distance athlete group: WLG), 5 male wheelchair-using swimming athletes with spinal cord injury (wheelchair-using swimming athlete group: WSG), 5 healthy male college long-distance athletes (school long-distance athlete group: SLG), and 5 healthy male college swimming athletes (school swimming athlete group: SSG). Informed consent was obtained from all subjects. [Method] The measurement periods were August to March 2009/2010. Exercise was performed in a climatic chamber at a temperature of 28°C with 60% RH while hot (42°C) or cold (15°C) water was circulated through a control tubing suit. The measurement items were thermoregulatory parameters (such as the perspiration rate, esophageal temperature, mean skin temperature, and osmotic pressure), a hormone (catecholamine), and an immunological parameter (reactive oxygen production by neutrophils). [Result] After exercise in hot environment (summer), no differences were observed in the thermoregulatory or hormonal responses among WLG, WSG, SLG and SSG. However, immune responses tended to increase more in WLG than in SLG. No difference was observed among the 4 groups in cold environment (winter). After exercise at 15 (cold water) or 42°C (warm water) using the control tubing suit, no differences were observed in thermoregulatory, hormonal, or immune responses among the 4 groups. Using warm water, thermoregulatory responses tended to be poorer in WLG and WSG than in SLG and SSG. Immune responses did not differ among the 4 groups. [Conclusion] These results suggest a risk of heat disorder due to impaired perspiration on exercise at a high temperature in wheelchair athletes with spinal cord injury. Preventive measures such as the use of a cooling jacket are required. In addition, it is important to clarify the degree of perspiration impairment in wheelchair athletes with spinal cord injury.

**INFLUENCE OF EXPOSURE TO COLD TEMPERATURE ON STRESS-INDUCED SALIVARY BIOMARKERS AND MUCOSAL IMMUNITY**

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Background: Exposure to cold temperature increases psychological stress. Psychological stress activates the hypothalamic-pituitary-adrenal (HPA) axis and the sympathoadrenal medullary (SAM) system (1). Under such conditions, immune function is impaired. It has been shown that salivary IgA levels, an index of mucosal immunity are lower in the first 4 months in Antarctic expeditioners (2). However, it remains unclear whether these changes occur immediately after exposure to cold temperature. The purpose of this study was to investigate whether exposure to cold temperature affects salivary biomarkers of the HPA axis, SAM system, and mucosal immunity in a short period. Methods: Ten healthy males and 2 females ( $25.2 \pm 6.3$  years) performed the following 2 experimental trials at least 1 month apart: (i) sat in a cold chamber ( $-15^{\circ}\text{C}$ ) for 30 minutes [cold trial (CT)]; and (ii) sat in a normal room ( $25^{\circ}\text{C}$ ) for 30 minutes [normal trial (NT)]. Salivary samples were collected pre-trial (baseline) and then at 15-minute (mid-point) and at 30-minute (post-point) cold exposure time points. Salivary cortisol (s-cortisol) as an index of HPA axis, s-amylase activity as an index of SAM system, and s-IgA were evaluated. Results: The levels of s-amylase activity in the CT showed a significant increase at mid- ( $P < 0.05$ ) and post-point ( $P < 0.01$ ) compared to baseline, whereas no significant changes were observed in the NT. For s-amylase activity, condition  $\times$  time interactions were observed ( $P = 0.01$ ). The levels of cortisol in the CT showed a significant increase at post-point ( $P < 0.05$ ) compared to baseline, whereas no significant changes were observed in the NT. For s-cortisol, condition  $\times$  time interactions were  $P = 0.11$ . The levels of s-IgA in the CT showed a tendency to decrease at mid- ( $-8.7\%$ ) and post-point ( $-27.8\%$ ) compared to baseline, but the changes were not significant, whereas in the NT, the levels were almost the same throughout the trial. Conclusion: These results suggest that both HPA axis and SAM system are activated immediately after exposure to cold temperature, whereas suppression of mucosal immunity does not occur in a short period. Grants: This study was supported partly by the Grant for The Polar Research Phase VIII Project in National Institute of Polar Research and Joint Research Program of the Institute of Low Temperature Science, Hokkaido University. References 1.Kawada S et al. Biomedical Research 30(4): 245-249, 2009. 2.Gleeson M et al. Immunology and Cell Biology 78: 616-622, 2000.

**HYDRATION STATE EVALUATION BEFORE AND AFTER A HALF-MARATHON**

LUCIANO SALES PRADO, EMERSON RODRIGUES PEREIRA, CAROLINA FRANCO WILKE, GUILHERME PASSOS RAMOS, ANDRÉ MAIA LIMA, RAUNO ÁLVARO DE PAULA SIMOLA, EMERSON SILAMI-GARCIA

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Introduction: The hydration status of an individual is known to directly influence performance during prolonged activities in warm environments, but the methods for its evaluations are contradictory. Methods: Aim of the present study was to determine the hydration status and ingested fluid volume of 14 amateur road runners ( $29 \pm 4$  y.o.,  $54.3 \pm 5.5$  mL.kg<sup>-1</sup>.min<sup>-1</sup>) before and after an official running road race of 21.1 km. Mean environmental data along the race were  $25.07 \pm 2.13^{\circ}\text{C}$  dry temperature and  $54.7 \pm 2.2\%$  relative air humidity. Ingested water volume was controlled using marked plastic bottles provided at the hydration stations located at 0, 2.5, 5.0, 7.5, 10.5, 14.0, 16.0 e 18.5 km from the start line. Hydration status was assessed using urine specific gravity (Usg), urine osmolality (Uosm), urine sodium and potassium concentrations ([Na+]<sub>u</sub>, [K+]<sub>u</sub>), plasma volume variation ( $\Delta$ plasma), plasma osmolality (Posm), and plasma sodium ([Na+]<sub>p</sub>) and potassium ([K+]<sub>p</sub>) concentrations. Furthermore, body mass variation ( $\Delta$ BM) was assessed by comparing body mass immediately prior and after the race. Results: Subjects consumed  $0.82 \pm 0.40$  L ( $0.45 \pm 23$  L.h<sup>-1</sup>) of water and sweat  $2.67 \pm 0.23$  ( $24 \pm 3.04$  mL.min<sup>-1</sup>) during exercise. Posm and [Na+]<sub>p</sub> increased after the race, accompanied by a decrease on plasma volume and BM, indicating a state of hypohydration after the race. However, in urine, only [Na+]<sub>u</sub> increased, while all other variables remained unaltered. No significant correlations were observed between Posm and  $\Delta$ BM, and between Uosm and Usg. Conclusion: Posm and  $\Delta$ BM appeared to be the most appropriated variables for detecting acute changes on hydration status at the conditions of the present study. References:

Armstrong LE (2007) Assessing Hydration Status: The Elusive Gold Standard. *J Am Coll Nutr* 26: 575S–584S. Popowski LA, Oppliger RA, Lambert GP, Johnson RF, Johnson AK, Gisolfi CV (2001) Blood and urinary measures of hydration status during progressive acute dehydration. *Med Sci Sports Exerc* 33:747–753.

### **A COMPARISON OF THE FLUID BALANCE OF UNIVERSITY AND NATIONAL LEVEL FEMALE BASKETBALL PLAYERS BEFORE AND DURING GAME PLAY**

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A comparison of the fluid balance of university and national level female basketball players before and during game play. Brandenburg, J.P., Gaetz, M. University of the Fraser Valley, Abbotsford, BC, Canada Introduction Proper fluid balance is important for athletic performance. Although elite athletes differ from non-elite athletes in a number of psychological, physical, and physiological qualities, it is unknown if these groups differ with respect to fluid balance. The objective of this study was to compare the fluid balance of university (non-elite) and national (elite) level female basketball players before and during game play. Methods Players of a national team (NT) (n: 11; age:  $24 \pm 3$  y; height:  $180.5 \pm 6$  cm; mass:  $78.6 \pm 8$  kg) and university team (UT) (n: 11; age:  $20 \pm 1$  y; height:  $175.5 \pm 8$  cm; mass:  $74.2 \pm 15$  kg) were assessed while competing in preseason games. Sixty - 45min before game time, players emptied their bladder and specific gravity (USG) was measured. Afterward players were weighed wearing a dry t-shirt and shorts. At completion of the game players towed off and were reweighed in the same attire. Throughout the warm-up and game players had access to fluid in individually labeled bottles. Players ingested fluids ad libitum and were not instructed to consume fluids. Fluid intake was determined by the difference in bottle mass prior to and at the end of the game. The duration (playing time) of both games was 40 minutes. Gym temperature and humidity at game time were  $24.5^{\circ}\text{C}$  and 67% for the NT game and  $24^{\circ}\text{C}$  and 63% for the UT game. Data are presented as mean  $\pm$  SD. Results The USG value for the NT players ( $1.004 \pm 0.002$ ) was significantly less ( $p < 0.001$ ) than that of the UT ( $1.017 \pm 0.007$ ). All NT players arrived with a USG  $< 0.010$  whereas only 3 UT players did the same ( $\chi^2=12.5$ ,  $p=0.002$ ). During game play NT players lost  $0.6 \pm 0.6$  kg, equivalent to a  $0.7 \pm 0.8\%$  loss in body mass and UT players lost  $0.25 \pm 0.5$  kg corresponding to a  $0.3 \pm 0.8\%$  loss in mass ( $p=0.2$ ). Sweat losses, for the combined duration of the warm-up and game, equaled  $2.0 \pm 0.8$  L and  $1.4 \pm 0.5$  L for the NT and UT players, respectively ( $p=0.041$ ). Fluid intake during the game for NT players equaled  $1.6 \pm 0.7$  L or 84% of sweat lost while UT players replaced  $1.3 \pm 0.7$  L of fluid or 99% of sweat lost ( $p=0.4$ ). Discussion All members of the NT were well hydrated before game time. In contrast, only 3 members of the UT were so with the remaining 8 players hypohydrated (4 minimally; 4 significantly). Consequently, once games begin UT players are more prone to becoming hypohydrated to levels that impair playing ability and health. Despite differences in sweat losses, players from both teams consumed fluid at volumes sufficient to keep in-game fluid losses to levels below which decreases in basketball playing ability occur. Regular fluid access and modest environmental conditions may have accounted for this. Strategies to improve pregame hydration should be a priority for university players.

### **CARBOHYDRATE INGESTION DURING EXERCISE IN THE HEAT DOES NOT INFLUENCE NEUROMUSCULAR RESPONSE FOLLOWING PROLONGED AND SUSTAINED SUB-MAXIMAL ISOMETRIC EXERCISE.**

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This study examined the effects of either a 6% carbohydrate drink (CHO) and an equivalent 6% CHO mixture ingested as capsules with distilled water versus corresponding placebo (PLA) treatments and a water (W) hydration treatment on neuromuscular parameters following a 60 km self-paced time trial in the heat ( $32^{\circ}\text{C}$  and 50% rh). Ten well-trained male subjects (mean  $\pm$  SD; age =  $26 \pm 3$  yr; mass =  $64.5 \pm 7.7$  kg; maximum oxygen uptake =  $70.7 \pm 8.8$  mL/kg/min; peak power output =  $323 \pm 41$  W) completed 5 x 60 km cycling time trials in a randomised double-blind fashion. The subjects ingested either PLA capsules or beverage in two trials and corresponding CHO in two trials and W in one trial whilst being informed that both drinks and capsules were CHO in all trials, except the W trial. Neuromuscular assessment which included maximum voluntary contraction (MVC), voluntary activation (VA), evoked twitch contractile properties (ECP) and compound action potentials (M-wave) were conducted pre and post 60 km and then immediately following a sustained isometric contraction at 20% MVC. There were no differences in time to complete the 60 km amongst treatments (range 130.2 - 143.1 min). Core temperature at the end of the trial was not different amongst treatments ( $\sim 38.1 \pm 0.5$  deg.C). A comparable reduction in MVC was observed post - exercise across all treatments (-13%,  $P < 0.05$ ). Voluntary activation was reduced post - exercise in the W treatment only (-2.1%). M-waves remained unchanged post exercise across treatments. ECP post - exercise were significantly altered across all treatments displaying both potentiation and fatigue related effects. The MVC, VA, and M-wave amplitude remained unchanged following the sustained submaximal isometric contraction across treatments. However, ECP demonstrated a significant reduction in the rate of relaxation (pre =  $155 \pm 40.2$  vs post =  $127.6 \pm 36.9$  Nm/s,  $P < 0.05$ ) and an increase in contraction duration (pre =  $173.9 \pm 18.1$  vs post =  $203.1 \pm 20.2$  ms,  $P < 0.05$ ) across all treatments. The present data suggest that the development of neuromuscular fatigue following self-paced cycling in the heat and as assessed by sustained sub-maximal contraction is possibly related to peripheral factors and it appears that carbohydrate ingestion during prolonged exercise in either beverage or capsule form may not provide a protective effect on the development of fatigue following such exercise.

### **ARTERIAL BLOOD PRESSURE RESPONSE TO SEVERE PASSIVE HEATING AT REST RELATES TO HYPERTHERMIA-INDUCED HYPERVENTILATION IN HUMANS**

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JSPS FELLOW (FUJII, N.), MEIJI UNIVERSITY (ICHINOSE, M.), UNIVERSITY OF TSUKUBA (HONDA, Y., TSUJI, B., WATANABE, K., NISHIYASU, T.), KOBE UNIVERSITY (KONDO, N.)

Introduction When subjected to passive heating at rest, individuals may exhibit an increase, a decrease or no change in mean arterial blood pressure (MAP). Passive heating at rest is also known to increase ventilation, but the magnitude of that response also varies greatly among individuals (Fujii et al. 2008). We tested the hypothesis that the arterial blood pressure response to passive heating at rest is associated with hyperthermia-induced hyperventilation in humans. Methods Eighteen healthy males were subjected to passive heating using legs-only hot water immersion and a water-perfused suit until the subject could no longer endure the heat. We then divided the subjects into two groups: in MAPNOTINC (n = 8) MAP did not increase by  $>3$  mmHg ( $-11.5$  to  $2.3$  mmHg), and in MAPINC (n = 10) MAP

increased by  $>3$  mmHg (9.7 to 32 mmHg). Results Heating-induced increases in esophageal temperature were similar in MAPNOTINC and MAPINC ( $+2.3 \pm 0.3$  vs.  $+2.4 \pm 0.4$  °C). However, subjects in MAPNOTINC showed significantly greater increases in minute ventilation (VE) ( $+19.1 \pm 7.8$  vs.  $+7.1 \pm 4.7$  l min<sup>-1</sup>,  $P < 0.05$ ) and greater decreases in end-tidal CO<sub>2</sub> pressure ( $-15.6 \pm 4.3$  vs.  $-5.1 \pm 4.3$  mmHg,  $P < 0.05$ ) than those in MAPINC. Among all subjects, heating-induced changes in VE significantly and negatively correlated with heating-induced changes in MAP ( $r = -0.74$ ,  $P < 0.05$ ). Discussion Although prolonged voluntary hypocapnic hyperventilation does not lower MAP when sympathetic nerve activity is intact, it does lower MAP through hypocapnia-induced vasodilation when sympathetic nerve activity is attenuated or absent (Onrot et al. 1991). Importantly, hyperthermia attenuates sympathetic vasoconstrictor responsiveness to  $\alpha$ -adrenergic agents in resting humans (Cui et al. 2002). We suggest differences in the degree of hypocapnia induced by hyperthermia-induced hyperventilation may have contributed to the variation in MAP seen with passive heating in the present study. In sum, our results suggest the extent of the MAP response to passive heating at rest is associated with the degree of hyperthermia-induced hyperventilation. References Cui J, Wilson TE, Crandall CG (2002) *Am J Physiol Regul Integr Comp Physiol* 283: R1221-1226. Fujii N, Honda Y, Hayashi K, Soya H, Kondo N, Nishiyasu T (2008) *J Appl Physiol* 104: 998-1005. Onrot J, Bernard GR, Biaggioni I, Hollister AS, Robertson D (1991) *Am J Med Sci* 301: 305-309.

### SWEAT ELECTROLYTES CONCENTRATION AFTER 10KM RUN ON ADMINISTRATION NSAID IN ATHLETES

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FACULDADE SOGIPA

Sweat electrolytes concentration after 10km-run on administration NSAID in athletes Bijoldo, J.M.1, Pezzi ,F.2, da Silva, E.R.3 1: Faculdade Sogipa (Porto Alegre, Brazil), 2:ESEF/UFRGS (Porto Alegre, Brazil), 3: LMH/UCS (Caxias do Sul, Brazil) Introduction The NSAID appears to influence the glomerular filtration rate and consequently the body fluid metabolism may alter the volume and electrolyte composition of sweat. The purpose of this study was to compare sweat rate and electrolytes concentration in runners after two simulated 10km runs under administration of NSAID Ibuprofen (IG) or Placebo (PG). Methods Sixteen athletes (30.7 $\pm$ 5.4 years, 63.9 $\pm$ 6.7 kg, 4.5 $\pm$ 1.2%, 172.6 $\pm$ 7.9 cm, 63.2 $\pm$ 5.4ml.kg.min<sup>-1</sup>) participated of the study. There was no case of self-reported recent use of substances that could impair the renal function Furthermore there was no reported case of kidney failure, hepatic problems or recently perceived or diagnosed Ibuprofen hypersensitivity among the participants, this being one of the inclusion criteria of the sample. The subjects performed two simulated 10km runs on an official athletics track (SC1 and SC2) in two distinct situations: under administration of NSAID Ibuprofen or Placebo (SC1bu and SC1pa respectively). The SC2 seven days after SC1 in order to allow the athletes to recover and to avoid the drug carry-over effect. Pharmacological treatment in SCs consisted in previous (1h) administration of a single dose capsule with 1.2g of Ibuprofen or placebo (lactose) and one member of the research team was especially assigned for drug randomization and administration (double blind). Before each SCs, absorptive patches (3M TEGADERM+PAD 3582) were attached on the skin to collect sweat (scapula), and body mass was measured (scale G-TECH, model BALGLA3C, resolution 0.05kg), with the athletes wearing only shorts after empty their bladders. After SCs, the patches were removed and the athletes emptied their bladders to measure body mass again, with them wearing only shorts and their bodies dry. [Na<sup>+</sup>], [Cl<sup>-</sup>] and [K<sup>+</sup>] in sweat were analyzed in duplicates (electrolyte analyzer, AVL 9180, Roche). Independent t-test was employed to compare groups as data were analyzed using the SPSS 13.0. Results For IG and PG, sweat volume corrected by body surface area (1.3 • 0.4 and 1.1 • 0.3 l.h<sup>-1</sup>) were not significantly different ( $p=0.123$ ). Sweat [Na<sup>+</sup>], [Cl<sup>-</sup>] and [K<sup>+</sup>] was similar between groups ([Na<sup>+</sup>]= 75 $\pm$ 25 and 72 $\pm$ 18 mmol.l<sup>-1</sup>; [Cl<sup>-</sup>]= 68 $\pm$ 14 and 65 $\pm$ 16 mmol.l<sup>-1</sup>; [K<sup>+</sup>]= 8 $\pm$ 2 and 9 $\pm$ 3 mmol.l<sup>-1</sup>, respectively). Discussion In this study there was no change in the volume nor the concentration of electrolytes in sweat possibly due to the low volume of the 10km race. Perhaps a longer race, where the metabolic requirement was greater, or administration of the drug in higher doses could influence the reabsorption capacity of sweat gland, reflecting on the concentration and volume of sweat.

## Poster presentations

### PP-PM34 Social Aspects of Health and Physical Activity

#### SOCIAL ASPECTS OF SPORTS PRACTISING IN INTEGRATED SETTINGS

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Introduction Being aware of the many challenges to promote true social inclusion through sports, the National Sports Academy have begun to consider alternative ways to bring youth with and without disabilities together for practicing sports. One such sport program is NSA Adapted Water Sports Camp. The camp is designed to use sports as a vehicle for improving not only campers' sports skills, but also their self-esteem, and confidence in building relationships with peers. We achieve this by carefully structuring all of our activities to ensure success. Participants are youth with disabilities (ID, CP, ASD). Teaching is done by skilled instructors who break tasks down into manageable chunks and present them in a logical sequence. In this way we can be sure that our campers will be successful. We acknowledge every accomplishment, and never miss the opportunity to provide positive feedback and recognition. The majority of the activities are designed as "Unified sports". The general aim of this study was to estimate the impact of this camp. Methods This study employed a qualitative design combining semi-structured interviews and thematic analysis to evaluate different components such as the development of: self-confidence and self-esteem; sport skills; social and adaptive skills; and development of relationships between the campers with disabilities and the students. The primary sources of data were interviews and field notes. The theoretical model is based on social impact assessment (SIA) methodology (Coreen M. at all). Data: 25 interviews with disabled campers, 42 reports from students, 12 parents' opinions, 7 reports from sports instructors, 5 interviews with supporting staff members. Results The integrated water sports camp appears to be a relatively simple idea – bringing together two groups of young people around a common interest in playing sport. Results showed that according to the parents these camps improved the existing sports skills of campers while also introducing campers to new sports. They report for improved self-confidence. Further, we found that campers with disabilities showed remarkable development in their social and adaptive skills while inclusion in social activities with the students wasn't satisfactory. Discussion According to the examined components the NSA camp has greater impact on the development of the participants with ID in both physical and cognitive aspects. Further work on prejudice and stigmatization is needed in order to achieve greater inclusion which in turn will impact the inclusion in the local communities. References 1. Coreen M. Harada, Gary N. Siperstein (2009). The Sport Experience of Athletes with Intellectual Disabilities: A National Survey of Special Olympics Athletes and Their Families, APAQ, Vol. 26, Issue 1,

## EFFICACY OF THE FAMILY INITIATIVE SUPPORTING CHILDREN'S HEALTH PILOT PROGRAMME IN THE NORTH EAST OF ENGLAND

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EFFICACY OF THE FAMILY INITIATIVE SUPPORTING CHILDREN'S HEALTH (FISCH) PILOT PROGRAMME IN THE NORTH EAST OF ENGLAND Dodd-Reynolds, C.1, Allin, L.1, Allen, D.2 1:Northumbria University (Newcastle upon Tyne, England), 2:County Durham and Darlington Community Health Services (County Durham, England) Introduction The Family Initiative Supporting Children's Health (FISCH) obesity project was developed in 2005 by the Durham & Chester-le-Street Lifestyle Initiative. It aims to prevent young people requiring further specialist obesity care through provision of a 10 week health and physical activity intervention over one school term. This pilot study examined the physiological and psychological impact of extending the programme over two terms (20 weeks). Methods A mixed methods design was used. Five schools (3 FISCH (n=91, 9.7±0.5y) and 2 control (n=44, 9.8±0.5y)) in County Durham and Derwentside took part. The programme was delivered by trained FISCH staff and teachers over 20 weeks and included weekly healthy-lifestyle sessions and extra-curricular physical activity. BMI, waist circumference, aerobic fitness and self-perception (Harter, 1985; Hill, unpublished) were assessed at baseline, 10 and 20 weeks; focus groups were conducted at 20 weeks to gauge children's experiences of the programme, health behaviour intentions and family involvement. Results No differences in BMI were seen between FISCH and control or over time. Waist circumference increased slightly in the FISCH group from 0-20 weeks (59.5±7.6 v 60.6±7.9 cm, p<0.01). Step test recovery heart rate was lower for both FISCH and control at 20 weeks compared to 0 and 10 weeks (p<0.05). Self-perception was not altered over 20 weeks, although a positive shift in global self-worth and perception of physical appearance was seen for one FISCH school between 0-10 weeks (p<0.05). Findings from focus groups identified changes to perceptions, attitudes and behaviours following FISCH, notably in doing a greater variety of activities, or trying to eat more healthily and experiencing greater physical fitness and mental wellbeing. They enjoyed the programme and indicated it reinforced and built on their existing knowledge of health. Some children talked about FISCH to parents or siblings at home, but whilst some children experienced support, there was also evidence of challenges and barriers to the changing of existing family lifestyles. Discussion The FISCH 20 week pilot showed positive impact overall, but no change in anthropometric and fitness variables over this duration. We recommend continuation of the FISCH programme, but with extended follow-up and a larger cohort, along with enhanced family involvement and support to maximise efficacy. References Harter S. (1985). Manual for the self-perception profile for children. University of Denver.

## EXAMINING THE FOOTBALL FOUNDATION'S EXTRA TIME PROGRAMME: HEALTHFUL CHANGE IN OLDER PEOPLE

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*THE FOOTBALL FOUNDATION*

EXAMINING THE FOOTBALL FOUNDATION'S EXTRA TIME PROGRAMME: HEALTHFUL CHANGE IN OLDER PEOPLE Trotter, L.1, Richardson, D. and Parnell, D.2. 1The Football Foundation (Registered Charity 1079309), Whittington House, 19-30 Alfred Place, London, WC1E 7EA. 2 The Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, UK. Introduction There is evidence of poor physical and emotional health alongside high levels of social exclusion in older people (over 55 years) in England (DOH, 2004). Extra Time (ET) aimed to promote positive healthful changes in older people and was delivered by Football in the Community (FitC) schemes, typically the charitable arms of Football Clubs (FC) in England. This research examines the effectiveness of ET in promoting healthful change in older people. Methods 422 participants, 90% over 60 years old (41% male, 59% female) from 14 of the 20 FitC schemes involved in ET completed entrance and exit surveys (after approximately 8 months engagement within ET between Sept 2009 – Jan 2011). The researchers utilised the principles of ethnography during a period of prolonged fieldwork and extensive observations (typically 1 day per week) in 6 of the 20 FitC schemes. Informal interaction and conversations were collated alongside the researchers' personal reflections. This included additional (but limited to one FitC scheme) baseline measurements of stature and body mass (n=10), which was followed up on a 6 weekly basis with participants. Results Pre-to-post programme survey results showed that 70% of participants reported being able to complete daily tasks easier with 56% reporting that they felt stronger. 84% reported having more support to call upon, with 89% feeling 'like they had someone looking out for them'. Participants reported greater feelings of happiness and confidence. 81% stated the involvement of the FC made ET 'more appealing'. The involvement of the club also offered a greater potential for engagement. Further results from the extensive contextual data indicated positive healthful changes in self confidence and lifestyle (e.g., smoking cessation, reduced alcohol intake). Moreover, within one FitC scheme, weight loss was measured and evidenced, alongside participants' stating that the intimate and bespoke support was critical to their sustained engagement. Discussion Both the national and bespoke research data showed positive (physical and emotional) healthful changes. The sense of support via ET staff and fellow participants suggests that ET is building social support and engagement. In this sense, it would appear that ET enables 'real' healthful changes to occur. References Department of Health, Physical Activity, Health Improvement and Prevention (2004). At least five a week: Evidence on the impacts of physical activity and its relationship to health. Accessed on February 2011, [www.dh.gov.uk](http://www.dh.gov.uk).

## CREATIVITY AND THE INFLUENCE OF THE PARTNER WHEN DANCING CONTACT IMPROVISATION: A MIXED METHODS APPROACH

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Introduction Contact improvisation (CI) is a form of dance based on motor creativity, improvisation and the physical contact between different improvisers dancing together. This generates different ways of moving and a varied use of motor creativity depending on the dancers involved (Torrents et al. 2010). The aim of this study was to detect differences in movement generation and creativity, depending on the partner, by means of an observational analysis combined with the subjective perception of the dancers. Methods Three contact improvisers were video-recorded while dancing in 5 min solos and duets in a space of 10 m x 10 m. A mixed methods approach (Creswell & Plano-Clark 2007) was used to analyse the data. Trials were sequentially observed by three dance experts using the observational instrument OSMOS (Castañer et al. 2009), with the movements of each dancer being analysed separately. The data obtained were then analysed with Theme Coder software. In addition, after observing the videos of their own dances, dancers responded individually to an oral interview about their motor creativity depending on the partner. The interviews were subjected to a content analysis using Nvivo-v8 Software. Results The observational results showed that motor creativity is affected by the partner, and that it is enhanced when dancing in duets (13 repeated T-patterns were obtained from the 3 solos trials, while just 5 were obtained from the 6 duets trials). The interview



data revealed that dancers identify their own style with the most repeated actions. Some of these actions coincided with observational results, such as the use of a spiralling movement by Participant 1 (75 times), the jumps by Participant 2 (45 times) and the locomotion combined with turns by Participant 3 (45 times). Dancers also considered that their style was especially modified due to the influence of the partner, and they agree that this helped them to be more creative. While they identified some original movements in their dance, they also believed that this form of dance is always original because of its improvisational nature. Discussion The sequential mixed methods approach used in this study shows that dancing with a partner enhances motor creativity. The influence of the partner is confirmed by both the quantitative results obtained through the observation of the movements performed and the qualitative approach based on the subjective comments of the dancers. References Castañer M, Torrents C, Anguera MT, Dinusová M & Jonsson G (2009). Behavior Research Methods 41(3): 857-867. Creswell JW & Plano-Clark VL (2007). Designing and conducting mixed methods research. Sage Publications, Inc. Torrents C, Castañer M, Dinusová M, & Anguera MT (2010). Journal of Creative Behavior, 44(1):45-61.

## THE CORRELATION BETWEEN SELF-PERCEIVED HEALTH STATUS AND PHYSICAL FITNESS, IN SEPTUAGENARIAN AND OCTOGENARIAN

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Introduction The health-related quality of life may be assessed by SF-36v2 questionnaire. This questionnaire is comprised of eight measures including physical functioning (PF) and role physical (RP), and combines two scales – physical (PH) and mental health. Handgrip (HT) and 6 minutes walking (6MW) tests may assess physical fitness. Whether or not changes in self-perceived health status are related with physical fitness in septuagenarian (70') and octogenarian's (80') is not clear. The aim of this study was to examine the relationship between the subject's perception of health and the physical fitness, in 70' and 80'. Methods Fifty-five 70' (75.2±3.0 yrs, 67.8±10.8 Kg, 1.53±0.11 m) and twenty-three 80' (84.9±3.5 yrs, 66.0±10.3 Kg, 1.52±0.11 m) volunteers were recruited from local population with fifty-three being women and twenty-five being men. The participants completed the SF-36v2 questionnaire, and were tested on HT of the right and left hand, and 6MW. T-Test was used to compare 70' and 80' on HT, 6MW and SF36v2 parameters. Pearson coefficient of correlation was used to assess the relationship between SF-36v2 results on PF, RP subscales and PH scale, and physical fitness tests. Results Significant differences were found between 70' and 80' in PF (61.55±24.87; 47.61±23.45,  $p < 0.05$ ), RP (52.65±26.15; 38.83±29.36,  $p < 0.05$ ) and PH scale (55.27±19.12; 46.04±15.23,  $p < 0.05$ ). In relation to physical fitness, significant differences were found between 70' and 80' in both hands (left – 22.42±9.99 Kg, 15.26±9.96 Kg; Right – 22.98±10.75 Kg, 17.61±10.31 Kg,  $p < 0.05$ ) and cardiorespiratory capacity (6MW) (364.44±99.36 m, 269.30±88.73 m,  $p < 0.001$ ). Moderate correlations were found between RP, PF and PH scale and HT ( $r = 0.37$  to  $0.46$ ,  $p < 0.001$ ), in 70'. In 80', moderate correlations were found between both PF and PH scale and 6MW ( $r = 0.44$  to  $0.58$ ,  $p < 0.001$ ). Discussion Results showed that 70' were stronger, had better cardiorespiratory capacity, and responded more positively than 80' when assessing self-perceived physical health scale. However, the muscle strength was found to be correlated with RP, PF and PH scale but not with cardiorespiratory capacity, in 70'. On the other hand, cardiorespiratory capacity was found to be correlated with PF and PH scale, in 80'. It appears that the muscle strength contributes significantly to the self-perception on physical health scale in 70' while a good cardiorespiratory capacity promotes self-perception on physical health in 80'.

## REACTION TIME OF CHILDREN WITH AND WITHOUT AUTISTIC SPECTRUM DISORDERS

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Autism has long been associated with movement abnormalities, although the neurobehavioural details of these abnormalities remain poorly defined. The purpose of this study was to compare simple and choice reaction times in students with and without autism. Methods A total of 34 children participated in the study. The group with autism consisted of 17 males and 7 females between the ages of seven and thirteen. The control group consisted of a total of 10 typically developing students. A laptop installed with a reaction time test software known as LabView was used for the tests. Results The means and standard deviations were calculated for comparison and the data were evaluated from the results of a t-test. Significant differences were found among all reaction time tasks ( $p < .001$ ), whereas the group consisting of children with autism demonstrated slower reaction times and greater standard deviations compared to the typically developing/ control group. Discussion The slower reaction time from the group with autism may have been directly related to deficits in the perceptual motor process. The differences in mean reaction times among all tasks ranged from about 350 msec to 387 msec, implying deficiencies at both the response and perceptual levels. The choice reaction time tasks did require motor reprogramming, but due to the similar ranges in mean reaction time differences between the two groups among all tasks, the results did not coincide with the results of Rinehart and associates' study (2001). The prevalence of motor impairments may have also been a factor in why the group with autism demonstrated significantly slower reaction times than the typically developing group. In a retrospective clinical record review by Ming, Brimacombe, and Wagner (2007), results suggested that fine motor control and programming deficits are common co-occurrence of children with ASD in this cohort. The reduced prevalence of motor deficits in older children suggest improvement over time, whether through natural progression, results of interventional therapy, or the combination of the two (Ming, Brimacombe, & Wagner, 2007). Therefore, younger children, such as the adolescents in this study, may not have received the services to improve their fine motor skills, which may be contributing factors in this study's tasks. References Ming, X., Brimacombe, M., & Wagner, G. C. (2007). Prevalence of motor impairment in autism spectrum disorders. Brain and Development, 29(9), 565-570. Rinehart, N. J., Bradshaw, J. L., Brereton, A. V., & Tonge, B. J. (2001). Movement preparation in high-functioning autism and Asperger disorder: A serial choice reaction time task involving motor reprogramming. Journal of Autism and Developmental Disorders, 31(1), 79-88.

## PROVIDING A REFERENCE POINT – PRACTITIONER REFLECTIONS FROM A COMMUNITY BASED FAMILY INTERVENTION DELIVERED WITHIN A PROFESSIONAL FOOTBALL CLUB

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Introduction: There is currently a paucity of research into the working practices of employees within Football in the Community (FitC) schemes (Watson, 2000). The Everton Active Family Centre is based at Goodison Park, and the result of a unique collaboration between Liverpool John Moores University (LJMU) and 'Everton in the Community' (Everton Football Club's official charity). The research offers an insight into complex and holistic nature of the work undertaken at the centre, and provides a reference point as to the characteristics that

combine to produce an effective support practitioner within such an environment. Methods: A total of 7 families were utilised in the research over a period of 7 months. The research objectives were facilitated through ethnographic principles. Methods of data collection included field notes, informal interviewing and discussion and more formal semi-structured interviews. Through a series of reflections, the practitioner aims to facilitate the readers understanding of the broad range of challenges they are faced with on a day to day basis, and the skill base required to meet these demands. Results: Interview data illustrated the flexible nature of the practitioner and the differing role it was playing within the family's lives (i.e., personal trainer, lifestyle coach, counsellor). A number of families identified the centre as simply a vehicle upon which to achieve their health targets. Conversely, for others the centre was playing a much more fundamental role, in allowing participants to gain more control of their lives. Reflections throughout the research illuminate the broad skill base the practitioner draws upon and the flexible nature of their role, when required to deal with more fundamental life issues such as mental illness, chronic disease and disability. Discussion: The research indicated that practitioners working in such health related football community programmes were exposed to an eclectic array of potential clients. Whilst each practitioner was experienced in a main area of expertise (e.g., fitness, health and/or social-psychological backgrounds) it is important to note that they each, in-turn, offered the client(s) a 'reference point' for the resolution of a number of health and lifestyle issues. In this regard, the practitioners must possess an adaptable, flexible and holistic approach to their work in order to deal with the diverse range of issues that the client brings in to this environment. References: Watson, N. (2000). Football in the community: what's the score? Soccer and Society, 1, 114-125.

## PROMOTING HEALTH IN HARD TO REACH AND DEPRIVED POPULATION THROUGH ENGAGING LOCAL COMMUNITIES

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Promoting health in hard to reach and deprived population through engaging local communities Minou, M.1, Murphy, R.1, Stratton, G.1 1: Research Institute for Sport and Exercise Sciences, Liverpool John Moores University. UK. Introduction People from ethnic backgrounds have low levels of physical activity (PA) (HSE, 2008). Influencing (PA) behaviours and identifying its determinants requires understanding and approaching it from a broader socio-ecological perspective (Sallis and Owen, 1999). Determining barriers to participation and promoting PA in BRM populations is inherent with difficulty (Yancey et al., 2004). This research aimed to develop a process by which BRM groups can be reached in the planning and evaluation phases of PA programme development and implementation. Method Two advisory groups, (Partners Advisory and a Community Research Advisory groups) that included representatives from local communities, leisure, recreation and educational organisations were set up to develop a research and delivery partnership. An action research approach was put into practice with a customised survey designed collectively by the advisory groups. The socio-ecological model (Sallis and Owen, 1999) was used to explore women's PA determinants. Survey findings informed the agenda of focus groups in order to explore key issues raised in the survey. Results Two hundred and thirteen women from 16 ethnic backgrounds completed the survey, whereas 17 women participated in follow up focus groups. Over half of the women consulted were not involved in PA. Findings indicated that PA in BRM women was influenced by intrapersonal, interpersonal, social and physical environmental factors. These included lack of motivation, time, access to information and facilities and the ability to speak English. Discussion This research demonstrated the significance of cultural and community partnership in advocating and empowering communities to collect robust evidence for health promotion and the development of needs-based over product-led based services. The interventions should provide a framework of support in relation to service provision ranging from making sure that women are aware of events and activities taking place through to providing appropriate resources and venues in order to get women to a place where they can start to lead more physically active lifestyles. References Health Survey for England, (HSE) (2008). Physical activity and fitness. Summary of key findings. Sallis, J.F. and Owen, N. (1999). Physical activity and Behavioural Medicine. Sage Publication, Inc. World Health Organisation, (WHO) (2011). Global Strategy on Diet, Physical Activity and Health Physical Inactivity: A Global Public Health Problem. Yancey, A.K., Kumanyika, S.K., Ponce, N.A., McCarthy W.J., Fielding, J.E., Leslie, J.P., Akbar, J. (2004). Population-based interventions engaging communities of colour in healthy eating and active living: a review. Preventive Chronic Diseases.

## HEALTH PROMOTION INTERVENTIONS AMONG DISADVANTAGED COMMUNITIES

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Health promotion interventions among disadvantaged communities Minou, M.1, Stratton, G.1, Murphy, R. 1 1: Research Institute for Sport and Exercise Sciences, Liverpool John Moores University. UK. Introduction Effective physical activity (PA) intervention on a public health level requires an inclusive concept that integrates various delivery approaches that meet specific needs of the target diverse subpopulations (Yancey et al., 2004). The "Work- Out" project involved practitioners (fitness activators) from the local communities and was designed to meet the specific needs and interests of inactive deprived communities through increased participation in PA (Bauman et al., 2002). Methods A bespoke survey was designed to measure the PA levels, maintenance of the behaviour change and service satisfaction. One hundred and fifty three participants completed the survey. Individual interviews guided by the socio-ecological model (Sallis and Owen, 1999) were conducted with participants, practitioners and managers (n=16) to identify the influence of the fitness activators and other social and environmental factors in promoting PA. The RE-AIM framework (Glasgow et al., 1999) was then applied to assess the effectiveness of the intervention in more detail. Results The survey revealed an 85% increase in PA levels. The project reached 1200 individuals from disadvantaged areas and 90% of participants were satisfied with the service. The intervention effectively increased people's engagement in the community and participation in PA. This was through the support system by the fitness activators and the provision of a 12-week free gym pass which removed barriers for participation. Fitness activators adopted a unique marketing strategy to recruit inactive disadvantaged people. The intervention was implemented successfully within the time line and the budget allocated. Participants maintained their activity levels 3 months post intervention. Discussion The multi-component community based intervention effectively promoted participation in PA and promoted social inclusion in a deprived area through providing social support and facilities, and removing barriers such as: cost and lack of access to information and resources. References Bauman, A., Bellew, B., Brown, W., and Owen, N. (2002). Getting Australia active. Towards better practice for the promotion of physical activity. Melbourne, Australia: National Public Health Partnership. Glasgow, R.E., Vogt, T.M., Boles, S.M. (1999). Evaluating the Public Health Impact of Health Promotion Interventions: The RE-AIM Framework. American Journal of Public Health 89(9):1322-7. Sallis, J.F. and Owen, N. (1999). Physical activity and Behavioural Medicine. Sage Publication, Inc. Yancey, A.K., Kumanyika, S.K., Ponce, N.A., McCarthy W.J., Fielding, J.E., Leslie, J.P., Akbar, J. (2004). Population-based interventions engaging communities of colour in healthy eating and active living: a review. Preventive Chronic Diseases.

## BEHAVIOR MODIFICATION PROGRAM FOCUSING PRIMARILY ON NON-EXERCISE ACTIVITY THERMOGENESIS HAVE EFFECT ON SELF-EFFICACY AND THE MODERATE -INTENSITY PHYSICAL ACTIVITY OF UNIVERSITY STUDENTS

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BEHAVIOR MODIFICATION PROGRAM FOCUSING PRIMARILY ON NON-EXERCISE ACTIVITY THERMOGENESIS HAVE EFFECT ON SELF-EFFICACY AND THE MODERATE -INTENSITY PHYSICAL ACTIVITY OF UNIVERSITY STUDENTS Takeshi Yamauchi 1, Katsuro Kitamura 2, Takahiro Nagayama 2, Jinro Takato 3, Toshimi Kudo 4, Takashi Sakata 1 1: Ishinomaki Senshu University (JPN), 2: Tohoku University (JPN), 3: Tohoku Bunka Gakuen University (JPN), 4: Miyagi Gakuin Women's University (JPN) Introduction One of the important considerations to examine the effectiveness of the non-exercise activity thermogenesis (NEAT) from various angles is thought to be the assessment of self-efficacy, in addition to the amount of physical activity. This intervention study documented the effect of behavior modification program focusing primarily on NEAT on self-efficacy and the amount of physical activity of university students who claimed to be unhealthy. Methods A 10-weeks behavior modification program focusing primarily on NEAT was implemented and the results were analyzed. Fifty participants were randomly assigned to either the intervention group or the control group. Participants in both groups took a 90-min seminar once a month for purposes of understanding health promotion, in particular NEAT. Participants in the intervention group wearing a triaxial physical activity monitor (actimarker EW4800P-K: Panasonic) except the time of bath and sleep underwent an intervention based on the results of physical activity monitor once a week during 10 weeks. Physical activity counts were converted into METs-time and divided into vigorous-intensity physical activity (at least 6 METs), moderate-intensity physical activity (at least 3 and less than 6 METs), and low-intensity physical activity (less than 3METs). A survey method of general self-efficacy was the questionnaire. Results In the intervention group, the results showed an increase in the amount of physical activity among participants who had moderate-intensity physical activity, while an upward trend was observed among the participants with low-intensity physical activity. Additionally, the students in the intervention group experienced a reduction in body weight and an enhancement in general self-efficacy. Summary These results demonstrated the effectiveness of behavior modification program focusing primarily on NEAT among unhealthy students.

## Poster presentations

### PP-PM35 Anthropometry 1

## WEIGHT LOSS AND CHANGES IN BODY WEIGHT DUE TO ACTIVE TRAINING PROGRAMS

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WEIGHT LOSS AND CHANGES IN BODY WEIGHT DUE TO ACTIVE TRAINING PROGRAMS Rojo, M. A.1, Benito, P. J.1, Peinado, A. B.1, Calderón, F. J.1 on behalf of the PRONAF Study Group 1: Facultad de Ciencias de la Actividad Física y del Deporte – INEF, Universidad Politécnica de Madrid (Spain). Introduction The world is facing major problems associated with the rapid increase in levels of overweight and obesity, such as chronic diseases and higher rates of disability (1, 2). Some studies (3-5) have analyzed the problem showing that diet is a prerequisite for weight loss. The aim of the present study was to analyze what was the influence of some factors in the body weight loss and generate an equation to predict it. Methods 87 overweight people (BMI: 25-29,9 kg•m<sup>-2</sup>), aged 18-50 years, participated in the study (36 men, 51 women). They were randomly assigned to four intervention groups: resistance training (RT, n=22), endurance training (ET, n=25), combined training (CT, n=23) and control group (C, n=19). All of them in combination with diet restriction during 6 months of intervention. The Pearson Product Moment Correlations were used to assess the relationships between weight loss and different descriptive variables. Step by step regression analysis was used to estimate the weight loss. Determination coefficient (R<sup>2</sup>) and standard error of estimation (SEE) was used to show the accuracy of estimation. Probability level for statistical significance was set at p=0.05. Results We obtained the following correlation coefficients for weight loss and body weight, sex, age, BMI and efficacy BMI 25 Index: r=0,222 (p=0,038), r=0,256 (p=0,016), r=0,184 (p=0,087), r=0,222 (p=0,038) and r=0,569 (p<0,001), respectively. With the regression analysis it was obtained the following predictive weight loss models: Weight loss (kg) = -8,507+0,524\*(BMI)+1,721\*(Sex, men=1, women=0) (R<sup>2</sup>=0,093; SEE=3.8 kg) Weight loss (kg) = -115,4+2,481\*(BMI)+0,541\*(Efficacy BMI 25 Index) (R<sup>2</sup>=0,768; SEE=1,92 kg) Discussion Hagan (6) showed that the weight loss is different according to sex. Other studies (4, 7, 8) have shown differences between the type of intervention realized. Del Corral (4) found that adherence to diet is a strong predictor of weight loss during a wide range of dietary restriction, so this variable should be included in the new prediction models. We conclude that the weight loss is related to the variables BMI and sex. References 1. Macfarlane DJ. British Journal of Sports Medicine. 2010;44(16):1197-201. 2. Worthy SL, et al. Health Education Journal. 2010;69(4):372-80. 3. Ballor DL, et al. The American Journal of Clinical Nutrition. 1988;47:19-25. 4. Del Corral P, et al. J Clin Endocrinol Metab. 2009 May;94(5):1602-7. 5. Kraemer WJ, et al. Journal of Applied Physiology. 1997;83:270-9. 6. Hagan RD, et al. Medicine & Science in Sports & Exercise. 1986;18(1):87-94. 7. Redman LM, et al. PLoS One. 2009;4(2):e4377. 8. Volpe SL, et al. J Am Coll Nutr. 2008 Apr;27(2):195-208.

## ANTHROPOMETRIC CHARACTERISTICS OF CLUB AND VARSITY LEVEL GAELIC GAMES PLAYERS AS DETERMINED BY DUAL X-RAY ABSORPTIOMETRY

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Introduction Assessment of body composition is a central component of performance profiling in Gaelic games. In research and applied settings estimated body fat percentage (BF %) is estimated from skinfold thicknesses (Reilly and Collins, 2008). Gaelic games literature reports wide variances in these estimates despite players being drawn from notionally similar populations. The variances may be due to technical errors in data collection and/or violation of generic assumptions regarding bone and tissue density. Dual X-ray absorptiometry (DXA) represents a methodology which may eliminate issues associated with skinfold based estimates of body composition. The aims of the present study were to establish reference values of body composition in Gaelic games players using DXA and to compare between the codes of Gaelic Football (GF) and Hurling (HRL). Methods Forty-three players; 20 GF and 23 HRL (age 21 ± 1.7 yrs vs 21 ± 2.1 yrs) respectively underwent whole body fan beam measurement by DXA (Hologic QDR, Delphi Series A, USA). Scans were analysed using standardised protocols with the Hologic QDR analysis software version 12.4. Measurement occurred at the midpoint of the competitive season, with all players engaged in training and competition. Derived variables included body mass (BM), fat mass (FM), lean mass (LM), body fat

percentage and bone mineral content (BMC). Results No significant differences in height ( $179.6 \pm 5.7$  cm vs  $180.2 \pm 7.1$  cm) and body mass ( $76.8 \pm 7.8$  kg vs  $81.6 \pm 9.0$  kg) were evident between the codes. BF% ( $16.2 \pm 4.7\%$  vs  $18.7 \pm 4.7\%$ ) did not differ between GF vs HRL ( $P > 0.05$ ). Fat mass was significantly lower in the GF vs HRL ( $11.5 \pm 3.7$  kg vs  $14.6 \pm 4.5$  kg) ( $P < 0.05$ ). No differences in LM ( $58.5 \pm 5.4$  kg vs  $60.0 \pm 7.1$  kg) ( $P > 0.05$ ) or BMC ( $2.5 \pm 0.3$  kg vs  $2.6 \pm 0.3$  kg) ( $P > 0.05$ ) between GF and HRL were apparent. Discussion Gaelic games players present a relatively homogenous anthropometric profile. The hurlers tended to be slightly taller and heavier with higher adiposity and lean muscle tissue mass than the GF although this was significant for FM only. BF% are at the higher end of previously reported values for these populations, reflecting the performance heterogeneity of the players, differing work rate and intensity profile of GF vs HRL codes and potential underestimation of adiposity attributable to skinfold methods. The current DXA BF% values represent the first reported DXA based norms for Gaelic games as such this will provide a data set to which field methods may be compared. Further extension of this data set to elite gaelic games populations is warranted. References, Reilly T, Collins, K. (2008). Eur J Sport Sci, 1, 84–94.

### **MORPHOLOGICAL CHARACTERISTICS AND SITUATIONAL EFFICIENCY OF K-1 SUPER HEAVYWEIGHT FIGHTERS AT THE K-1 GP FINAL TOURNAMENT 2010**

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**Introduction** What this article aims to do is to identify K-1 fighters' situational efficiency parameters by registering the use of a group of tactical and technical elements applied by the winners and defeated fighters in the Final K-1 Grand Prix Tournament in Japan in 2010. **Methods** The sample consisted of eight top-level K-1 super heavyweight fighter specialised in different contact sports (boxing, kick boxing, karate, muay thai, etc.) fighting according to K-1 rules. Data were collected on the basis of video recordings of seven fights, based on which the K-1 tournament analysis was performed. The collected data were processed using descriptive statistics. Variables were processed using the formula for the technical and tactical elements application efficiency in K-1 fights  $K-1 = x / Ny \times 100 \%$ . **Results and discussion** The basic descriptive parameters of morphological characteristics of all fighters indicate that the average height is 191.5 cm, ranging from 182 to 212 cm. The average weight is 109.5 kg, ranging from 90 to 133 kg. From the analysis of the punches and kicks frequency we can conclude that the total frequency of punches is 1294 or 67.4%, and kicks 625 or 32.6% of the total number of received blows at the tournament. The most frequent punches were direct punches 783 or 40.80%, whereas the most frequent kicks were low kicks 330 or 17.30%. Hand techniques are more dominant than leg techniques most likely due to their energetic efficiency since they require less energy. From we can gather that the most dominant defence techniques are pulling away 343 or 24%, hand blocks against punches 338 or 23.7%, evasion 331 or 23.2%. Further on, we have hand blocks against kicks 182 or 12.8%, leg blocks against kicks 178 or 12.5% of the total number of blocks applied during the tournament. This coincides with the analysis of punches and kicks frequency. Suggests that the most dominantly used tactical means is combined tactics (6 or 42.9%), followed by offensive tactics 5 or 35.7% and defensive tactics 3 or 21.4%. We can see that the victory was most frequently achieved by decision 4 or 57.1 %, by knock-out 2 or 28.6%, and by forfeit due to injury 1 or 14.2 % . **Conclusion** The analysis of the K-1 GP Final Tournament in Japan in 2010 points out the statistical dominance of the hand boxing technique over the leg techniques since the former require less energy, they are also much faster, simpler, and have a larger impact on the course of the fight The larger frequency of circular kicks and knee blows characteristics of Muay Thai, kick boxing and MMA suggest that boxing, Muay Tahi, kick boxing and MMA are fundamentally important for fighting successfully in K-1. **References** Kapo, S. (2006). Structural Analysis and Model of K-1 Top Level Fighters. Dissertation (In osnian). Faculty of Sports and Physical Education, University of Sarajevo. BiH. Valera, D. (1973). (1973). Karate la competition Paris: Ed Serdirey

### **ANTHROPOMETRIC CHARACTERISTICS OF ELITE KENYAN MARATHON RUNNERS**

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**Introduction** Despite over the last ten years several studies attempted to explain the success of Kenyan marathon runners proposing explanations included environmental-, psychological-, and physiological-factors, little is known about the anthropometric characteristics of them. Consequently, the aims of this study were to describe the current anthropometric profiles of elite Kenyan marathon runners and establish a set of reference values useful for future investigations on athlete selection, talent identification, and training programme development. **Methods** In a cross-sectional design, 14 male Kenyan runners were assessed for the measurement of skinfolds, segment lengths, breadths, and girths according to previous works (Carter and Heath, 1990; Norton and Olds, 2004; Stuelcken et al., 2007). All variables except body mass and height were measured on the right side of the body in triplicate with the median value used as the criterion. To estimate body density (BD) multiple regression equations were calculated using the sum of 3-skinfolds method (Jackson and Pollock, 1978) and then converted to percentage of body fat (% BF) (Siri, 1961). The somatotype, somatotype dispersion mean (SDM), somatotype attitudinal mean (SAM), and height to weight ratio (HWR) were calculated using the method and equations of Carter and Heath (1990). **Results** The mean (s) of age, height, weight and marathon personal best were 27.7 (3.7) yrs, 171.2 (6.1) cm, 57.7 (4.0) kg, and 02h 07min 16s (01min 55s). The mean (s) of BD, % BF, SDM, SAM, and HWR were 1.13 (0.02), 8.8 (0.07) %, 4.6 (3.6), 0.5 (0.1), and 44.3 (1.0), respectively. The mean (s) endomorphy, mesomorphy, and ectomorphy were 1.5 (0.3), 1.6 (1.8), and 3.8 (0.7), respectively. **Discussion** The mean somatotype of Kenyan marathon runners evaluated could be defined as ectomorph, having ectomorphy as dominant, and endomorphy and mesomorphy more than one-half unit lower. Despite population comparisons would be required to identify any connection between specific anthropometric dimensions, these reference data should be useful to practitioners and researchers, providing useful information for talent identification and for the assessment of training progression in marathon. **References** Carter JEL, Heath BH. (1990). Somatotyping: Development and applications. Cambridge University Press, Cambridge Jackson AS, Pollock ML. (1978). Br J Nutr, 40, 497-504 Norton K, Olds T. (2004). Anthropometrica. University of New South Wales Press Ltd., Sydney Siri WE. (1961). In Techniques for measuring body composition, 223. National Academy of Sciences-National Research Council, Washington, D.C Stuelcken M, Pyne D, Sinclair P. (2007). J Sports Sci, 25, 1587-1597

### **PROPOSITION OF EQUATIONS FOR PREDICTING BODY FAT VALUES IN PROFESSIONAL SOCCER PLAYERS**

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**Introduction** An accurate estimation of body composition in athletes, especially soccer players, provides an important component in a training program, in the control of body weight and the maintenance of a high level of physiological functioning. However, there is a

noticeable lack of specific predictive equations for soccer athletes. Therefore, the aim of this study was to propose mathematical equations for elite soccer athletes, using anthropometric measures for predicting body fat and DXA as a reference method. Methods This study involved 31 male professional footballers who participated in the Professional League of Brazil, with mean values of age of  $21.48 \pm 3.38$  years, body mass  $79.05 \pm 9.49$  kg, height  $181.97 \pm 8.11$  and body fat  $13.68 \pm 4.22\%$ . The athletes underwent an analysis of anthropometric measurements of weight, height, body circumferences, bone width, and skinfolds and as a reference for comparison, we used the Dual-energy X-ray Absorptiometry - DXA. To obtain the equations for estimating body fat we used the multiple regression technique. Results Several equations were proposed from the analysis performed in this study, but the equations that showed the best results for the adjusted coefficient of determination ( $R^2a$ ) and standard error of estimate (SEE) of body fat percentage, were as follows:  $\%BF = 0.83196071$  (midaxillary) +  $0.16367624$  (abdominal) +  $0.75492553$  (thigh) -  $2.33295828$  ( $R^2a = 0.839$ , SEE = 1.690)  $\%BF = 0.67901792$  (midaxillary + thigh) +  $0.07619429$  (abdominal + midaxillary) +  $0.06801188$  (chest + abdominal + midaxillary + thigh) -  $2.37873851$  ( $R^2a = 0.840$ , SEE = 1.689)  $\%BF = 0.75055662$  (midaxillary + thigh) +  $0.13910823$  (abdominal + midaxillary) -  $2.46345040$  ( $R^2a = 0.845$ , SEE = 1.662)  $\%BF = 0.67901792$  (midaxillary + thigh) +  $0.14420618$  (abdominal + midaxillary) +  $0.06801188$  (thigh + chest) -  $2.37873850$  ( $R^2a = 0.849$ , SEE = 1.689) Discussion Considering also other statistical indicators, the mathematical models proposed in this research showed determination coefficients higher than the ones reported by Reilly et al (2009)  $R^2 = 0.78$  in a study involving footballers and Eston et al (2005),  $R^2 = 0.79$  and  $0.67$ , proposed for non-athlete individuals. The adjusted coefficient of determination ( $R^2a$ ), presented by Reilly et al (2009) in their study with the goal of proposing an equation to predict body fat for soccer players, was lower ( $R^2a = 0.73$ ) than the values found in our results. References ESTON, R.G. et al. Prediction of DXA-determined whole body fat from skinfolds: importance of including skinfolds from the thigh and calf in young, healthy men and women. *European Journal of Clinical Nutrition*. v.59. p.695-702, 2005. REILLY, T et al. How Well do Skinfold Equations Predict Percent Body Fat in Elite Soccer Players?. *Int. J. Sports Med*. v.30, p.607 – 613, 2009.

## MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES OF THE YOUNG BALLET DANCERS

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MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES OF THE YOUNG BALLET DANCERS Suzovic, D.1; Porcic, B.2 1 Faculty of Sport and Physical Education, Belgrade, 2 Ballet School "Lujo Davico", Belgrade Introduction Little data are available on growth and development of young classical ballet dancers. The objective of this study was to determine how growth and development processes determine the morphological and motor abilities of young female dancers. The growth and maturation showed influence in morpho-functional abilities at young female dancers (Steinberg, N. et al. 2008). Methods Eighty-four girl students of the Primary Ballet School of 12,84 ( $\pm 1,14$ ) years of age (mean (SD)), and the body height 157,0 ( $\pm 9,0$ ) cm and body mass 43,1 ( $\pm 7, 6$ ) kg. were divided into 4 sub-samples according to the school grade (n = 26 (1st grade); 16 (2nd); 24 (3rd) and 18 (4th), respectively, aged 11,58  $\pm 0,58$  (1st grade), 12,68 $\pm 0,59$  (2nd), 13,33 $\pm 0,57$  (3rd) and 14,13 $\pm 0,68$  (4th). Their BMI was derived from their body height and body mass. The data regarding the motor abilities were obtained by applying the standard EUROFIT test battery which determines the order of implementation of individual tests, recommended for standardized use in the countries of the European Council (Kukulj et al. 1993). It was hypothesized that the maturation have influence on morphological and also on motoric abilities at young dancers. The results were analyzed using descriptive (mean and SD) and comparative (1-way ANOVA) statistical procedures. Results and discussion The obtained findings support the hypothesized effect of maturation. Specifically, the results revealed the differences in morphological characteristics, but not in body composition. The youngest girls were the lightest and with the lowest body mass. They also revealed significantly lower BMI, when compared with the students of the third and fourth grade. The evaluated motor abilities suggested the differences among the groups in the Plate Taping, Standing Abroad and the Agility test 10x5m, where generally the oldest girls revealed better scores than the youngest. Conclusion We can generally conclude that the development at the studied age is not characterized with changes in body composition, while the specific ballet and gymnastic practices could improve motor abilities to reach the necessary requirements for ballet performance. From the practical aspect, however, the obtained findings suggest that the applied EUROFIT battery of motor ability tests could be used as one of the criteria for early selection at classical ballet school (Wyon et al. 2004 ). Acknowledgments The study was supported in part by a grant from Serbian Research Council (#145082). References Kukulj, M. et al. (1993): *Fizicka kultura*, 47, 4: 196-200, Steinberg, N. et al. (2008): *Am J of Hum Biol*, 20, 299-307, Wyon, M. et al. (2007): *J Strength Cond Res*, 21(2): 389-393,

## FUNCTIONAL AND BODY COMPOSITION CHARACTERISTICS OF TOP CZECH FEMALE SOCCERS

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FUNCTIONAL AND BODY COMPOSITION CHARACTERISTICS OF TOP CZECH FEMALE SOCCERS Bunc,V. Hráský, P., Baláš, J. Faculty of P.E and Sports Charles University, Prague, Czech Republic Introduction The laboratory testing - evaluation of changes in morphological, cardiorespiratory and metabolic variables during exercise, may help to explain the process of adaptation to the training stimulus, and these variables could be used for training checking. The most frequently used variables for the characterisation of training state are related to the VT. Another variable which may be used for indirect evaluation of changes in adaptation to exercise is the energy cost of exercise. Methods Nowadays could be used together with long time used classical parameters of body composition – body fat content and free fat mass - also other variables which may characterise the BC like are body cell mass (BCM) and extracellular mass (ECM). The fact that differences in body size and BC influence the predisposition and interpretation of parameters such as absolute and relative  $VO_{2max}$  and/or physical performance is well known. Less well studied are the effects of differences of BC on functional variables in top female soccer players. The physiological profiles of 27 top Czech female players (national team members) (mean age =  $23.0 \pm 3.4$  years, mass =  $78.9 \pm 6.3$  kg, height =  $182.4 \pm 5.4$  cm,  $\%BF = 10.8 \pm 2.1\%$  and  $ECM/BCM = 0.78 \pm 0.06$ ) were measured on the treadmill with 5% inclination. Results Mean  $VO_{2max.kg^{-1}}$  was  $54.6 \pm 3.5$  ml.kg<sup>-1</sup>.min<sup>-1</sup>. Mean value of maximal running speed was  $15.6 \pm 1.0$  km.h<sup>-1</sup>, and  $LAm_{ax}$  was  $11.2 \pm 1.3$  mmol.L<sup>-1</sup>. The selected variables at the VT level corresponded to  $VO_{2.kg^{-1}} = 43.6 \pm 1.4$  ml.kg<sup>-1</sup>.min<sup>-1</sup>,  $\%VO_{2max.kg^{-1}}$  at VT level were  $79.8 \pm 1.5\%$ , speed =  $13.0 \pm 0.4$  km.h<sup>-1</sup>,  $\%v_{max}$  at VT level were  $83.3 \pm 1.4\%$ . The energy cost of running was  $3.85 \pm 0.22$  J.kg<sup>-1</sup>.m<sup>-1</sup>. Discussion The actual motor performance and thus the actual training state is partly a consequence of their genetic predisposition and partly a consequence of the moving training they undertake. In practice it is difficult to separate these two components. As in other sports events where the skills play the decisive role, the physiological data are not the sole predictor of racing success. It is necessary remark that these standards are necessary but not only sufficient conditions for success in the race, but the decisive predispositions for long lasting successful training process. These data play important role in selection of talents for particular sports event. Conclusion We may conclude that the physiological characteristics of top female players should be as follows:  $ECM/BCM < 0.75$ ,  $VO_{2max.kg^{-1}} > 56$  ml.kg<sup>-1</sup>.min<sup>-1</sup> in defenders, and  $> 60$  ml.kg<sup>-1</sup>.min<sup>-1</sup>, in midfielders and forwards. Maximal speed (at 5% inclination) should be  $> 16$  km.h<sup>-1</sup> in all

players, the speed at VT > 13.0 km.h<sup>-1</sup>, %VO<sub>2</sub>max at VT level > 81.0%, and the energy cost of running < 3.83 J.kg<sup>-1</sup>.m<sup>-1</sup>. The study was supported by grant of Czech Ministry of Education MSM 115100001.

## BIOCHEMICAL AND BODY COMPOSITION EFFECTS OF ULTRA RUNNING

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**Introduction** An increasing number of subjects are participating in various ultra races. Although ultra races are considered to be harmful to health, evidence is sparse regarding the harmful or beneficial effects of ultra races on a whole body composition or biochemical level. **Methods** 8 experienced long distance runners (7 male, 1 female; age 44±2, BMI 23.5±0.5, number of marathons finished 108±27) participating in the Danish ultra race event "7 marathons in 6 days" (1), underwent biochemical screening (blood sampling) and body composition assessments (dual-energy X-ray absorptiometry) before and after the race. Data are presented as Mean±SEM. **Results** Overall finish time for the 7 marathons was 28.3±1.4 h (range 23.4 – 34.4 h) with the last 3 marathons significantly faster than the first two marathons (p<0.05). The average fastest single marathon finish time occurred at day 7 (3:50±0:11:28, range 3:14:44 – 4:42:58 h) and slowest was day 2 (4:10:24±0:14:11, range 3:27:08 – 5:21:28). A substantial decrease in fat mass (12.0±2.3 vs. 10.4±1.9 kg, p<0.05) was seen with a corresponding increase in lean body mass (62.8±2.9 vs. 64.7±3.0 kg, p<0.05) leading to no weight change overall. Biochemical screening showed minor muscle cell damage after the race (Creatine Kinase: 198.9±48.4 vs. 639.9±99.4 U/l, p<0.05) and a corresponding small increase in inflammatory markers such as C-reactive protein (1.0±0 vs. 6.0±1.1 mg/l, p<0.05). Alanine (ALT) and aspartate (AST) transaminases, traditionally seen as evidence of liver cell damage also showed a minor increase (ALT: 26.8±3.6 vs. 38.8±5.3 U/l, p<0.05. AST: 29.1±2.8 vs. 56.6±7.1 U/l, p<0.05), whereas no changes were seen in liver function markers. No haemolysis was seen. Fasting insulin levels dropped (49.3±7.8 vs. 22.5±2.7 pmol/l, p<0.05) with no changes in fasting glucose. An improved cholesterol profile with decreased total cholesterol (4.9±0.3 vs. 4.4±0.2 mmol/l, p<0.05) and increased high-density lipoprotein cholesterol (1.7±0.2 vs. 2.0±0.1 mmol/l, p<0.05) was found. **Discussion** In this small sample of highly trained subjects, no major adverse effects were seen after running 7 marathons in 6 days. On the other hand, markers of metabolic health were significantly improved following the race. **In conclusion**, it was shown that daily marathon running for 6 days did not elicit a large physical damage measured by a broad range of biochemical variables, and that certain health related parameters, such as fat mass, total cholesterol and HDL, improved substantially following the event. **References** 1: <http://www.tejnlif-lob.dk/www/index.php/62448timer/resultaterultrammarathonforside/res2010ultrammarathon>

## ANTHROPOMETRIC PROFILE OF ELITE MALE ICE CLIMBERS AND ITS INFLUENCE ON COMPETITION RANK

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**Introduction:** Although, Ice climbing World Cup is organized in the last ten years and some National Championships even longer, anthropometric profile of ice climbers remained unknown. The aim of this study was to determine anthropometric profile of elite ice climbers (IC) and its influence on competition rank. **Methods:** The 23 male (age 26.7±5.9) participants of the Ice climbing World Cup were measured day before competition. Control group (age 23.8±2.6) was made of 23 non climbers (NC), students from Faculty of sport. The variables measured included age, height, weight, body mass index, % body fat by bioimpedance, % segmental body fat (trunk, left and right arms, -legs), fat mass, leg length, arm span, ratio of arm span to height (Ape index), right and left handgrip strength, handgrip strength to body mass ratio (SMR), pincer strength (dominant hand, i.e. thumb and forefinger), handgrip endurance (dominant hand), endurance of shoulder's muscles, foot raise, hip flexion, hip abduction and climbing ability trough standing position (Grant S., 1996; Mermier CM., 2000; Watt PB., 2003; Giles LV., 2006). **Results:** Elite ice climbers compared with NC have less height, weight, % body fat, BMI, BMR, FFM and TBW (p<0.05). They have the same arm span and leg length but higher Ape index. Tests of strength, endurance and flexibility are the same, except that Ice climbers have significant better hip abduction (p<0.05). Age, handgrip endurance, SMR, foot raise and hip abduction had significant influence on competition rank in Ice climbing (p<0.05) while handgrip strength (left and right) shown significance of (p<0.01). **Discussion:** Elite ice climbers have moderate body composition with low fat % and good hip flexibility. This anthropometric profile of elite ice climbers have shown that except endurance, strength and flexibility, success on competition is influenced by experience which coming with age, as well as with improvement of climbing techniques. **References:** Grant S., Hynes V., Whittaker A., Aitchison T. (1996). J Sport Sci, 14, 301-309. Mermier CM., Janot JM., Parker DL., Swan JG., (2000). Br J Sport Med 34, 359-366 Watts PB., Joubert LM., Lish AK, Mast JD, Wilkins B. (2003). Br J Sports Med 37, 420-424. Giles LV., Rhodes EC., Taunton JE. (2006). Sport Med 36(6),529-545.

## THE WAIST MEASURE POINT AFFECTS THE DIAGNOSIS OF CENTRAL OBESITY

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THE WAIST MEASURE POINT AFFECTS THE DIAGNOSIS OF CENTRAL OBESITY Rodriguez, D.2,3, Silva, V.1, Guiselini, M.2, Pontes Jr, F.L.3 1: FEFISO/YMCA (Sorocaba, Brazil), 2: IREP (Sao Paulo, Brazil), 3: USJT (Sao Paulo, Brazil), 4: USP (Sao Paulo, Brazil) **Introduction** According to the systematic review by Ross et al. (2008) the midpoint and umbilical point are the most used to measure the waist circumference. Taking this in consideration, the aim of this study was to analyze how the waist measurement point affects the diagnosis of central obesity. **Methods** We evaluated 13,129 persons (7047 women and 6082 men), aged between 10 and 79 years. The indicators of central obesity were considered waist circumference (WC), waist/hip ratio (WHR), conicity index (CI) and waist/height (WHtR). All indicators of central obesity were determined for the midpoint (MID) and umbilical point (UMB). The mean difference (MD) between the MID and the UMB was determined based on algorithmic UMB subtraction (minuend) less than the MID (subtrahend). We used operational definitions proposed for two Brazilians author (Pitanga e Lessa 2004, 2005 e 2006), and we used the tests of two-way ANOVA, post hoc Newman-Keuls, frequency table and chi-square test (P ≤ 0.05). **Results** All indicators of central obesity showed significant differences which affect significantly those results as following; (p <0.01) between the MID and UMB. In WC, MD of 6.16 cm for women and 3.18 cm for men, (p <0.01) the prevalence of central obesity in 17.5% for women and 12.4% for men. In the WHR, MD of 0.063 for women and 0.031 for men, (p<0.01) the prevalence of central obesity in 28.2% for women and 16.6% for men. In CI, MD of 0.093 for women and 0.043 for men, (p<0.01) the prevalence of central obesity in 45.8% for women and 20.8% for men. In WHtR, MD of 0.038 for women and 0.018 for men, (p<0.01) the

prevalence of central obesity in 11.5% for women and 10.7% for men. Discussion Studies that determine the morbimortality through anthropometric indicators showed that the WC, WHR, CI and WHtR, explain the morbimortality better than BMI (Pitanga e Lessa 2004, 2005 e 2006). However, the systematic review by Ross et al. (2008), involving 120 studies showed that several points are used to measure the WC. According to the results presented in this study, the point of WC measurement affects significantly the diagnosis of central obesity. Therefore, if the abdominal obesity is defined at the midpoint, for example, no other point must be used for diagnosing abdominal obesity. References Pitanga FJ, Lessa I. (2004). *Rev Bras Epidemiol*, 7(3), 259-269. Pitanga FJ, Lessa I. (2005). *Arq Bras Cardiol*, 85(1), 26-31. Pitanga FJ, Lessa I. (2006). *Rev Assoc Med Bras*, 52(3), 157-161. Ross R, Berentzen T, Bradshaw AJ, et al. (2008). *Obes Rev*, 9(4), 312-25.

## Poster presentations

### PP-PM36 Physiology: Immunology 2

#### TRAINING LOAD, STRESS TOLERANCE AND UPPER RESPIRATORY SYMPTOMS IN PROFESSIONAL BASKETBALL PLAYERS

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**Introduction** The main goal of sport training process is to maximize athletic performance. In order to achieve this goal, it is imperative to prescribe appropriate training loads to induce positive outcomes, enhancing performance. Therefore, the aim of the present study was to investigate the behavior and relationships among internal training load (ITL), stress tolerance (ST) and upper respiratory symptoms (URS) in professional basketball players during one macrocycle training. **Methods** The sample was composed by 12 professional basketball athletes ( $22 \pm 5$  years,  $94 \pm 22$  kg, and  $196 \pm 10$  cm). The study was conducted for 19 weeks. The macrocycle was separated by three distinct phases (preparatory phase = [P1], and two competitive phases = [P2 and P3]. In order to assess internal training load, the session ratings of perceived exertion (session-RPE, Foster 1998) was utilized for every training session and official match. The Daily Analysis of Life Demands for Athletes' questionnaire (DALDA; sources and symptoms of stress) and the Wisconsin Upper Respiratory Symptom Survey (WURSS-21) were used on a weekly basis to assess ST and URS severity, respectively. **Results** The results from ANOVA with repeated measures showed significant differences among the three phases to all analyzed variables ( $p < 0.05$ ). The ITL showed significant increments from P1 to P2. At P3, the answers "better than normal" (DALDA; for both sources and symptoms) showed a significant decrease. A significant increase to URS severity was noted to P3. In addition, significant relationships were verified between ST and URS at P3 (URS x Sources "worse than normal" = 0,69 and URS x Symptoms "worse than normal" = 0,60). The answers "better than normal" seems to better explain the changes in ST. **Discussion** The main finding of the present study was the congruence among the psychometric tools, during the main phase of the season (P3), we noted significant increments in URS associated with amplified stress despite of the reduction in ITL. These results suggest that other factors (i.e. emotional and psychological) than ITL alone could induce to increments in the stress levels as well as in URS. Moreover, the answers "better than normal" (DALDA) seem to better explain the changes in ST, indicating the importance to retain this variable to monitoring the stress reaction. In summary an approach incorporating in conjunction these psychometric tools could be an efficient means of monitoring reaction to stress in professional basketball during an entire macrocycle in accordance to a psychophysiological perspective. **References** Foster, C. Monitoring training in athletes with reference to overtraining syndrome. *Medicine and Science in Sports and Exercise* 1998; 30 (7): 1164-1168. Rushall, B.S. A Tool for Measuring Stress Tolerance in Elite Athletes. *Journal of Applied Sports Psychology*, 1990: 2 (5): 51-66.

#### RECOVERY-STRESS STATE AND IMMUNOLOGICAL VARIABLES AFTER DIFFERENT TRAINING PERIODS IN SWIMMERS

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**Introduction:** Immunological and psychological variables are commonly used as an index of training stress (Gleeson, 2002), even though significant differences between immunological variables after different training phases may not be observed (Coutts et al. 2007). We investigated the effects of different training loads on recovery-stress state (RSS) and immunological variables. **Methods:** Subjects were highly trained, male swimmers ( $17.7 \pm 1.3$  y.o.). RSS and immunological variables (monocytes, lymphocytes, eosinophils and total leukocytes) were evaluated after two distinct training phases. During the first phase (T1), subjects swam approximately 50.000 meters/week during 01 week. During the subsequent phase (T2) (04 weeks), swimmers covered an average of 45.000 meters/week at a considerably higher intensity. RSS was evaluated using the RESTQ-Sport questionnaire for the Portuguese language (Costa & Samulski, 2005). The Student's t-test and Pearson's correlation coefficient were used for parametric variables. The Wilcoxon test and Spearman correlation coefficient were used for non-parametric variables. Significance level was  $p < 0.05$ . **Results:** Lymphocyte levels increased significantly from T1 to T2 ( $2005,6/\mu\text{l} + 321,78$  vs  $2230,0/\mu\text{l} + 472,51$ ). No significant changes were observed in RSS. After T1, positive correlations between monocytes and "social relaxation" and a significant negative correlation between lymphocytes and "social stress", "conflicts/pressure" and "self-efficacy" were observed ( $p < 0.05$ ). After T2, positive correlations between leucocytes and "being in shape" and between lymphocytes and "emotional exhaustion" were noted ( $p < 0.05$ ). **Conclusion:** Neither the immunological variables, except lymphocyte levels, nor psychological aspects were sensitive to the alterations on training routine used in the present study. Correlations between immunological and psychological variables showed no identifiable pattern. Even though the investigated variables may be useful for monitoring training programmes, their behaviour after different training modes deserve further investigation. **References:** Costa, L.O.C.; Samulski, D.M. Processo de validação do questionário de estresse e recuperação para atletas (RESTQ-Sport) na língua portuguesa. *Revista Brasileira de Ciência e Movimento*, 13, p.79-86, 2005. Coutts, A.J.; Wallace, L.K.; Slattery, K.M. Monitoring changes in performance, physiology, biochemistry, and psychology during overreaching and recovery in triathletes. *International Journal of Sports Medicine*, 28, p.125-34, 2007. Gleeson, M. Biochemical and immunological markers of overtraining. *Journal of Sports Science and Medicine*, 2, p.31-41, 2002.

### EFFECTS IN LIPID PROFILE OF THREE DIFFERENT EXERCISE PROTOCOLS IN OVERWEIGHT PEOPLE

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**EFFECTS IN LIPID PROFILE OF THREE DIFFERENT EXERCISE PROTOCOLS IN OVERWEIGHT PEOPLE** Romero, B<sup>1</sup>; Morencos, E<sup>1</sup>; Peinado, A. B<sup>1</sup>; Butragueño, J<sup>1</sup>; Cupeiro, R<sup>1</sup>; Rojo, M. A.; Benito, P. J<sup>1</sup>; Calderon, F. J<sup>1</sup> on behalf of the PRONAF Study Group <sup>1</sup> Facultad de Ciencias de la Actividad Física y del Deporte – INEF. Universidad Politécnica de Madrid. (Clinical Trials gov number: NCT01116856) **Introduction** Major risk factors for cardiovascular diseases (CVD) include hypertension, smoking, serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), low levels of high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG). Physical inactivity and reduced cardiorespiratory fitness contribute to the risk of CVD, whereas there is consistent, substantial, and strong evidence that physical activity is a deterrent for developing cardiovascular disease [1]. The aim of this study was to know what kind of exercise could be more effective to improve lipid profile in overweight people. **Methods** Ninety participants with overweight (18 – 50 years; BMI > 25 and < 30 kg/m<sup>2</sup>) were randomized to one of the following groups: strength training (ST; n = 22), aerobic training (AT; n = 25), a combination of AT and ST (COM; n = 23), 3 times/wk for 24 wk, and control group (CG; n = 20). All of them in combination with diet restriction. The measurements took place for all subjects before training at weeks 1 to 4, and after 16 weeks of training in weeks 21 to 24. All groups were evaluated for changes in blood concentrations of lipoprotein-lipids, cardiovascular fitness, body composition, and dietary composition. Two way ANOVA with repeated measures was used to determine differences between moments (before and after intervention). The significant level was set at  $\alpha \leq 0.05$ . **Results** Lipid profile showed improvements in all groups. Triglycerides (TG) had a significant decreased in ST (23.53%;  $p < 0.001$ ) and AT (14.29%,  $p < 0.05$ ). AT, COM and CG significantly reduced total cholesterol (TC) 11.4%, 21.75% and 16.88% ( $p < 0.01$ ) respectively. Low-density lipoprotein-cholesterol (LDL-C) was significantly decreased in COM (16.15 %,  $p < 0.001$ ) and CG (14.7 %,  $p < 0.001$ ). **Discussion** The results of the present study are in agreement with recently reported results that showed improvements in lipid profile with aerobic training [2, 3], resistance training [4] and combination [5]. In summary the present study showed that all training methods may improve lipid profile. **References** 1. Blair, S.N., et al. *Med Sci Sports Exerc* (2001); 33:762-64. 2. Stensvold, D, et al. *J Appl Physiol* (2010); 108: 804-10. 3. Sillanpää E, et al. *Eur J Appl Physiol* (2009); 106: 285-96. 4. Strasser B, and Schobersberger, W. *J Obes* (2011). 5. Pittsavos, C, et al. *Q J Med* (2009); 102: 609-16.

### MONOCYTE INTRACELLULAR CYTOKINE PRODUCTION IN ELITE CANOEISTS AND NON-ATHLETES

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**Introduction** Exercise training or higher levels of physical activity are known to exert anti-inflammatory effects. In responses to exercise the monocytes produce pro-inflammatory cytokines like IL-1 $\beta$ , IL-6 and tumor necrosis factor (TNF). The present study examined the effect of training on monocyte intracellular cytokine production in elite canoeists after an off training period of 6 weeks and in non-athletes. **Methods** The sample was composed by 11 canoeists athletes, with a mean of  $22.0 \pm 4.3$  years old,  $77.2 \pm 6.7$  Kg weight and  $177.5 \pm 5.6$  cm high with an initial  $\dot{V}O_{2\max}$  of  $61.2 \pm 5.5$  ml.Kg.min<sup>-1</sup> and 7 health men, who had no practice of regular exercise, with a mean  $18.5 \pm 1.3$  years old,  $81.3 \pm 10.7$  Kg weight and  $171.9 \pm 4.5$  cm high. Blood samples were collected by venopuncture. In the present study, intracellular cytokines in blood leukocytes were analyzed by flow cytometry. Results are expressed as the percentage and number of cytokine-producing cells in CD33+ populations. The absolute count was determined by multiplying the percentage of cytokine-positive monocytes by the concentration of monocytes in peripheral blood. For quantification of the amount of cytokine within positive cells, the mean fluorescence intensity of positive events was obtained. **Results** There were no significant differences between groups in white blood cells, lymphocyte, monocyte and granulocyte counts ( $p > 0.05$ ). The percentage of monocyte intracellular cytokine expression was higher in athletes for IL-1 $\beta$  ( $p < 0.05$ ) and lower for IL-6 ( $p < 0.05$ ) and TNF- $\alpha$  ( $p < 0.05$ ). **Discussion** Athletes appear to have an attenuated cytokine response. Regular physical training has been demonstrated to attenuate the immune response to exercise in either direction (Gokhale et al., 2007). Pedersen et al. (2004) have concluded that IL-6 has a modulatory effect on TNF- $\alpha$  along with a variety of functions such as: induction of lipolysis, suppression of TNF production and stimulation of cortisol production. The altered relationship between IL-6 and TNF- $\alpha$  and the significant higher values in untrained subjects suggest that a source of IL-6 other than the muscle may be interfering in the network (Smith et al., 2000). Our study observed that same after an off training period of 6 weeks where the monocyte intracellular cytokine expression was different between athletes and non-athletes. **References** Gokhale R, Chandrashekara S and Vasanthakumar KC. (2007). *Cytokine*, 40, 123- 127. Pedersen BK, Steensberg A, Fischer C et al. (2004). *Proc Nutr Soc*, 63, 263–267. Smith LL. (2000). *Med Sci Sports Exerc*, 32(2), 317–31.

### IMPACT OF TWO DIFFERENT RESISTIVE EXERCISE METHODS ON POST-EXERCISE IMMUNE CELLS AND CORTISOL PLASMA LEVELS

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**IMPACT OF TWO DIFFERENT RESISTIVE EXERCISE METHODS ON POST-EXERCISE IMMUNE CELLS AND CORTISOL PLASMA LEVELS** Rodriguez D.1 Neves R. X.2, Falconi C. A.2, Almeida V.T.2, Siqueira U.2., Charro M. A.2, Pontes Jr F. L.3, Junior A. F.1, 2 1 USJT (São Paulo, Brazil); 2 USCS (São Caetano/SP, Brazil); 3 USP ( São Paulo, Brazil) **Introduction:** Resistive exercise may induce muscle damage and acute inflammatory response (Peake et al. 2005). A single bout of intense resistive exercise may induce transient immunosuppressive effect. However, the manner that the immune system will be challenged depends in great part of the characteristic of the training session (Chen et al. 2009). The aim of this investigation was to determine the effect of two different resistive exercise methods on acute lymphocytes, leukocytes and monocytes and cortisol plasma levels. **Methods:** Young adult men (n= 10;  $26.1 \pm 6.3$  years old;  $174.0 \pm 5.4$  cm-height;  $76.4 \pm 13.3$  kg- weight;  $15.5 \pm 5.4$  % body fat) with no previous experience in resistive exercise were divided into two groups. Both groups performed two different exercise sessions with one week interval between them. The training sessions consisted in three consecutive exercises for the same muscle group (bench press, incline bench press and peck deck) with workload determined by one maximum repetition (1MR) test. The variable intensity group (VIG) performed 3 maximum repetitions (MR) sets for each exercise at 67%, 74% and 80% of 1MR. The constant intensity group (CIG) performed 3 MR sets for each exercise at 75% of 1MR. Blood samples were obtained from an antecubital vein at rest



and immediately after the exercise sessions. The immune cells and cortisol were analyzed by dual-labeled flow cytometry. Student t paired test ( $p < 0.05$ ) was applied to compare pre and post immune cells and cortisol plasma levels. Results: Data evidenced similarity for all plasma analyzed variables pre-post resistive exercise session in CIG. On the other hand VIG presented significant decrease in lymphocytes post-exercise ( $2843 \pm 129^*$ ) compared with pre values ( $3809 \pm 249$ ) ( $*p < 0.05$ ). Cortisol levels also presented increase ( $p < 0.05$ ) after variable intensity session ( $162 \pm 24$  PRE;  $312 \pm 41^*$  POST). Conclusion: Crewther et al. (2008) reported that hormonal responses are proportional to the load lifted however, data allowed us to conclude that the variable intensity session was more stressful to immune system than constant intensity loads. The effect of different intensities (VIG and CIG) did not present the same impact on immune cells and stressor hormones (cortisol). Also we may suggest that if variable intensity method has to be applied it should be performed for shorter periods of time. References Peake J, Nosaka K, Suzuki K. (2005) *Exerc Immunol Rev*; 11:64-85. Chen TC, Chen HL, Lin MJ, Wu CJ, Nosaka K. (2009) *Eur J Appl Physiol*, 106(2):267-75. Crewther B, Cronin J, Keogh J, Cook C. (2008) *J Strength Cond Res*;22:250-5.

## EFFECTS OF BILLAT TRAINING ON BLOOD LIPIDS AND IMMUNE SYSTEM IN FEMALE SERBIAN JUDOKAS

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**Introduction** Training is one of the methods to improve exercise performance, but too much training and competitions cause adverse effects in biochemical and hematological parameters and affects on health state of athletes. The present study was designed to evaluate the changes in total antioxidant activity, total and differential white cell counts and blood lipids at female Serbian judokas after four week training program, without weight reduction. **Methods** The sample of this research consisted 9 female judokas from Serbia national team, age  $23.11 \pm 3.95$  years, who take a bronze medal on European team championship. Blood samples were collected to measure blood lipids, total and differential white cell counts and total antioxidant activity. Complete blood tests were done on instrument SAFIR firm Abot. Biochemical parameter has been providing on instrument ADVIA 1800 firm Bayer Siemens. Total antioxidant activity in serum were done by FRAP method. **Results** General results of study showed a significant increase in total cholesterol concentrations after second measurement ( $p < 0.001$ ) at female Judokas, significant decrease of HDL-C ( $p < 0.05$ ), and significant increase in nonHDL and LDL-C concentrations ( $p < 0.001$ ). In addition, decrease ( $p < 0.05$ ) were found in eosinophile count and increase in monocytes and basophiles after training program. **Discussion** This study has documented that this training program has no negative effect on total antioxidant activity of athletes without proper nutrition, but on lipid profile indicate otherwise. Therefore, beneficial adaptations in lipoprotein profile must be achieved with moderate training intensities and proper nutrition (Aellen et al., 1993). Lipids have important beneficial biological functions. These include usage of triglycerides for energy production, fat storage in adipose tissues, and usage of cholesterol as a component in phospholipids of cellular membranes or in the synthesis of steroid hormones (Heitkamp et al., 2008; Kelley and Kelley, 2009). Regular monitoring of these health-related variables of female judokas players can provide valuable information about their health, metabolic and cardiovascular status. However, results from our research demand attention in further training program, which may have probably provoked negative effects on the lipid profile in elite Serbian female judokas. **Reference** Aellen R, Hollmann W, Bouteiller I. (1993). *Int J Sports Med*.14, 396-400. Heitkamp HC, Wegler S, Brehme U. (2008). *J Sports Med Phys Fitness*. 48, 113-119. Kelley GA, Kelley KS. (2009). *Prev Med*. 48, 9-19.

## PRE-SEASONAL PREPARATION TRAINING AND IMMUNE RESPONSES IN YOUNG WELL-TRAINED SOCCER PLAYERS

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**Introduction** It was suggested that athletes involved in long-term high intensity exercise are susceptible to upper respiratory tract infection (Nieman et al., 1990); since various aspects of immune function are temporarily suppressed following strenuous physical activity (Pedersen & Hoffman-Goetz 2000). This response might be a limiting factor in exercise performance (Tuan et al. 2008). However, although this is evident during long-term high-intensity training little is known regarding the immune responses to strenuous soccer-specific pre-seasonal preparation training in young soccer-players. The purpose therefore of the present study was to examine the immune responses to 8-weeks of overload pre-seasonal training in young well-trained soccer players. **Methods** All anthropometric measurements, physical fitness components and immune responses of eighteen ( $n=18$ ) well-trained soccer-players were evaluated in two occasions: a) immediately prior to the initiation of preparation period (pre-conditioning) and b) following the completion of the 8-weeks' training program (post-conditioning). **Results** Pre-seasonal training did not affect absolute white ( $\times 10^3/\text{micl}$ ) and red ( $\times 10^6/\text{micl}$ ) blood cells but it significantly increased relative (%) number of resting circulating blood neutrophils ( $p < 0.005$ ) and decreased blood lymphocytes ( $p > 0.005$ ). Blood monocytes, eosinophils basophils and platelets were not altered ( $p > 0.05$ ). Plasma cortisol was significantly lower at post-conditioning ( $p < 0.05$ ). Body weight, BMI, resting systolic and diastolic blood pressure and sit-and-reach flexibility all were not different between pre- and post- conditioning ( $p > 0.05$ ). HRmax and body fat % were reduced ( $p < 0.05$ ) and aerobic capacity, leg explosiveness, muscular endurance [1 min-sit-ups and 1 min-push-ups] were improved ( $p < 0.05$ ) by the end of preparation period. **Discussion** In conclusion overload pre-seasonal preparation training induced increased mobilization of relative number of neutrophils counts and decreased relative number of lymphocytes counts in young high-level soccer players. This may suggest an immunosuppression and potential susceptibility to infections. These responses may partially be explained by the physiological muscle-damaged responses to strenuous long-term exercise training. It remains however, to be determined potential physiological techniques for counterbalancing these immune responses to long-term strenuous exercise training. **References** Nieman DC, Johanssen LM, Lee JW, Arabatzis K. (1990). *J Sports Med Physical Fitness*. Pedersen BK, Hoffman-Goetz L. (2000). *Physiological Reviews*, 80(3), 1055-1081 Tuan TC, Hsu TG, Fong MC, Hsu CF, Tsai KKC, Lee CY, Kong CW. (2008). *Br J Sports Med*, 42, 11-15.

## EFFECTS OF STRENGTH TRAINING AND FISH OIL SUPPLEMENTATION ON LYMPHOCYTE ACTIVATION MECHANISMS

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**EFFECTS OF STRENGTH TRAINING AND FISH OIL SUPPLEMENTATION ON LYMPHOCYTE ACTIVATION MECHANISMS** Gorjão R.1, Barquilha G.1, dos Santos A.J.1, Momesso C.1, Curi R.1, Piñon-Curi T.C.1; Hirabara S.M.1 1Post-Graduate Program in Human Movement Sciences, Cruzeiro do Sul University, 2Department of Physiology and Biophysics, University of Sao Paulo, Brazil **INTRODUCTION** High intensity strength exercise may induce muscle damage resulting in an inflammatory response that may modulate lymphocyte activation mechanisms (1). Studies have shown that n-3 fatty acid supplementation reduces inflammatory process in subjects submitted to aerobic exercise (2). The

purpose of this study was to examine the effects of strength exercise training and n-3 fatty acid supplementation on lymphocyte activation mechanisms. **METHODS** Sixteen untrained male subjects (25 ± 5 years of age) participated in this study. The strength training protocol was performed during seven weeks, three times a week. The protocol consisted of alternation between hypertrophy and strength sessions. Eight subjects were supplemented for 2 months with 3 g/day of fish oil (FO) (54% EPA and 23% DHA). Blood was taken from trained subjects before and immediately after the first session of hypertrophy exercise. After 8 weeks of training and supplementation the blood was taken before and immediately after the session of hypertrophy exercise. CD25 expression in CD4+ lymphocytes, DNA fragmentation and membrane integrity were evaluated by flow cytometry; proliferative capacity were determined by incorporation of [2-14C]-thymidine. Akt and ERK1/2 phosphorylation were detected by western-blotting. **RESULTS** The proliferative capacity of lymphocytes decreased after the first hypertrophy session (4362 ± 370 to 2630 ± 304 cpm). After two months of training no difference was observed. The supplementation did not alter proliferation. There were no differences in DNA fragmentation and membrane integrity in any situation. Percentage of CD25 positive cells was decreased after the first hypertrophy session (22 % to 9 % of total lymphocytes) but returned to the initial values after 8 weeks of training. Akt and ERK1/2 (proteins related to lymphocyte proliferation) phosphorylation were decreased after the first hypertrophy session, however, no effect was observed in the end of the training. Likewise, fish oil supplementation had no effect. **DISCUSSION** The present study indicates that there is a reduction in lymphocyte function after a week of high intensity session of hypertrophy exercise in untrained individuals. This is due to an inhibition of intracellular pathways related to proliferation. Fish oil did not alter lymphocyte response. Moreover, the chronic training decreased lymphocyte proliferation without changing signaling pathways. This effect is probably related to an alteration in circulatory cell population leading to a lower lymphocyte self-activation. **REFERENCES** 1.Ramel et al. (2003) J Sports Sci, 21: 1001–1008. 2.Pedersen et al. (2000) Int. J. Sports Med, 21(1), 4–9. Support: Fapesp, Capes and CNPq

### LEUKOCYTE COUNTS ARE INFLUENCED BY MENSTRUAL CYCLE AND CARBOHYDRATE INGESTION IN WOMEN DURING PROLONGED EXERCISE IN A HOT ENVIRONMENT

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**Introduction** Ingesting carbohydrate drink during prolonged strenuous exercise prevents an increase in circulating leukocyte counts. This evidence suggests that carbohydrate substrate metabolism influences an immune system in such an exercise. We reported in the previous study that a menstrual cycle affects substrate oxidation in which the carbohydrate oxidation in the luteal phase was increased as compared to follicular phase. Based on these results, we hypothesized that menstrual cycle and carbohydrate ingestion affect the circulating leukocyte counts during a prolonged exercise in a hot environment. **Methods** Six healthy women with regular menstrual cycles completed total of four trials which consists of 90 min of cycling exercise at the intensity of their 50% VO<sub>2</sub>peak with the performance test afterwards in a hot environment. Each trial was performed either with the ingestion of carbohydrate drink or the placebo drink pre and during exercise at their follicular phase (FP) and luteal phase (LP), respectively. The data of the concentration of expired gas, heart rate, and rectal temperature were collected during the exercise. Blood samples were taken before and after exercise and every 30 min during exercise. **Results** The results in this study were that 1) menstrual cycle affected the leukocyte counts during prolonged exercise in a hot environment, about 37% higher in LP as contrast with in FP at 90th min of exercise, 2) ingestion of carbohydrate drink during exercise suppressed the acute increase of leukocyte and diminished the difference in increase of leukocyte counts between FP and LP, 3) the effects of menstrual cycle and ingesting carbohydrate drink in the response of leukocyte during prolonged exercise was associated with the substrate metabolism in each trial. **Discussion** It is well known that acute increase of leukocyte during exercise leads to the reduction of leukocyte after exercise as compared to pre exercise, resulted in the decrease in their immune system. Suppression of increase in leukocyte by ingesting carbohydrate might be linked with the attenuation of the susceptibility to a viral infection. Ingesting carbohydrate during prolonged strenuous exercise might be needed in women with regular menstrual cycle, especially in luteal phase, not only for a substrate supplementation but also for a prevention of decrease in their immune system.

### EFFECTS OF CIRCENCIS PHYSICAL EXERCISE ON LYMPHOCYTE ACTIVATION IN OVERWEIGHT AND EUTROPHIC CHILDREN

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**EFFECTS OF CIRCENCIS PHYSICAL EXERCISE ON LYMPHOCYTE ACTIVATION IN OVERWEIGHT AND EUTROPHIC CHILDREN** Momesso CM.1; Takeo F.2; Cassoni C.1; Cury-Boaventura MF.1 Caçula K.1; Guirado S.1; Borges CN.1 Coneglian V.2; Hirabara SM.1 ; Curi R.2; Pithon-Curi TC.1 Gorjão R.1. 1Post-Graduate Program in Human Movement Sciences, Cruzeiro do Sul University, 2Department of Physiology and Biophysics, USP, Brazil **INTRODUCTION** Obesity associated with sedentary lifestyle can lead to changes in the immune system function, resulting in the development of inflammatory diseases. The occurrence of these diseases may be related to a change in the primary control exerted by T lymphocytes on the immune system (1). The aim of this study was to evaluate the mechanisms of lymphocyte activation in overweight children, when performing or not circencis physical exercises. **METHODS** The studied group was composed by 43 children, pubescent, divided in four subgroups: Overweight Children (OWC) (10.67 ± 0.90 years old and BMI 23.02 ± 2.74); Overweight Exercise (OWE) (10.00 ± 1.41 years old and BMI 24.64 ± 3.03); Eutrophic Children (EC) (11.00 ± 1.24 years old and BMI 17.51 ± 1.98); and Eutrophic Exercise (EE) (10.60 ± 1.06 years old and BMI 16.80 ± 2.53). OWE group practiced circus activities twice a week, during six months. CD95 and CD25 expression in CD4+ lymphocytes, DNA fragmentation and membrane integrity were evaluated by flow cytometry and proliferative capacity by incorporation of thymidine. **RESULTS** A higher lymphocyte proliferative capacity was observed in OWC and OWE groups when compared to EC (3509 ± 887.2; 2694 ± 560.4 and 1768 ± 208.2 cpm, respectively). The same was observed in comparison to EE (2313 ± 111 cpm) groups. In OWC group a lower expression of CD25 was found when compared with EC and EE groups (160 ± 44.63, 355.9 ± 109.6 and 341 ± 134, respectively). On the other hand, the OWE group (363.9 ± 151.0) presented a higher expression of CD25 when compared with the OWC group. In the CD95 expression, EC (953.9 ± 101.2) and EE groups (736.7 ± 194.6) showed higher values than the OWC group (522.1 ± 125) and OWE group (551.6 ± 144.5). **DISCUSSION** The present study indicates that a modification of immune system regulation occurs in overweight children. The decreased CD25 expression and increased proliferative capacity in non-stimulated cells may indicate an unbalance in lymphocyte regulation, once CD25 is related to regulatory T cell function. These cells are involved in the suppression of excessive activation of peripheral lymphocytes. In addition, a lower expression of CD95 is related to a fail in the inhibition of excessive lymphocyte proliferation. Furthermore, although circencis activities were not able to change the lymphocyte final response, CD25 expression was increased. These alterations indicate that overweight children are more prone to develop diseases related to

immune system function. References 1.Grom AA, Hirsch R. (2000). *Curr Opin Rheumatol*. 12, 420-424. SUPPORT: FAPESP,CAPES AND CNPQ

## CHARACTERISTICS AND EVALUATION OF QUALITY OF LIFE IN A GROUP OF PATIENTS UNDERGOING CHEMOTHERAPY TREATMENT

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**Introduction** Life's quality is a wide concept which includes the individual's perspective in relation to their objectives, their satisfactions and their concerns. The identification of quality of life of the oncologic patient, currently, is a fundamental source to measure the results of the treatment in the patient's perspective. His/her assessment allows the understanding of how different therapeutic interventions influence the patients' results (NICOLUSSI, 2010). Therefore, the goal of this research was to evaluate the quality of life of a patients' group with neoplastic disturbances neoplasms who are undergoing a chemotherapy treatment in Ascomcer Hospital, located at Juiz de Fora city. **Methodology** This study has as bases the transversal descriptive analysis of people with cancer who undergo a chemotherapy treatment. There were interviewed 40 patients of both sexes and who were starting their second chemotherapy session. The interview was executed through the questionnaire of life quality 'SF36.' **Results** We observed the female predominance in relation to the male, being the average age 57,4 years old. The breast cancer was the most frequent, attacking 60% of the patients, and soon afterwards the colorrectal cancer, representing 17,5%. The Functional Capacity was the item that obtained the larger index, 69,9% and in relation to the gender it obtained the result more significant taking into account the statistics. The Practice of Physical Activity was about four times bigger in women than in men considered in this study. This result can be related directly to the functional capacity variables, general health state, vitality, social aspects and mental health, because in these the scores found obtained higher medium between the adult women in relation to adult men. **Conclusion** That investigation was able to show that the aspects regarding the multiple dimension and to subjectivity, presented in the concept of Life Quality and represented by their respective domains, can be taken as the north because of the progress of the therapeutic possibilities and also because of the improvement in the prognostics for the cancer treatment. **References** CICONELLI, R. M. et al. Translation for the Portuguese language and validation of the generic questionnaire of evaluation of life quality SF36. *Brazilian magazine of Rheumatology*. MORRIS, G. S. et al. Pulmonary rehabilitation improves functional status in oncology patients. *Archives of Physical Medicine and Rehabilitation*, Nashville, v. 90, in the. 5, p. 837-841 2009. NICOLUSSI, THE. C.; SAWADA, N. THE. Factors that influence the quality of patients' life with colon cancer and straight. *Acta From São Paulo of Nursing, Ribeirão Preto*, v. 23, n. 1, p. 125-130 2010.

## PHYSICAL EXERCISE AND PROSTATE CANCER: DESIGN AND METHODS

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**Introduction and aim** Prostate cancer (PC) growth is stimulated by the presence of androgens (testosterone). Hence androgen deprivation therapy (ADT) is an effective treatment in these patients. However, ADT has side effects, such as reduction in muscle mass and bone mineral density, increased fat mass, increased risk of fatigue and depression, as well as reduced quality of life. Physical exercise is therefore suggested as an effective counter measure against the listed side effects (1). Especially strength training, which counteracts the decrease in muscle mass and bone health, should be of great interest for prostate cancer patients undergoing ADT. To the authors best knowledge no studies has so far investigated the mechanisms behind the muscle wasting observed in ADT treated PC patients, or how cellular mechanisms are influenced by strength training. Consequently, the main aim of this part of the Physical Exercise and Prostate Cancer study (PEPC) is to investigate the effect of ADT alone or combined with strength training on satellite cells and myonuclei per muscle fiber, as well as androgen receptor and heat shock protein content in a leg muscle (m. vastus lateralis). **Study design** PEPC is a randomized clinical trial in which an exercise group (EG), following a four months supervised strength-training program aimed to improve muscular strength and hypertrophy, is compared with a control group (CG), following standard care and maintaining their habitual activity level. Patients in both groups undergoes strength tests and muscle biopsies at baseline (before first ADT injection), after six to nine months on ADT (pre-intervention assessment) and after the 16 weeks of intervention (post-intervention assessment). **Intervention** The EG perform three strength-training sessions per week, where one session is performed at 90 % of 10RM. After 2 weeks of low load familiarization to strength training, the following 14 weeks consists of 1 to 3 sets with 6-10 RM where the loads increases progressively. Nine exercises are performed: squat, leg press, standing calf raises, leg curl, leg extension, chest press, seated rowing, shoulder press and biceps curl. **Progress** Between January 2009 and February 2011, 55 patients have been included. So far 31 patients have completed the intervention; 14 in the exercise group and 17 in the control group. Eight patients have dropped out; four in the exercise group, two in the control group and two before randomization. Inclusion of patients will end during autumn 2011, and the last posttest will take place four months after. **Reference** 1. Galvao et al. *Prostate Cancer and Prostatic Diseases* 10: 340-346, 2007.

## Poster presentations

### PP-PM37 Resistance Training

## LACTATE THRESHOLD, VENTILATORY AND SURFACE ELECTROMYOGRAPHY IN RESISTANCE EXERCISE

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**LACTATE THRESHOLD, VENTILATORY AND SURFACE ELECTROMYOGRAPHY IN RESISTANCE EXERCISE** Fontana KE.1, Nasser and Smith SV.1 **FA.2** 1: Laboratory of Exercise Physiology - College of Physical Education and 2: GPDS-Electrical Engineering, University of Brasilia **Introduction** Resistance exercise (RE) has been subject of several scientific studies, because what was done only for aesthetic purposes, now stands out for its contribution in promoting health and sports. To understand the determinants of RE is necessary to analyze the phenomena under the biochemical, biomechanical and physiological factors. The objective was to identify and compare the anaerobic threshold (AT) by lactacidemia, spirometry and surface electromyography (SEMG) in RE on curl biceps. **Methods** Thirteen healthy young adults with at least two months experience in ER ( $21.3 \pm 2.6$  years) performed incremental dynamic protocol resisted graded in fractions of 1 RM.

Blood samples were collected simultaneously (lactate), ventilatory and heart rate (Cardiopulmonary Spirometry) and SEMG (linear array of 16 channels). AT was determined by visual inspection of the curve of blood lactate (Wasserman and McIlroy, 1964), ventilation and ventilatory equivalents (O<sub>2</sub> and CO<sub>2</sub>) (Wasserman et al., 1973) and by the first break point of the linearity of the curve of SEMG speed conduction of the nerve impulse average over time (CV) based on the concept of maximum likelihood (Salomoni et al., 2007). The AT was expressed and compared in terms of VO<sub>2</sub>, HR, absolute and relative workload (kg, % 1RM). The coincidence between the methods was analyzed by repeated measures ANOVA and Bland-Altman method from the perspective of validating the SEMG to AT determination. Results and Discussion It was possible to identify the AT in all three methods. The SEMG was validated when compared to lactacidemia (gold standard). Aguiar et al. (2010) and Hendrix et al. (2009) also detected AT by SEMG (RMS and MMF) in isometric ER. In dynamic ER, Barros et al. (2004) and Azevedo et al. (2005) determined the AT (lactate) around 30% 1RM, higher than that found in this study (21.5% 1RM). The anaerobic threshold may have been postponed due to the training time of the subjects measured in these studies. More studies need to be made regarding the standardization of the methodological and analytical determination of AT. References Salomoni S, Soares FA, Nascimento FA, Veneziano WH, Rocha AF (2007). IFMBE Proceedings CLAIB, 1049-1053. Wasserman K, McIlroy MB (1964). The American journal of cardiology, 14, 844-52. Wasserman K, Whipp BJ, Koyl SN, Beaver WL (1973). Journal of applied physiology, 35, 2, 236-43. Aguiar AP, Oliveira JC, Stefanelli VC, (2010). Revista Andaluza de Medicina del Deporte, 3, 2, 62-67. Barros CL, Agostini GG, Garcia ES, Baldissera (2004). Motriz, 10, 1, 31-6. Azevedo PH, Oliveira JC, Aguiar AP (2005). Edeportes, 10, 87. Hendrix CR, Housh TJ, Johnson GO (2009). Journal of neuroscience methods, 181, 1, 45-51.

## BLOOD LACTATE KINETIC IN CIRCUIT STRENGTH TRAINING

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Introduction For an interpretation of blood lactate concentration [La] in strength training it has to be known what kind of exercise structure and involved muscle mass produce and metabolize lactate. Our hypothesis is that lactate metabolism works better in repeated bouts of the same muscle group than in a combination of exercises of different muscle groups. Beside metabolism of lactate in heart, liver and brain, type 1 muscle fibres are dependent from the availability of lactate. Lactate transport in the same muscle group via cell-to-cell shuttle would predominate in multiple set training whereas lactate transport in blood during exercise of different muscle groups is handicapped by a restricted blood flow in the working muscle. The purpose of the study was to investigate the influence of a strength training with different muscle groups like Super Series or circuit strength training on [La] and lactate kinetics. Methods Ten male sport students (25±5years; 183±7cm; 76±23kg) participated at 3 different days in 3 different exercise protocols. Super Series (SS3) consisted of a 3 set agonist-antagonist exercise session i.e. Leg Extension (LE) and Leg Curl (LC). The subjects did 3 sets with 3min rest between the sets and 5s rest between the 2 exercises. The 1-set-circuit training (CT) consisted of 6 exercises i.e. LE, LC, Biceps Curl, Bench Press, Abdominal Press and Lat Machine with 1min rest between the exercises. Furthermore, 3-set-training with the Leg Extension (LE3) exercise was performed with 1min rest between the sets. Each of the bouts was performed with the 10 RM-defined additional load and a constant movement velocity of 4s per repetition. Before exercise was a warm up with 10 repetitions of 30% 10 RM. Lactate samples were taken at rest, immediately before and after each bout and 2, 4 and 6min after the last bout. Results CT leads to a continuous increase in [La]. In session LE3 [La] only increases in between the sets and is interrupted by stagnation or decrease during 2nd (3.7±1.0 to 3.5±0.6mmol/l) and 3rd (5.6±1.1 to 5.1±1.0mmol/l) set. In session SS3 [La] increases in between the sets. During the 1st and 2nd part (LE; LC) of set 2 and 3, [La] stagnates respectively decreases. Discussion The results support that multiple sets of the same muscle group (LE3) stimulate lactate metabolism of type 1 fibres in strained muscle. If muscle had high lactate production in a set before, the availability of lactate via cell-to-cell shuttle for metabolism during bout is greater than the availability via bloodstream during one after another bout of different muscle groups (CT). In alternately conducted exercises for 2 different muscle groups (SS3) lactate metabolism during set leads to stagnation of blood lactate also. Lactate metabolism in distal tissue like heart or distal seated type 1 fibres does not seem to rise in progression of exercises for different muscle groups. So CT reveals continuous increase of [La] during and in between the sets.

## ECCENTRIC EXERCISE AS A TOOL TO COMBAT OBESITY IN OVERWEIGHT INDIVIDUALS

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Introduction Most resistance exercise programs include dynamic repetitions with both concentric and eccentric muscle contractions. It has been reported that eccentric exercise can cause greater favorable changes on health parameters than concentric exercise (Pashalis et al., 2010). In addition, eccentric exercise produces less cardiovascular stress (Meyer et al., 2003) suggesting that it may be more suitable for overweight individuals. Methods Sixteen overweight females were allocated randomly into two equal-sized groups. Participants visited the laboratory once a week for four subsequent weeks to perform the isokinetic concentric or eccentric exercise protocol (5 sets of 15 maximal voluntary actions in each of their lower limbs in the seated position). Isometric, concentric and eccentric peak torque, were measured before and 3 days after the first and the last exercise session. Plasma triacylglycerols (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL) and low-density lipoprotein cholesterol (LDL) were measured at the same points. Results Muscle strength decreased at day 3 only after the first exercise session in the eccentric group. By week 4, both training sessions increased resting muscle strength. Regarding blood lipid profile all indices were favourably modified at day 3 after the first session of exercise in the eccentric group only. By week 4, the resting levels of blood lipid profile in both groups were not significantly changed. However there was a trend for favorable changes in the eccentric group only. Discussion The greater gain in muscle torque that appeared after eccentric training could be partially attributed to the greater muscle hypertrophy that follows eccentric training compared with concentric training (Farthing and Chilibeck 2003). Therefore, it seems that eccentric training can induce health-promoting effects that may improve quality of life. However, more time than four week is needed before favorable changes in blood profile appear as reported after 8 weeks of eccentric training (Pashalis et al., 2010). References Meyer K, Steiner R, Lastayo P, Lippuner K, Allemann Y, Eberli F, Schmid J, Saner H, Farthing JP, Chilibeck PD. (2003). Eur J Appl Physiol, 89:578-86. Dudley GA, Tesch PA, Miller BJ, Buchanan P. (1991). Aviat Space Environ Med, 62, 543-50. Paschalis V, Nikolaidis MG, Theodorou AA, Panayiotou G, Fatouros IG, Koutedakis Y, Jamurtas AZ. (2010) Med Sci Sports Exerc, PMID: 20508540.

## BLOOD LACTATE KINETIC IN MULTIPLE SET STRENGTH TRAINING

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**Introduction** Strength training increases blood lactate in between and after exercise. Metabolic disturbance and high lactate concentrations stand for adaptational processes in muscle. The altitude of blood lactate concentration [La] depends on production in working muscles, in particular of type 2 fibres. Furthermore, [La] depends on transportation via monocarboxylate transporter to other tissue, where lactate is used for metabolism. During exercise lactate transportation to proximal seated type 1 fibres has main relevance, because of restricted blood flow. The enhanced blood flow after exercise leads to a better distribution of lactate in body, so that lactate can be metabolized in distal tissues like heart, liver, brain and distal type 1 muscle fibers. Strained muscle volume and exercise structure influence [La] and lactate kinetic. The purpose of the study was to investigate the influence of strained muscle volume on [La] and lactate kinetics in between and after multiple sets of strength training with the same muscle group. **Methods** Ten male sport students ( $23 \pm 2$  years;  $180 \pm 5$  cm;  $73 \pm 8$  kg) men participated at 4 different days in 4 equal exercise protocols with different size of muscle volume i.e. Biceps Curl one armed (BC1), Biceps Curl two armed (BC2), Leg Extensor one legged (LE1) and Leg Extensor two legged (LE2). Each of 3 sets was performed with the 10 RM-defined load and a movement velocity of 2 s for both concentric and eccentric phase. Blood lactate samples were taken before training at rest (R) and immediately before (pre) and after (post) each set (pre 1, post 1, pre 2, post 2, pre 3, post 3) as well as 2, 4, and 6 min (post 3a, post 3b, post 3c) after finishing exercise. **Results** [La] was significantly higher after LE2 ( $6.8 \pm 1.6$  mmol/l) and significantly lower after BC1 ( $2.8 \pm 0.7$  mmol/l) in comparison with all other methods, respectively. There was no difference between BC2 ( $4.3 \pm 1.1$  mmol/l) and LE1 ( $4.4 \pm 1.1$  mmol/l). In progression of exercise procedure the post-values were getting smaller in comparison with the pre-values of each set. During the 3rd set of LE2 blood lactate concentration even decreased significantly ( $p < 0.05$ ) from pre 3 ( $5.8 \pm 1.5$  mmol/l) to post 3 ( $4.9 \pm 1.5$  mmol/l). The increase in between the sets was getting lower in exercise progression. **Discussion** It could be expected, that maximum in [La] depends on the strained muscle volume, so LE2 resulted in the highest values and BC1 in the lowest. Furthermore, higher [La] in progression of exercise session increases lactate metabolism in strained muscle, so [La] stagnated or even decreased during set 2 and 3. On the one hand lactate is metabolized particularly in heart and type 1 fibres in the strained muscle. On the other hand lactate elimination from type 2 fibres to blood is limited by restricted blood flow with the result of high peak of metabolic stress in muscle. High peak of metabolic stress in muscle could be one important factor for adaptational processes in strength training.

## STRENGTH TRAINING CONTROL BY MEANS PEAK POWER CRITERIA IN ELITE FUTSAL SPANISH PLAYERS DURING A SEASON

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**Introduction** Training in athletes with peak power criteria has been proposed in some studies (Izquierdo et al., 2002; 2004). It has been suggested that linear encoder may be valid to control muscle power adaptations in sport (Gaasvaer & Bahr, 1999). Nevertheless, there do not exist any study that had controlled the strength training by means peak power criteria in elite Futsal players. Thus, the purpose of the present study was to control the strength training by means the criteria of peak power in leg press during a training season. **Methodology** 12 elite Spanish futsal players carried out three progressive test in leg press at 20, 40, 60 and 80% 1RM estimated (Brzycki, 1993). Mechanical power (expressed in watts (W)) of each repetition was measured and recorded by means Muscledab system (Ergotest innovation, Norway). Power curves were plotted using average power over the whole range of movement in concentric mode in leg press. The first test was carried out at the beginning of the training season (T1), the second one 3 months after (T2), and the third one 6 months after respect to the first one (T3). The average of the peak power of each repetition of all trainings during the whole season were quantified (TL1: training load corresponding to 2 months before the first test, TL2: training load corresponding to 3 months before the second test, and TL3: training load corresponding to 3 months before the third test). All players performed 1 or two strength training sessions per week at the gym in leg press (3 sets of 5 repetitions, around 90% of peak value of power: T1:  $91 \pm 4\%$ , T2:  $89 \pm 6\%$ , and T3:  $91 \pm 4\%$ ) during the whole training season. Comparisons between variables were made by means a repeated measured ANOVA. Statistical significance was set at  $p < 0.05$ . **Results** Peak power training was controlled during all training season (LT1:  $1132 \pm 139$  W, LT2:  $1153 \pm 141$  W, and LT3:  $1171 \pm 140$  W), although during LT3 players performed higher training intensity respect to LT1 ( $p < 0.01$ ). It was not found significant differences for peak power expressed in kg (T1:  $137 \pm 11$  kg, vs. T2:  $145 \pm 7$  kg, and T3:  $144 \pm 6$  kg). In spite of there were no significant differences for peak power between T2 ( $1212 \pm 114$  W) and T3 ( $1229 \pm 130$  W), there were differences between T1 vs. T2 ( $1156 \pm 133$  W vs.  $1212 \pm 114$  W,  $p < 0.05$ ) and T1 vs. T3 ( $1156 \pm 133$  W vs.  $1229 \pm 130$  W,  $p < 0.05$ ). Then peak power increased 4.6% and 5.9% since T1 vs. T2 and T1 vs. T3, respectively. **Conclusions** The present study suggests that to perform 1 or 2 strength training sessions around 90% of peak power is sufficient stimulus to improve peak power in elite futsal players at least until the middle part of the training season. **References** Brzycki M. (1993). JOPERD, 64, 88-90. Gaasvaer JI, Bahr R. (1999). Med Sci Sports Exerc, 31(5), S280. Izquierdo M, Ibáñez J, Häkkinen K, Kraemer WJ, Ruesta M, Gorostiaga EM. (2002). J Sports Scie, 22, 465-478. Izquierdo M, Häkkinen K, Gonzalez-Badillo JJ, Ibáñez J, Gorostiaga EM. (2002). Eur J Appl Physiol, 87, 264-271

## BLOOD LACTATE CONCENTRATION DURING THREE DIFFERENT CIRCUIT WEIGHT TRAINING PROTOCOLS IN MEN AND WOMEN

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(Clinical trial gov number: NCT01116856) **Introduction** Differences in lactate concentration between genders have been quantified during resistance exercise 1, but never during Circuit Weight Trainings (CWT), neither comparing different protocols at the same intensity. Therefore, the aim of this study was to compare venous blood lactate concentrations in men and women during three different CWT. **Methods** 15 men ( $22.53 \pm 2.59$  years;  $76.66 \pm 6.45$  kg;  $177.21 \pm 3.77$  cm) and 14 women ( $20.14 \pm 2.88$  years;  $60.38 \pm 5.43$  kg;  $164.36 \pm 5.06$  cm), all healthy, non-smoking and active, performed three different CWT: Machine Circuit (CM), Free Weight Circuit (FW) and Combined Aerobic-Free Weight Circuit (CE). The CWT consisted on three laps of eight 8 exercises, trying to involve the same muscular groups. The intensity was set at 70% of 15 RM and 70% of the HRR during the aerobic phases. Venous blood samples were analyzed immediately after each lap and every two minutes in the recoveries between laps, using the YSI 1500 SPORT lactate analyser. Three way ANOVA with repeated measures was used to determine differences between protocols and genders. The significant level was set at  $\alpha \leq 0.05$ . **Results** We found interaction among gender, protocol and measurement ( $F(8.554) = 4.524$ ,  $p < 0.001$ ). The analysis showed significant higher lactate values

for men in all the measurements ( $p < 0.001$ ), and significant lower concentrations in CE compared to the others protocols ( $p < 0.001$ ). Furthermore, we found some significant differences between MC and FWC, especially at the end of the session. Discussion Our data are in agreement with previous studies, reporting higher values in men than in women 1-2. This could be due to the higher fibre I muscle percentage in women 3, the hormonal state 4-5 or the greater relative external load lifted by men 2. We have also found less lactate concentration during CE, perhaps due the aerobic phase that helped lactate oxidation 6-7. Therefore, we can conclude that during CWT men have higher lactate concentrations than women, and that anaerobic contribution depends not only on the intensity of the session but also on the protocol used, and this influence is presented in both genders. References 1. Bellezza, PA, et al. J Strength Cond Res (2009); 23: 203-8. 2. Scott, C, et al. JEPonline (2008); 11: 56-63. 3. Staron, RS, et al. J Histochem Cytochem (2000); 48: 623-9. 4. D'Eon, TM, et al. Am J Physiol Endocrinol Metab (2002); 283: E1046-55. 5. Ellis, GS, et al. J Appl Physiol (1994); 77: 209-15. 6. Gladden, LB. Med Sci Sports Exerc (2008); 40: 477-85. 7. Miller, BF, et al. J Physiol (2002); 544: 963-75.

## HUMAN SKELETAL MUSCLE REMODELING WITH ECCENTRIC AND CONCENTRIC TRAINING

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**Introduction** Muscle hypertrophy and strength gain are the most evident consequences of concentric and eccentric resistive training. The responses to these two training modes may only be compared for loading protocols matched for neural activation. This fundamental requirement, stipulated by the FORCE-VELOCITY relation [1, 2], is normally not met by conventional resistance training, since the same absolute load is displaced in the concentric and eccentric phases. Hence motor units must necessarily be de-recruited in the eccentric phase to enable the load to be lowered. Therefore, the aim of the study was to investigate the structural and functional adaptations of human skeletal muscle (Vastus Lateralis - VL) in response to pure eccentric and concentric training when matched for neural activation. **Methods** Twelve young healthy males were assigned to a pure concentric (CG) or pure eccentric (EG) resistance-training group. Training consisted of 4 series of 8-10 repetitions with a load of 80% of the concentric (CG) or of the eccentric (EG) 1RM performed on a leg-press machine (Technogym). Maximum voluntary isometric contraction (MVC) torque was measured from 90° to 150° of knee extension. Muscle volume (VOL) was measured using MRI and muscle architecture (fascicle length, Lf, and pennation angle) was assessed in vivo by ultrasonography. Results Training increased muscle volume in both groups, but the increase was two-fold greater in the CG (10%) compared to the EG (5%); an increase in fascicle length was observed in both groups but significantly greater in the EG (12%) compared to the CG (5%). Conversely, pennation angle increased more in the CG than in the EG (30% and 5% respectively). Physiological cross-sectional area (PCSA) increased by 5% in the CG but paradoxically decreased in the EG after the training period, may due to the relatively greater increase of Lf compared to muscle volume in the EG. Isometric MVC increased similarly after both types of training (CG = 9%; EG = 11%). Discussion These findings show that eccentric and concentric training, when matched for neural activation, lead to markedly different structural adaptations of human skeletal muscle. This observation suggests that separate myogenic mechanisms are triggered by the two of contraction modes. This hypothesis seems consistent with findings of different muscle cell signaling responses to concentric and eccentric loading in animal skeletal muscle [3, 4]. References 1-Hill AV. Proceeds of Royal Society B, vol. 126:136-195, 1938 2-Katz B. J.Physiol. 1939; 96; 45-64 3-Wrethman C et al. J Physiol 535: 155-164, 2001 4-Martineau and Gardiner. J Appl Physiol 91(2):693-702, 2001

## CHANGE IN THE IMMEDIATE POST-EXERCISE BLOOD PRESSURE RESPONSE AFTER ISOMETRIC EXERCISE TRAINING AND ITS RELATIONSHIP WITH REDUCED RESTING BLOOD PRESSURE

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**Introduction** The cessation of exercise is known to provide a unique challenge to blood pressure control. There have been suggestions that this challenge might provide the stimulus for reductions in resting blood pressure following isometric training. Therefore, there were two purposes to this study (a) to identify changes in the immediate post-exercise blood pressure responses (IPER) before vs. after isometric training and (b) to relate these changes to the training-induced reductions in resting blood pressure. **Methods** 11 subjects were asked to participate in a 4-week double-leg isometric training study. Before and after the training the immediate post-exercise blood pressure response (IPER) to 2 minutes of double-leg isometric exercise at 22%MVC was investigated. Systolic (SBP), diastolic (DBP) and mean arterial (MAP) blood pressures were recorded continuously using finger plethysmography (Finometer). Individual blood pressure values were established at 20s intervals throughout a 5 minute post-exercise period and pre- to post-training changes in IPER at 1, 2, 3, 4 and 5 minutes were established and correlated with reductions in resting SBP, DBP and MAP after training. Results The 5-minute IPER appeared to be tri-phasic, with the greatest relative change in IPER, after training, at 2 minutes ( $-3.11 \pm 7.58\%$ ). However, this relative change was not correlated with the reductions in resting blood pressure. Rather, the 5-minute IPER relative change after training, although much smaller, was strongly correlated with the reductions in resting SBP ( $r=0.76$ ;  $p<0.01$ ). Discussion These findings raise the possibility that (i) the mechanism responsible for the reductions in resting blood pressure after isometric training might involve physiological systems similar to those involved in the IPER (ii) the 5-min IPER could be used as a simple indicator of the efficacy of isometric training in reducing resting blood pressure and (iii) accentuating the post-exercise blood pressure challenge might enhance the reductions in blood pressure observed after isometric training.

## RESISTANCE TRAINING WITH LOWER VELOCITY LOSS WITHIN A SET PRODUCES GREATER STRENGTH GAINS COMPARED WITH HIGHER VELOCITY LOSS

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**RESISTANCE TRAINING WITH LOWER VELOCITY LOSS WITHIN A SET PRODUCES GREATER STRENGTH GAINS COMPARED WITH HIGHER VELOCITY LOSS** Pareja-Blanco, F.1, Sánchez-Medina, L.1, Suárez-Arrones, L.1, González-Badillo, J.J.1 1:UPO (Seville, Spain) **Introduction** One variable whose role has not been sufficiently investigated when designing resistance training (RT) programs is movement velocity (Izquierdo et al., 2006). We have recently shown that velocity loss can be used to quantify neuromuscular fatigue during RT (Sánchez-Medina and González-Badillo, 2011). This study aimed to examine the effect of training with different mean repetition velocity losses on strength performance. **Methods** Sixteen strength-trained male professional soccer players (mean(SD): age 23.8(3.5) yr, body weight 75.0(8.5) kg, body fat 11.8(1.9)%, muscle mass 48.3(1.9)%), were randomly assigned to one of two groups: 15% (V15; n=8) or 30% (V30; n=8) velocity loss. Subjects trained during 7 wk for a total of 18 sessions following a periodized RT program using the full squat. The two groups trained at

the same relative intensity in each session (increasing from 50% to 70%RM over the course of the study) but differed in the maximum percent velocity loss allowed in each set (15% vs. 30%). When this limit was exceeded the set was terminated. Subjects were required to perform each repetition at maximal velocity. Velocity was monitored in each session and visual and auditory feedback provided in real time by means of a linear velocity transducer sampling at 1,000 Hz (T-Force System, Ergotech, Spain). A t-test for paired samples was used to compare mean differences between groups. Results Both mean number of repetitions per set (6.0 for V15, 10.6 for V30) and total number of repetitions performed (260.3 for V15, 435.1 for V30) were significantly lower for V15. Following training, the V15 group obtained significant increases ( $p < 0.05$ ) in 1RM strength (12.7%), maximum (13.5%) and mean power output (9.9%), whereas for V30 there were no significant increases in any of the variables analyzed. Discussion These findings indicate that short-term velocity-based resistance training using a 15% velocity loss limit seems to produce greater neuromuscular performance improvement compared to a 30% velocity loss limit in experienced professional soccer players. Conceptually, this would stress the importance of finding the optimal training volume during RT. The results suggest that performance improvements can be compromised when a given threshold of training volume is exceeded (González-Badillo et al., 2006) and that using a moderate number of repetitions not to failure provides a favorable environment for achieving greater strength increases. References González-Badillo JJ, Izquierdo M, Gorostiaga EM (2006). J Strength Cond Res, 20(1), 73-81. Izquierdo M, González-Badillo JJ, Hakkinen K et al. (2006). Int J Sports Med, 27(9), 718-724. Sánchez-Medina L, González-Badillo JJ (2011). Med Sci Sports Exerc. DOI:10.1249/MSS.0b013e318213f880

## EFFECT OF KETOGENIC DIET ON EXPLOSIVE STRENGTH PERFORMANCE IN ELITE ARTISTIC GYMNASTS

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Introduction Despite the increasing use of low carbohydrates/ketogenic diets (KD) on weight control and management of metabolic syndrome (Westman et al., 2007) there are paucity of researches about effects of KD diets on sport performances (Phinney et al., 1983a, 1983b). KD diets maybe useful in sports with weight class divisions. The aim of our study was to investigate the influence of KD on explosive strength performance, specifically in elite artistic gymnasts. Methods 8 male subjects (age 20.9 +/- 5.5 yrs) were recruited. Several physical and performance tests (body composition analysis, hanging straight leg raise, ground push up, parallel bars push up, pull up, squat jump, countermovement jump, 30 sec continuous jumps) were administered before and after 20 days of KD with support of phytoextract (Tisanoreica Diet; Paoli et al., 2010). During the KD the athletes consumes less than 20g of CHO per day and performed the normal training program. After three months the same protocol of tests (during a similar training period) was performed before and after 20 days of typical mediterranean diet. Results We utilized a repeated-measure t-test. No significant differences were detected between KD and Mediterranean diets in Squat Jump, countermovement jump, parallel bars push up and pull up but there are nearly significant increase during KD in ground push up and hanging straight leg. A more clear significant differences were detected on body composition: after KD there was a decrease of Kg of fat (from 4.95 +/- 1.05 to 3.92 +/- 1.05  $p < 0.019$  and a decrease of fat percentage (from 7.40 +/- 1.43 to 5.74 +/- 1.43  $p < 0.01$ ) with a contextual slightly but non significant increase in muscle mass. Discussion Despite concerns of coaches and doctors about the possible detrimental effects of low carbohydrates diets on performances and the well known importance of carbohydrates on performance (Maughan et al., 1997) there are no data about KD and explosive strength performance. The undeniable and sudden effect of KD on fat loss maybe useful for those athletes who compete in sports based on weight class. We've demonstrated that using KD for a short time period (i.e. 20 days) has no negative effect on explosive strength performance. References Maughan RJ et al., (1997). J Sports Sci, Jun;15(3):265-75. Paoli A et al., (2010). Agro Food Ind Hi Tec July/August 2010;21(4):24-29. Phinney SD et al., (1983b) Metabolism. Aug;32(8):769-76. Phinney SD et al., (1983a). Metabolism, Aug;32(8):757-68. Westman EC et al., (2007). Am J Clin Nutr, Aug;86(2):276-84.

## ENERGY EXPENDITURE INCREASES AFTER STRENGTH TRAINING IN COMBINATION WITH PROTEIN SUPPLEMENTATION IN NON-STRENGTH-TRAINING ADAPTED HEALTHY SUBJECTS

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Introduction: It is well known that post-exercise energy expenditure (EE) is increased after high-intensity resistance training (HRT). One study recently could demonstrate that protein supplementation could additionally increase 24h- and 48h-EE after a single strength-training bout in strength-training adapted people. However, it is not clear whether this effect also exist in non-strength-training adapted moderately trained sport students. Therefore, the aim of this study was to investigate the additional effects of an oral protein supplementation plus an acute bout of HRT on acute and longer-lasting EE. Methods: Six healthy resistance-untrained sport students (four men and two women) participated in a blind cross-over-design. All subjects completed a protein trial (PROT) and a placebo trial (PT) in a randomized order. REE and RER were measured on three consecutive days at the same time in the morning (7:00, 8:00, or 9:00 a.m.). On the first day after baseline measurements, subjects consumed a protein-rich (PROT) liquid supplement (13.7 g of carbohydrate, 0.9 g of fat, 38.2 g of protein; 205 kcal (mean ± sd), or placebo (PL) liquid supplement (13.7 g of carbohydrate, 0.9 g of fat, 9.7 g of protein; 103 kcal (mean ± sd) 30 min before a single bout of HRT (6 exercises, 4 sets, 12 reps., 70% 1-RM). REE and RER were measured 24h and 48h after HRT using indirect spirometry. Immediately after HRT, EE was measured for 3.5 h at fixed time points, again using indirect spirometry. Results: Energy expenditure during the training was the same for HRT after PROT and PL (EE (kcal/kg/day): PROT: 120.6±9.0, PL: 122.1±8.5). REE was significantly elevated 24h and 48h after PROT and HRT ( $p \leq 0.05$ ), while REE was only elevated 24h after HRT in PL ( $p \leq 0.05$ ), but not 48h later (baseline-, 24h-, and 48h-values for REE (kcal/kg/day): PROT: 24.1±0.8, 28.5±1.6, 27.5±1.3; PL: 24.6±1.2, 26.3±2.3, 25.0±1.6). Acute post-exercise EE was significantly higher in PROT as compared to PL from 0.25h to 0.75h and from 1.75h to 2.25h after HRT ( $p \leq 0.05$ ). We could not detect any differences in RER in both PROT and PT 24h or 48 h after HRT compared with baseline ( $p > 0.05$ ). Conclusions: The intake of a protein-rich energy supplementation lead to a longer-lasting increase in energy expenditure after one single bout of high resistance training in non-strength-training adapted sport students, indicating ongoing muscle-building processes when amino acid availability is high enough. This study clearly supports the concept of combining strength training and protein supplementation even in non-strength-training-adapted moderately trained people.

## Poster presentations

### PP-PM38 Children and Physical Activity 1

#### LONGITUDINAL CHANGES IN PHYSICAL ACTIVITY OVER TWO YEARS IN YOUNG CHILDREN

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Background: Limited information is available about changes over time in objectively measured daily physical activity in young children. This study evaluates if accelerometer-measured physical activity tracks or changes over two years. Methods: Daily physical activity was assessed by the Actigraph accelerometer for four consecutive days in 167 children (boys n=90, girls n=77) aged 7.9-11.1 years at baseline. Follow-up measurements were performed 2.0±0.1 yrs later (range 1.9-2.1 yrs). General physical activity (GPA) was considered to be mean count per minute. Minutes of light physical activity (LPA), moderate physical activity (MPA), moderate and vigorous physical activity (MVPA) as well as vigorous physical activity (VPA) per day were calculated. Results: Spearman rank order correlation indicated low-moderate tracking of MPA, MVPA, VPA in both boys and girls, and GPA in boys ( $R=0.24-0.40$ ,  $P<0.05$ ). No significant tracking was detected for LPA, and GPA in girls. Several physical activity variables were lower at follow-up: In girls; LPA (-12%), and in boys; GPA (-14%), LPA (-10%), and VPA (-27%). Conclusion: This study shows that accelerometer-measured physical activity tracks at a low-moderate degree from age 10 to age 12 years. It is of concern that several physical activity variables were lower at follow-up in both boys and girls.

#### OBESITY INDICES AND PHYSICAL SELF-DESCRIPTION OF SECONDARY SCHOOL CHILDREN AGED 13 TO 15 YEARS OLD

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Introduction Obesity often leads to changes in personality and behaviour of children as manifested in the form of depression, withdrawal and low self-esteem (Biddle & Armstrong, 1992). The self in adolescence is shaped primarily by social interactions of adolescents, through which the self-image is changing to respond to differences between the way that they perceive themselves and the reactions of others. The aim of the present study was to assess the obesity idiocies and physical and global self-esteem of overweight/obese adolescents. Methods 125 healthy pupils (52 males and 73 females), aged 14.5±0.8 yrs, participated in the study and were divided according to their gender (male, female) and their obesity (normal, overweight/obese) as defined by IOTF criteria (Cole et al., 2000). Anthropometrical measurements (BMI, body composition, abdominal circumference) were obtained and a physical self-description questionnaire (PSDQ) was applied which composed on seventy questions about strength, body fat, activity, endurance and fitness, sport competence, coordination, health, appearance, flexibility, general physical self-concept, and self-esteem (Marsh et al., 1994). Results From the PCA analysis, six components were extracted, with eigenvalue above 1, explaining 69.84% of the total variance, and were labelled in the following order: 1-Physical self-esteem (16.81%), 2-Low Self-Esteem (15.85%), 3-Total self-esteem (13.75%), 4- Sports Competence (12.96%), 5- Endurance (5.87%) and 6-Health (4.59%). The data analysis showed that there are significant differences between males and females in physical self-perception factors ( $p<0.01$ ) and low confidence ( $p<0.05$ ). Also, significant difference were observed among overweight/obese and normal body mass children in their views concerning physical fitness ( $p<0.05$ ), total self-esteem ( $p<0.05$ ) and low confidence ( $p<0.001$ ). In addition, Pearson correlation coefficients showed statistically significant association of BMI with physical factors of self-esteem ( $r=-.294$ ,  $p<0.01$ ) and low self-esteem ( $r=.704$ ,  $p<0.001$ ). Similar correlations showed respectively, the percent body fat ( $r=-.315$  &  $r=.458$ ,  $p<0.01$ ), while the abdominal circumference was associated only with low confidence factor ( $r=.543$ ,  $p<0.001$ ). Discussion These results indicate that overweight/obese children differ in overall self-esteem than children with normal body mass. Moreover, the fact that indicators of obesity were associated significantly with the physical self-esteem and low self-esteem suggests that exercise and participation in various types of physical activity can modulate the levels of perceived athletic competence and self-esteem enabling overweight/obese teenagers to reinforce the image of their physical and overall self-esteem. References Biddle S & Armstrong N (1992). SSM, 34(3):325-331. Cole TJ, Bellizzi MC, Flegal KM, & Dietz WH (2000). BJSM, 320:1-6. Marsh, HW, Richards, GE, Johnson, S, Roche, L, & Tremayne, P (1994). JSEP, 16:270-305.

#### CHILDREN'S PHYSIOLOGICAL AND METABOLIC RESPONSES TO GUIDED ACTIVE PLAY

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Introduction Many suggest that play is the single most effective strategy for increasing physical activity among children and adolescents (Active Healthy Kids Canada, 2009). Whether children's games, when organized into a guided active play (GAP) session, sufficiently engages children in moderate-vigorous (MVPA) to vigorous (VPA) physical activity, is uncertain. The purpose of the study was to determine the volume (kcal) and intensity (kcal/min, METs, %HRM) of 10 children's games on different days (r). Methods Children (9.8±0.9 yrs) were assessed for VO<sub>2</sub>, HR, VCO<sub>2</sub>, RER, energy expenditure (EE) and METs on a treadmill (for 3 min each at 4, 6 and 8 km/h (0% grade)). Accelerometers were validated and equations estimated kcal and METs of 10 games performed during 4 guided active play sessions (1hr each). Results Average EE across all games was 0.055±0.011 kcal/kg/min of playing; with a range of 0.039 kcal/kg/min to 0.071 kcal/kg/min of GAP ( $p<0.05$ ). HR averaged 75% HRM, with a range of 53-89%HRM. Percent of time playing at moderate (4.5-6 MET) and vigorous (>6 MET) activity ranged from 14% to 36% ( $p<0.05$ ) across all games. Volume and intensity levels of the same games played on different days were similar ( $p>0.05$ ). Discussion This study confirms the potential benefits of guided active play to positively contribute to the caloric expenditure and intensity levels required of children and adolescents in support of health and fitness. Moreover, guided active play creates an environment that allows for the amount and intensity of physical activity for children playing self-directed games to be similar from one session to the next. These results are encouraging considering they were accomplished in a safe, fun and social environment that supports the development of a child's self-confidence in relation to being physically active. It has been reported that participating in a free a guided active play environment contributes positively to a child's self- confidence and social development and contributes to their satisfaction with participation (Henle, 2007). References Active Healthy Kids Canada. The active healthy kids Canada report card on physical activity for children and youth. Retrieved from [http://www.activehealthykids.ca/ecms.ashx/ReportCard2009/AHKC-Longform\\_WEB\\_FINAL.pdf](http://www.activehealthykids.ca/ecms.ashx/ReportCard2009/AHKC-Longform_WEB_FINAL.pdf) Henle S. (2007). Introduction to play. In R. McCarville & K. MacKay (Eds.), Leisure for Canadians (pp. 15-22). State College, PA: Venture Publishing. Supported by funding from GlaxoSmithKline.



### CORRELATION BETWEEN OBESITY, FITNESS AND BEHAVIORAL FACTORS IN SCHOOLCHILDREN OF CITY OF FRANCA-SP, BRAZIL.

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 1: UNIFRAN (FRANCA-SP), 2: UNIARAXÁ (ARAXÁ-MG), 3: UNAERP (RIBEIRÃO PRETO-SP), 4: FESP-UEMG (PASSOS-MG), 5: FMRP-USP-NEUROLOGIA (RIBEIRÃO PRETO-SP), 6: UNESP (BAURURU-SP)

**Introduction** The substantial increase in the prevalence of obesity and its related diseases such as heart disease, hypertension and diabetes is due largely to the two variables are behavioral: low levels of habitual physical activity and sedentary behaviors. This study sought to identify the relation between obesity, usual level of physical activity and sedentary behaviors in schoolchildren aged 11 to 12 years in the city of Franca- SP. **Methods** Participated of the study 77 students of three public schools. Were used as indicators of obesity the body mass index (BMI), fat percentage and waist to hip ratio (WHR). The usual level of physical activity and sedentary habits were estimated by cardiorespiratory fitness assessed by the Cooper test and questioner. To analyze the relationship between obesity and behavioral factors (physical activity and sedentary habits) and cardiorespiratory fitness test was used Pearson correlation. The analysis was conducted using the statistical software GraphPad InStat® for Windows® and the significance value of 0.05 was adopted for all statistical procedures. **Results** The percentage of obesity found in the sample was 10.4%, 7.8% and 22.1% according to BMI, fat percentage and WHR, respectively. With respect to cardiorespiratory fitness, 62.3% of students fell into category 'Low'. Of the three measures of body fat used in the study, two were highly correlated with the level of physical fitness: BMI and fat percentage. The observed association with WHR was not significant. **Discussion** The negative correlation between cardiorespiratory fitness and obesity supports the hypothesis that excess weight has an inverse relationship with the level of cardiorespiratory fitness. This fact can be explained because children are overweight spend much energy and greater efforts in the movement of their bodies that is outside the normal range, compared to their non-obese peers. This condition seems to discourage the obese children the practice strenuous and/or long-lasting activities, thus contributing to a vicious cycle of weight gain.

### INFLUENCE FACTORS ON PHYSICAL ACTIVITY PROGRAMS PARTICIPATION AMONG DIFFERENT AGE'S GROUPS

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**Introduction:** Despite the implementation of a several global and local policy strategies to promote physical activity (PA), the most European adults are insufficiently physically active for optimal health benefits. Investigation considers identification of preferences and individual goals regarding exercise programs one of the main aspects that influence PA participation patterns (Buman et al., 2010). The aim of this study was to evaluate the participation level on local exercise programs and compare the most valued factors that influence the participation on those programs, among different age's groups. **Methods:** The study included a randomly recruited sample of 745 subjects (53% males and 47% females), classified in 4 age groups: young(Y) (15-24years, n=185); young adults(YA) (25-39years, n=182); adults(A) (40-60years, n=201); older(O) (>61years, n=177). A survey was specifically designed to evaluate the participation on local exercise programs and to examine different factors (personal, environmental and program-related) associated to exercise participation. This survey was applied on interview form using a Likert scale (1-5). Age groups were compared used Chi-Square test (95%) and the factors proportions for dependents groups were compared used Cochran's Q test (95%). **Results:** 82±2% of sample rarely or never participated on the local exercise programs and the regular participation level tends to decrease with the age with significant differences after 40 years age (Y-13%; YA- 11%; A-5%; O-7%). No significant age differences were found for the following factors: price (47±2% ), structures facilities (47±3%), instructors formation (33±4%) and uninteresting activities (24±3%). However, lack of time (71±4%), scheduling (57±5%) and teaching methodology (34±1%) are significantly more appointed by Y, YA and A groups. Local proximity (37%) is significantly more referred by older people (O) (p<0.05), and social environment is more suggested by YA age group (21%) (p<0.05). **Discussion:** Despite the several health benefits from exercise, the majority of the subjects show a very low participation level on local exercise programs. Lack of time, price and scheduling are the most important influence factors found in this study, according with Epstein and Roemmich (2001). However the results indicated that the type of physical activities and the teaching methodology could also influence on exercise programs participation. Some differences on participation factors were found among age's groups, according their needs and social characteristics. These factors must be considered on exercise programs prescription to create a stronger motivation and adherence to a active live style. **References:** Buman P, Daphna L, Yasova P, and Giacobbi Jr (2010). Descriptive and narrative reports of barriers and motivators to physical activity in sedentary older adults. *Psyc. of Sport Exerc.*, 11, 223-230; Epstein L and Roemmich J(2001). Reducing sedentary behavior: role in modifying physical activity. *Exer.Sport Sci.Rev.*,29(3), 103-108;

### INVESTIGATING THE DIFFERENCES BETWEEN OBESE AND NON-OBESE CHILDREN ON PHYSICAL ACTIVITY

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**Introduction:** There is an increasing prevalence of obesity among children (1). While some studies have examined the association between physical activity (PA) as a behavioral risk factor and overweight in older children, few studies have been conducted in young children (1). There are diverging findings in previous studies of PA and obesity in children, because of the different methods that have been used to assess daily physical activity. Eston et al. (2) have been shown that a triaxial accelerometer provides the best assessment of activity in children. The purpose of this study was to investigate the differences between obese and non-obese children 7-8 years old on PA with the use of triaxial accelerometer. **Method:** Seventy two children (age  $7.6 \pm 0.4$ ) participated in this study. BMI was used as obesity indicator. Children were categorized as non-obese (G1) and overweight/obese (G2) group, according to the age-adapted values. Daily PA was assessed by RT3 (Stayhealthy Inc, Monrovia, CA) for 4 consecutive days (two weekdays and a weekend). Total daily counts were calculated. Activity counts were classified according to moderate (3-5.9 METs) and vigorous (>6 METs) intensities. Analysis of variance with repeated measures was used to assess differences in total daily PA and in the average time spent in moderate and vigorous PA through four different days, according to BMI status. **Results:** There were no significant differences in the average daily total counts of PA and in the average daily minutes of moderate and vigorous activity in G1 and G2 but there were significant differences in minutes of moderate and vigorous activity between weekdays and weekend in both groups (P<0.05). The frequency of G1 who met the international recommendation of one hour of moderate to vigorous activity per day was 96.9% on weekdays and 90.65% at the weekend. However, the frequency of G2 was 92.6% on weekdays and 83.35% at the weekend. **Discussion/conclusion:** To our knowledge, this is the first study which has examined objectively measured PA of non-obese and overweight/obese children 7-8 years old with triaxial accelerometer.

From our results it seems that at this age PA is not the main contributing factor in childhood obesity. However, a non-significant trend of fewer minutes spent in moderate and vigorous PA in higher BMI categories and the smaller frequency of overweight/obese children who met the recommendation of 60 minutes of moderate to vigorous activity per day, shows that intervention PA programs should be planned for overweight/obese children even at a young age, and with special focus on more activity at the weekend. References: 1. Metallinos-Katsaras ES, Freedson P, Fulton J, Sherry B. (2007). Obesity, 15, 686-694 2. Eston R, Rowlands A, Ingledew D. (1998). J Appl Phys, 84(1), 362-371

### ASSOCIATIONS BETWEEN CHANGE OF PHYSICAL FITNESS AND CHANGE OF LIFESTYLE HABITS IN JAPANESE ADOLESCENTS: AN EXAMINATION OF THE DOSE-RESPONSE RELATIONSHIP

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**Introduction** Most studies related to lifestyle habits of adolescents have focused on associations with health outcomes. It has been reported that there are associations between physical fitness and several health outcomes in adolescents (Ortega et al., Int J Obes 2008, 32: 1-11). However, literature focusing on the association between physical fitness and lifestyle habits, and the dose-response relationship, is scarce. And also, there is a need for longitudinal studies, since the previous study was based on a cross-sectional survey which provided only limited information about the changes in lifestyle habits and the physical fitness of adolescents. Therefore, the purpose of this study was to examine the associations between a change of lifestyle habits and a change of PF in Japanese adolescents, and to clarify the dose-response relationship. **Methods** The participants were 279 Japanese adolescents aged 11-13 (145 boys, and 128 girls). Data were collected three times; once a year over a three-year period. Survey items included eating habits (3-point ordinal scale: eating breakfast every day; 3, sometimes; 2, never; 1), physical fitness (Japan Fitness Test: Grip Strength, Sit-ups, Sit & Reach, Side Steps, 20m Shuttle Running, 50m Dash, Standing Long Jump, and Handball Throwing). Physical fitness in participants was graded into five categories according to norm-referenced criteria. A chi-square test and A latent growth modeling (LGM) were used to examine the influence of the change in lifestyle habits score to a change in a physical fitness score. In the LGM, the intercept term provides the initial level of scores and the slope describes how much a score was changed from initial value over time (Park and Schutz, RQES 2005, 76: 176-192). Statistical significant was set at .05. **Results** The results of a chi-square test showed that there were two significant associations; the first between being poorly-fed (having poor eating habits) and a decline in total fitness score (Chi-square (4) = 10.40,  $p < .05$ ), and the second between the decline in TV/video game viewing time and improvement in the total fitness score (Chi-square (4) = 22.89,  $p < .05$ ). Results for LGMs indicated good fits to the data (e.g., CFI = 1.000, RMSEA = .000, respectively). A latent growth model analysis revealed that an improvement in eating habits was significantly related to an improvement in the total fitness score (Unstandardized coefficient: 1.13, SE = .55). **Conclusions** These findings, which are limited to the statistical method used in the study, might suggest the following: 1) changes eating habits and TV/video game viewing habits are associated with a change in physical fitness, 2) the annual increase in the rate of the total fitness score in the group that improved eating habits was 1.13 points higher than the other groups. This study was supported by the Japan Society for the Promotion of Science (Grant-in-Aid for Young Scientists B: 21700673).

### LOWER LIMB POWER IN OVERWEIGHT AND NORMAL WEIGHT CHILDREN

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Ferunaj, P., Çina, R., Erindi, A. University of Sports, Tirana (Albania) **Introduction** It is obvious that physical inactivity is a contributing factor for childhood overweight (1) and low physical fitness (2). During their leisure time children perform more short term high-intensity exercises, such as jumping events or racket sports than long-term activities (3). Very few studies reported the relationship of body weight with anaerobic power in children, expressed in jumping. **Methods** A random sample of 40 Albanian children (boys,  $n = 20$ ; girls,  $n = 20$ ) with mean age  $11 \pm 0.47$ , was divided into an 'overweight' and 'non-overweight' based on body mass index, lower limb power was assessed by ergo jump in Squat Jump (SJ) and counter movement jump (CMJ). In 'non-overweight children (G1;  $n=23$ ) BMI between 18.5 kg.m<sup>-2</sup> and 20 kg.m<sup>-2</sup>; and in 'overweight' (G2;  $n=17$ ) BMI was between 24.5 kg.m<sup>-2</sup> and 26.5 kg.m<sup>-2</sup>. **Results** Overweight girls had inferior performances on both tests (SJ 18.07 cm (SD 3.07) and CMJ 20.43 (SD 3.30) compared with non-overweight counterparts (SJ 22.17 (SD 2.57), CMJ 25.6 (SD 4.76) ( $p < 0.001$ ). The overweight active boys had greater power than overweight non active girls, statistically no significant, but smaller than non-overweight girls. Overweight boys had lower values on SJ (20.54 cm (SD 4.19) and CMJ 22.83 cm (SD 4.51) compared with non-overweight (SJ 24.23 (SD 1.80) and CMJ 27.28 (SD 0.94)  $P < 0.01$ . Fat was calculated with the perimeters formula (4) in normal weight boys (22.76%) and girls (21.08%) and lean body mass in overweight boys (40.97 kg) and girls (35.92 kg). **Discussion** The possibility exists, that overweight children may be affected by their weight during explosive movements involving the lower limb muscles groups. Results suggest that predominant factor in jumping ability in this age is bodyweight. Low power limb level of overweight boys and girls can be explained with their adiposity and lack of muscle mass, and this is a factor why their parents engage them in some form of physical activity. The parents of non-overweight children do not care for inactivity of their children, until they are not overweight. **References** 1. Trost S, Kerr L, Ward D, Pate R. Physical activity and determinants of physical activity in overweight and non-overweight children. International Journal of Obesity and Related Metabolic Disorders 2001;25:822-9. 2. Morrow J, Freedson P. Relationship between habitual physical activity and aerobic fitness in adolescents. Pediatric Exercise Science 1994;6:315-29. 3. Cooper, DM New horizons in pediatric exercise research. In: New horizons in pediatric exercise science. CJR Blimkie and O. Bar-Or O, Editors. Champaign (IL): Human Kinetics, 1995:1-24 4. Hodgdon J., Beckett M., 'Prediction of percent body fat for U.S. Navy men and women from body circumferences and height'. Reports No. 84-29 and 84-11. Naval Health Research Center, San Diego, Cal. 1984.

### EXERCISE FOR HEALTH AND PHYSICAL PERFORMANCE IN CHILDREN OF AGE 15 YEARS OLD IN TIRANA

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ACADEMY OF PHYSICAL EDUCATION AND SPORT

**Exercise for Health and physical Performance in children of age 15 years old in Tirana** Martiri, A.1, Mema, F.1, Qeleshi, A.1, 1: UNIVERSITY OF SPORT OF TIRANA **Introduction:** A number of strategies have shown promise for increasing physical active lifestyle. Studies have show that the incorporation of multiple (2-4) short bouts of exercise (10 -15 minutes in length) performed each day can significantly improve cardio respiratory fitness ( DeBusk, R.F., et. al 1990, Jakicic et. Al 1995,) **Objectives:** To objectively investigate the problem of engage in exercise for health .... **Subjects:** This study engages 300 children-boys and girls 15 years old in public (" Jeronim de rada") and non public ("Reze

Drite" ) school . Methodology: questionnaire assessment Exercise for health and performance has been applied. (Poul M.Insel and Walton T.Roth 1988). Results: Data from questionnaire show: In Private School at moderate level in scale 32 % (boys 13 % girls 29%), at superior level 30 % boys 15 % girls 15%), and optimal level 23 % boys 22 girls 1% ). In Public School at moderate level in scale 28 % (boys 10 % girls 18%), at superior level 53 % (boys 32 % girls 21%) and optimal level 14 % (boys 9 % girls 5%). Discussion: This modest study show a significant data that children 15 years old engages in exercise for health .We expected from this study more positive value but anyway in superior level (where the participation here is often engages in regular exercise ) we find promise data, plus in optimal level (where a person at this level enjoys a regular exercise program) data low value ,but better for children in private school. These two school are in the middle of capital and as we see the situation speak themselves. References- 1 DeBusk, R.F., U. Stenestrand, M. Sheehan and W.L.Haskell.1990. Training effects of long versus short bouts of exercise in health subjects. *American Journal of Cardiology* 65:1010-1013. 2 . Jakicic, J.M., R.R. Wing, B.A. Butler, and R.J. Robertson.1995.Prescribing exercise in multiple short bouts versus one continuous bout: Effects on adherence, cardio respiratory fitness, and weight loss I overweight women .*International Journal of obesity* 19: 893-901.

## 6 MINUTE ENDURANCE RUN TO DETERMINE ENDURANCE CAPACITY: A QUESTION OF MOTIVATION?

KOCH, B.1, KOBEL, S.1, WEBER, S.1, BRANDSTETTER, S.1, DREYHAUPT, J.2, WIEDOM, M.2, MUCHE, R.2, STEINACKER, J.M.1  
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**Introduction** Aerobic endurance performance has an important role with regards to the prevention of cardiovascular risk factors. To determine endurance capacity in childhood and adolescence the 6 minute endurance run is currently used in many sports performance profiles (Tomkinson & Olds, 2007). In this study, it was examined whether children's motivation is sufficiently pronounced to complete the test. Motivation is operationalized by using an objective parameter (course of heart rate). **Methods** 45 children (age:  $7.5 \pm 0.6$  years; bmi:  $16.4 \pm 2.8$ ; 15.6% overweight; 60% boys) performed a 6 min endurance run in the sports hall (Graf et al., 2004). Heart rate (HR) was assessed using Actiheart®. Mean HR was calculated in beat-per-minutes (bpm) for each one-minute period. Data of second to sixth period were analysed with repeated measures ANOVA. **Results** During the 6 min run boys showed significantly better performance than girls ( $914 \pm 189$  m vs  $805 \pm 106$  m;  $p=0.017$ ). Mean HR in boys was  $189 \pm 12$  bpm (maximum HR:  $204 \pm 8$  bpm), in girls  $184 \pm 16$  bpm (maximum HR:  $199 \pm 13$  bpm; all n.s.). Regarding the course of HR, repeated measures ANOVA did not show a significant time effect on mean HR from second to sixth period. This suggests that mean HR stays on a high level over the course of all time periods of the test. Neither sex nor overweight status did influence the above. **Discussion** By using the objective parameter course of HR, a high level of motivation throughout the entire period of the 6-minute run was documented in all children, regardless of gender, age and overweight status. Thus, the 6 min run proved to be a valid instrument to assess endurance capacity, even in younger children and those without any running experience. **References** Tomkinson GR, Olds TS. Secular changes in pediatric aerobic fitness test performance: the global picture. In: Tomkinson GR, Olds TS (Hrsg.). *Pediatric fitness – secular trends and geographic variability*. Med Sport Sci. Basel 2007; 50: 46-66 Graf C, Koch B, Dordel S et al. (2004) Physical activity, leisure habits and obesity in first-grade children. *Eur J Cardiovasc Prev Rehabil* 11: 284–290

## ENERGY EXPENDITURE IN CHILDREN DURING TREADMILL LOCOMOTION ASSESSED BY ACTIHEART® AND INDIRECT CALORIMETRY

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**Background** Accurate measurement of physical activity in children is still a challenge. Combining heart rate (HR) and accelerometry may overcome limitations with either method used on its own (Brage et al, 2005). This study therefore aimed to compare the estimated energy expenditure (EE) from the combined HR and movement sensor Actiheart® with the gold standard indirect calorimetry during treadmill locomotion in primary school children. **Methods** Resting energy expenditure (REE) and submaximal EE (treadmill walking and running, 5 phases, 2-8 km/h) were measured in 15 children ( $9.2 \pm 1.5$  yr; 9 girls; BMI  $16.14 \pm 1.35$ ; recruited from the local sports club) by indirect calorimetry (Cortex Metamax 3, Germany) during a progressive treadmill exercise bout whilst wearing two Actiheart® (CamNtech, Cambridge, UK) - one at level with the third intercostal space and one just below the apex of the sternum. Using the Branched Model of Actiheart®'s software ("Child: GroupHR/GroupAct") to calculate total EE (TEE) METs were calculated and compared with the oxygen uptake generated by indirect calorimetry. **Results** METs increased linearly with each treadmill stage for activity sensor and indirect calorimetry (Actiheart®  $y=2.54+1.40 \cdot x$ ; indirect calorimetry  $y=2.40+1.89 \cdot x$ ). However, the correlations between Actiheart® and indirect calorimetry were non-significant and vary per stage between -.133 and .120. Overall, TEE measured by Actiheart® underestimates the values measured by indirect calorimetry ( $6.72 \pm 2.33$  METs and  $8.03 \pm 3.07$  METs, respectively) over all treadmill phases by 9.75% ( $\pm 23.05$ ). No placement effect was found on movement counts for either treadmill phase and speed, nor was there a significant placement effect on HR data during the first 4 treadmill phases. **Conclusion** Physical activity EE underestimation at vigorous intensities has been reported previously (Corder et al, 2005). This study however, shows Actiheart® consistently underestimates TEE in primary school children throughout all treadmill phases compared with indirect calorimetry. Placement can be disregarded as limiting factor since recordings of both Actiheart® correlated significantly with each other in HR data and movement counts. **References** Brage, S. et al (2006). Effect of combined movement and heart rate monitor placement on physical activity estimates during treadmill locomotion and free-living. *Eur J Appl Physiol*, 96:517-24. Corder, K. et al (2005). Comparison of PAEE from combined and separate HR and movement models in children. *Med Sci Sports Exerc*, 37(10): 1761-7.

## Poster presentations

### PP-SH12 Sports Psychology 2

#### EXPERT YOUTH COACHES' CONCEPTS OF STRENGTH TRAINING IN LONG TERM ATHLETE DEVELOPMENT

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**Introduction** Necessary performance improvements in competitive sports cannot be achieved exclusively through the optimization of high performance training in the adult stage but require a long-term performance build up process (Rost, 2002). Therefore, systematic strength training should begin in the junior age segment and aim at both prevention and performance enhancing targets (Carl and Horn, 2008).

What appears to remain unaddressed is the question of how to correctly apply strength training in youth sports in the process of long term training. The purpose of this study was to analyze expert youth sports coaches' understanding of their incorporated practice of strength training and to identify basic principles for long term athlete development. Methods Following a qualitative research methodology, data were collected from qualitative, semi-structured interviews. An interview guide was developed to allow for the optimal comparability of the data and to ensure that each interview addressed the required topics. Data were analyzed by using coding procedures and inductive categorization methods inspired by grounded theory principles (Glaser and Strauss, 1967) in order to identify core categories and themes (case study approach). Fifteen expert youth-coaches ( $n = 15$ ) participated in this part of the study reported here. The coaches were classified as expert coaches based on specified criteria related to multiple success in coaching. Specifically, expert coaches were defined by the number of successfully coached athletes who reached international competitions in the sport-specific high performance age. Results The evaluation of the data focused on reconstructing strategies for a long term design of strength training. Analysis of the transcribed interviews led to three cross-case-concepts that fulfilled the function of a "conditio sine qua non" related to top sports performance in the adult stage: "health-prevention", "presupposition for optimal technique", "presupposition for specific training methods and exercises". All concepts can be summarized under the higher order concept "presupposition-training", which is embedded in a basic training philosophy that focuses strictly on sports specific success in the peak performance age. References Carl, K., Horn, A. (2008). Krafttraining im Nachwuchsleistungssport. 1-23. Leipzig: Leipziger Verlagsanstalt GmbH. Glaser, B. G., Strauss, A. L. (1967). Discovery of the grounded theory: Strategies for qualitative research. Chicago, IL: Aldine. Rost, K. (2002). Trainingsprinzipien. Fundament der Trainingswissenschaft. 71-84. Köln: Sport und Buch Strauß. Supported by the Federal Institute of Sports Science (BISp) IIIA1-070504/08-10]

## EFFECT OF GENDER ON MOTIVATIONS AND CONCERNS OF ONLINE SPORT CONSUMERS

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INTRODUCTION: In considering the growth of online sport business, it is important for sport marketers and managers to understand the opportunities, limitations and consumers' need presented by online sport marketing (Rein, Kotler & Shields, 2007). To fully realize the business opportunities of the Internet, sport marketers need to develop better understanding for online sport consumers and their behavior (Hur, Ko & Valacich, 2007). Therefore, the purpose of this study was to investigate the effect of gender on motivations and concerns of online sport consumers. METHOD: 1154 online sport consumer from a shopping website were participated in this study (896 male, 258 female). Data were collected by the Scale of Motivation and Concern for Online Sport Consumption (SMCOSC) (Altun, 2011) to identify the online shopping motivations and concerns of online sport consumers. The motivation scale has 45 items with 5 subscales (diversion, information, economic motive, socialization and convenience). The concern scale has 27 items with 5 subscales (security-privacy, product quality, customer services, delivery and cost). Internal consistency reliabilities of the each of the scales were .96. Participants who bought only sport products filled out the scale through the internet. Two 2x5 (respondent's gender x shopping motives and respondent's gender x shopping concerns) MANOVA was conducted to examine the effect of gender on motivations and concerns of online sport consumers. RESULTS: MANOVA results showed that there were a significant difference in the online sport consumers' motivation scores of SMCOSC subscales in terms of gender [Wilks's  $\Lambda(4) = 0.960, F(5-1148) = 9.637, p < .01$ ]. Follow up ANOVA results showed that there were a significant mean difference between convenience [ $F(1-1152) = 4.366, p < .05$ ] and socialization [ $F(1-1152) = 31.489, p < .01$ ] subscale scores of online sport consumers in terms of gender. As the convenience motive of women is higher than that of men, socialization motive of men is higher than that of women. MANOVA results showed that there were a significant difference in the online sport consumers' concern scores of SMCOSC subscales in terms of gender [Wilks's  $\Lambda(4) = 0.974, F(5-1148) = 6133, p < .01$ ]. Follow up ANOVA results showed that there were significant mean difference between security-privacy [ $F(1-1152) = 11634, p < .01$ ] and delivery [ $F(1-1152) = 21.721, p < .01$ ] subscale scores of online sport consumers in terms of gender. The concern of men on security-privacy and delivery is higher than that of women. DISCUSSION: It might be concluded that gender is a distinguishing factor for online sport consumers' motivations and concerns on their online shopping. REFERENCES: Hur, Y., Ko, Y.J., Valacich, J. (2007). Motivation and Concerns for Online Sport Consumption. Journal of Sport Management: 21(4), 521-539. Rein, I., Kotler, P., Shields, B. (2007). The Future of Sports Media: What Do The Fans Want? The Futurist: 41(1), 40-43.

## PERCEIVED RELATIVE SPORT-SPECIFIC PHYSICAL FITNESS RELATES TO MENTAL TOUGHNESS IN ELITE MALE HANDBALL PLAYERS.

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Introduction Mental toughness (MT) in a sporting context has been defined as 'the ability to consistently perform toward the upper range of your talent and skills regardless of competitive circumstances' (Loehr, 1994, p. 5) and a high level of MT has been proposed as a critical attribute for elite level performance (Sheard, 2010). Sport-related MT is undoubtedly borne from interactions between life experience and those experiences specific to sport. In contact team sports at a high competitive level such as elite handball which has high demands on strength and power (Gorostiga et al., 2006), it is reasonable to suggest that an individual's level of MT could not be achieved in isolation and without comparison to their peers with whom they have to compete for position, and even more-so in comparison with their opponents who they have to defeat in order to succeed. The purpose of this study was to investigate the relationship between perceived relative levels of sport-specific physical fitness and MT in elite male handball players. Methods Forty eight handball players from the premier league and first division in Norway (mean age  $20.7 \pm 5$  years) responded to questions asking them to rate their level of strength, speed & endurance relative to the other players in the league on a scale of 1 (amongst the worst) to 10 (amongst the best) and completed the 43-item Mental (M,  $\alpha = .85$ ), Emotional (E,  $\alpha = .82$ ), and Bodily (B,  $\alpha = .62$ ) Toughness Inventory (MeBTough, Mack & Ragan, 2008). Results Significant correlations were apparent between perceived relative endurance and B ( $\rho = .44$ ), E ( $\rho = .36$ ) & M ( $\rho = .29$ ); between perceived relative speed and B ( $\rho = .35$ ) & E ( $\rho = .33$ ); and between perceived relative strength and B ( $\rho = .47$ ). Discussion Whilst higher perceived relative strength, endurance & speed were all related to greater levels of bodily mental toughness, a scale that most reflects the physicality of sport, relative endurance would appear to be the one factor related to all aspects of mental toughness in handball. Further evaluation of the MeBTough inventory is required and future research should investigate the impact on Mental Toughness of improvement in both actual and perceived sport-specific physical fitness. References Gorostiga EM, Grandados C, Ibanez C, Gonzales-Badillo JJ, Izquierdo M (2006). Med Sci Sports Ex 38(2) 357-366. Loehr JE. (1994) The New Toughness Training for Sports: Mental, Emotional, and Physical Conditioning From One of the World's Premier Sports Psychologists: Penguin Putnam, NY. Sheard, M. (2010). Mental Toughness – the Mindset Behind Sporting Achievement. Routledge, London.

## THE RELATIONSHIP BETWEEN SPORTS ALEXITHYMIA, SOCIO-DEMOGRAPHIC VARIABLES AND ATHLETES BURN-OUT

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**Introduction** Prior studies have shown that alexithymia is a personality trait that is associated with the difficulty in identifying and describing feelings and externally oriented thinking. Present studies of alexithymia have been widely expanded into other areas of psychology such as clinical psychology. However, past studies of alexithymia have not investigated it in the sports psychology area. Initial studies showed a common result that alexithymia was clearly associated with burn-out, indicating that the alexithymic characteristic might be one of the risk factors in athlete burn-out. The purpose of this study was to develop a new alexithymia scale for Japanese university athletes, and investigate the relationship between alexithymia and burn-out among university athletes. **Methods** Participants in this study were 259 university athletes (males=102, females=157, mean age=19.8, SD=1.1). They were given a questionnaire divided by socio-demographic variables, 20 alexithymia question items that edited Gotow alexithymia Scale in athletes, 28 burn-out question items in athletes from October to December 2010. In order to develop the Sports Alexithymia Scale(SAS) and Burn-Out Scale for Athletes(BOSA), exploratory factor analyses was conducted and to examine the statistical differences in socio-demographic variables, t-tests and one way ANOVA were conducted to the mean scores of SAS and BOSA. Multiple regression analyses were conducted to show the relationships between SAS and BOSA. **Results** The results of exploratory factor analysis revealed a 3 factor model in SAS and a 4 factor model in BOSA. Confirmatory factor analyses and reliability analyses confirmed the structural validities and factor reliabilities. The results of the analyses showed that the mean score of SAS and BOSA factors were significantly different among gender, grades and type of team, and the factors of SAS were significantly associated with the factors of BOSA. **Discussion** The results showed that high alexithymic individuals prefer to participate in individual competition sports. Alexithymic individuals prefer an environment where it is not imperative to have a personal support system. The results of one-way ANOVA showed that freshman sophomore and juniors have higher alexithymia than senior students, indicating that belonging to a sports team over a long term has positive effects on athletes' personality. The results of multiple regression analysis indicated that alexithymia is one of the risk factors for the burn-out state in athletes. The alexithymia trait in athletes needs to be examined on this scale more in future research. **Reference** 1)Gotow Kazufumi, Kodama Masahiro, Sasaki Yuji 1991. Is alexithymia unidimensional? Development of a 2 factor model alexithymia questionnaire Tsukuba psychological research, 21:163-171R.

## DEVELOPMENT OF PHYSICAL AND SOCIO-PSYCHOLOGICAL STRESSORS SCALE FOR UNIVERSITY ATHLETES

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**Introduction** Although numerous studies have demonstrated a relationship between stressful life events and the occurrence of physical and psychological disorder, little attention has been given to examining the association between life stress and athletic stress. The purpose of this study was to develop Physical and Socio-Psychological Stressors Scale for University Athletes (PSPSSUA) and to examine the relationship between Stressor variables of PSPSSUA and socio-demographic variables, stress response variables. **Methods** The subjects of 390 university students (male=193, female=197; mean age=19.70, SD=1.18) were asked to answer a questionnaire that was composed of socio-demographic questions, 70 stressor question items that were acquired from our preliminary survey in June, 2010 and Stress Response Scale for High School Athletes (SRSHSA) that were made of 32 question items developed by Shibukura (1999). Step-wise exploratory factor analyses, confirmatory factor analyses and reliability analyses were conducted to develop the PSPSSUA. In order to examine the socio-demographic differences, t-test and one-way ANOVA were conducted to PSPSSUA and SRSHSA. Step-wise multiple regression analyses were conducted to examine the correlation between PSPSSUA and SRSHSA. **Results** The results of step-wise exploratory factor analyses identified a ten-factor model with 40 items on PSPSSUA. Confirmatory factor analyses and reliability analyses confirmed that the scale had satisfactory fit indices of structural validities and Cronbach's alpha coefficient reliabilities. The results of t-test showed that the mean scores of some PSPSSUA factors were significantly different between male and female athletes. The result of one-way ANOVA found that sophomore athletes showed statistically higher scores than freshmen athletes on several PSPSSUA factors. The results of step-wise multiple regression analyses that were set PSPSSUA as independent variables and SRSHSA as dependent variables showed that the sub-scales of PSPSSUA were significantly associated with the sub-scales of SRSHSA. **Discussion** The results of t-test and one-way ANOVA indicated that there are differences in stressor cognition level between male and female and among athletes' grades. The results of step-wise multiple regression analyses implies that stress management programs and mental training programs for psychological relaxation can be beneficial to reducing athletes' stress level. Further studies with longitudinal design will be needed to examine effective psychological intervention methods. **References** Lazarus, R. S., and Folkman, S. (1984) Stress, appraisal and coping. New York: Springer. Takayuki Shibukura (1999) Development of Stress Response Scale for High School Athletes. Japanese Journal of Sport Psychology. 26 (1) : 19—28.

## COMPETITIVE ANXIETY IN ATHLETES AGED 15 AND 16.

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1. Cuka, A. 2. Zhurda, Y. 1: UST (Tirana, Albania), 2: UST (Tirana, Albania) **Introduction** Anxiety in athletes originates from early age. Competitive sport imposes high levels of anxiety at youngsters. Anxiety, being a part of competitive experiences, must be managed by athletes in order to help their performance. Thus, the aim of this study is to investigate on the level of competitive anxiety at youngsters, so that it can be recognized and managed for a better performance. **Methods** Subjects of this study are 218 youngsters aged 15 and 16 (48 females). They practise team and individual sports. The instrument used is the Sport Competition Anxiety Test, SCAT by Martens, Vealey and Burton, 1990. The data gathered by the questionnaire are processed by SPSS, 15.0 version, program. The reliability analyses and alpha method are also used. **Results** 8.71% of the subjects are characterized by a high level of competitive anxiety, 58.26% are at an average level and 33.03% at a low level. Alpha Chronbach 0.875. Athletes who practise individual sports indicate higher level of competitive anxiety both for the highest grade. i.e. 8.51% of them vs. 8 % of team sports players, and at average grade 61.75% vs. 56.52% of subject who practise team sports. **Discussion** The subjects are characterized by different levels of competitive anxiety trait, both in total number as well as according to types of sport and gender. More than half of the subjects are characterized by an average level of anxiety, only a low percentage are characterized by a high level of anxiety. Athlete's performance, depending on interactive processes and

situations, is affected by their anxiety. Being able to face pressure and anxiety is an integral part of sport. (Hardy, Jones & Gould 1996). Differences between males and females are noticed. Girls reflect higher indicators of the anxiety at average and high level, yet the percentage of girls with a low level of anxiety is equal to the half of that of boys. The reliability shown by Alpha = 0.875. The study identifies differences according to type of sport, i.e. a team vs. individual sports. Athletes of individual sports show higher anxiety levels compared to those of team sports. Alfa Chronbach 0.875. This corresponds with the studies of Weinberg (2007) that states that "children playing individual sports experience greater anxiety than those playing team sport". Competitive anxiety indicators are reflected in youngsters competitive activities. A considerable percentage of the subjects experience preoccupation, worry about their performance both before and during competition, only 22% do not feel worried. References Hardy, L., Jones, G., & Gould, D. (1996). *Understanding Psychological Preparation for Sport: Theory and Practice of Elite Performers*. Wiley, Chichester. Weinberg, R.S. & Gould, D. (2007). *Foundations of sport and exercise psychology*. (4th ed.). Champaign, IL: Human Kinetics.

### **RELATIONSHIP BETWEEN INJURY, PAIN AND PERSONALITY IN ATHLETES.**

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**Objective** This study aims to examine how athletes perceive, live with and manage pain episodes, and sensitivity in responding to the signs and limits, which are essential in the search for better results. Aiming to analyze the relationship between injury, pain and personality traits in athletes was used Pain Inventory for Sport (SIP) which is an instrument that measures five sub-scales, being direct confrontation (COP), cognitive (COG) catastrophizing (CAT), avoidance (AVD) and body awareness (BOD) and Total Coping Response (TCR = COP + COG - CAT) an overall indicator of the ability of athletes to play their role to experience physical injury or painful conditions. Another instrument used was the Neuroticism Scale Factor (EFN), a sub-scale Factor Personality Battery (BFP), based on the Five Factor Model (CGF). The EFN is composed of sub-factors Vulnerability (N1), emotional instability (N2), Passivity / Lack of Energy (N3) and depression (N4). **Method** The study included 11 athletes, 81.8% male, aged between 22 and 42 years ( $M = 28.91$ ,  $SD = 5.97$ ) who had evidence of Multiathlon 2009. Of these three (27.3%) had some type of injury, 4 (36.4%) were not injured but had had some type of recent injury and other 4 (36.4%) had no injury. **Discussion** The data indicated that the instruments have proven reliable in this sample, with accuracy rates by means of Cronbach's alpha of 0.96 for the EFN and 0.72 for the SIP. There was no difference in relation to gender in both instruments, although the averages are higher for women, but only in relation to BOD factor is the gender difference was significant in Student's *t* test, which can demonstrate a lower body awareness in women. However, it is noteworthy that this difference may relate to the number of female subjects in the sample that was less than masculine. Regarding the age variable, there were no differences between the factors of the instruments by means of ANOVA, however there was significant negative correlation between age and vulnerability, passivity / lack of energy and total neuroticism, which allows us to infer that the extent in advancing age, show lower percentiles on these factors. **Conclusion.** It is noteworthy in the scale of Neuroticism that the athletes had median ratings (36.4%) and very low (45.5%) in vulnerability, low results (36.4%) and very low (27.3%) in Instability Emotional ratings medians (27.3%) and very low (45.5%) in Passivity / Lack of Energy and average results (45.5%), low (18.2%) and very low (18.2%) in Depression. Regarding the overall classification of Neuroticism also focused on low (27.3%) and very low (36.4%). Finally significance was found regarding the variable lesion only in relation to variable CAT, which was significant in Student's *t* test, allowing to infer that injured athletes who never had a higher average score at the facet catastrophizing. There is, however, nearly significant negative correlations between moderate injury and N1, N2 and N4.

### **SELF CONFIDENCE PERFORMANCE RELATIONSHIP: THE MEDIATING ROLE OF COPING**

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**SELF CONFIDENCE- PERFORMANCE RELATIONSHIP: THE MEDIATING ROLE OF COPING** Levy, A.1, Nicholls, R.2, Polman, R.3 1: Edge Hill University (UK), 2: University of Hull (UK), 3: Victoria University (Australia) **Introduction** To achieve sporting excellence it is generally believed that athletes need to possess a high degree of self-confidence. However, the mechanisms which account for the self-confidence performance relationship is unclear. An important starting point when considering potential mechanisms is to identify pertinent mediator variables. A potential construct that may mediate the confidence-performance relationship is coping. Therefore, this study aimed to elucidate whether coping acted as a mediating influence. **Methods** Four hundred and fourteen athletic performers (222 male, 192 female, mean  $\pm$  SD; age  $21.63 \pm 6.45$  yr) took part in this study. The State Sport Confidence Inventory (SSCI; Vealey, 1986) measured confidence among the athletes. To assess coping, Gaudreau and Blondin's (2002) Coping Inventory for Competitive Sport (CICS) was adopted. Following competition, participants subjectively rated their performance satisfaction. Participants completed the SSSI prospectively, one hour before their competitive event started. The CICS and subjective performance were measured retrospectively, one hour following competition. **The multiple mediation analysis with bootstrapping** conducted in the present study was preferred above the causal step strategy. **Results** The mediation analysis for coping at the dimensional level revealed that task (BCa 95% CI 0.0028-0.0093) and disengagement-orientated coping (BCa 95% CI 0.0010-0.0063) partially mediated the effect of sport confidence on subjective performance. The mediation analysis for coping at the strategy level revealed that mental imagery (BCa 95% CI 0.0060-0.0165) and resignation (BCa 95% CI 0.0055-0.0144) coping partially mediated the effect of sport confidence on subjective performance. **Discussion** Findings revealed that task-orientated coping was a positive partial mediator, whereas disengagement-orientated coping was a partial negative mediator of the confidence-performance relationship. Of the 10 different coping strategies assessed, only mental imagery (task-orientated coping) and resignation (disengagement-orientated coping) had partial mediating effects. Importantly, task-orientated coping may act as an effective mechanism in which to improve confidence and performance. To achieve this, sport psychologists need to ensure that athletes appropriately use mental imagery. Additionally, sport psychologists need to ensure athletes avoid the use of disengagement coping strategies such as resignation. Doing so may negate the debilitating effect low confidence has on performance. **References** Vealey R. (1986). *J Sport Psychol*, 8, 221-246. Gaudreau P, Blondin JP. (2002). *Psych Sport Exerc*, 3, 1-34.

### **MENTAL SKILLS IN SOUTH AFRICAN AND UK UNIVERSITY STUDENTS**

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**Introduction** Whilst mental skills are both holistic and naturally occurring such skills can be trained for specific settings such as sport and exercise to improve performance outcomes and enhance an athlete's psychological well-being. Mental skills are often measured indivi-

dually and/or collectively using internationally developed scales. This study was conducted with three primary aims: 1) to acquire preliminary norms for Bull's Mental Skills Questionnaire employing an International sample, 2) draw comparisons across subscale means derived from UK and South African groups, 3) to investigate relationships between subscales on the inventory. Methods Data were collected from 500 South African and 209 UK male and female, university students ( $M=20.18$ ;  $SD=2.61$  and  $M=22.17$ ;  $SD=5.20$ , respectively). Participants were administered Bull's Mental Skills Questionnaire (Bull, 1991) which consists of seven mental skill subscales: imagery ability (ia), mental preparation (mp), self-confidence (sc), anxiety and worry management (awm), concentration ability (ca), relaxation ability (ra) and motivation (m). Results Means and standard deviations for the subscales and total score were as follows (South Africa : UK, respectively): ia (18.55; 3.46: 18.57; 3.36), mp (18.55; 3.73: 17.31; 3.75), sc (17.48; 4.10: 16.38; 3.75), awm (15.32; 4.99: 15.78; 2.89), ca (17.96; 4.45: 18.23; 4.58), ra (16.27; 4.59: 15.58; 2.89), m (19.07; 3.64: 19.46; 3.33) and total (123.22; 18.79: 121.30; 17.51). In the South African sample significant correlations emerged between all subscales except between imagery ability and anxiety and worry management. The UK sample evidenced significant correlations between all subscales ( $p<0.05$ ). Discussion Preliminary norms were established and were shown to be similar across the UK and South African samples. The results indicated a high level of correlation amongst subscales in both groups. Future work is planned to expand the study to include additional International samples and to investigate further the relationship between mental skills and psychological well-being in athletes. References Bull, S. J. (1991). Sport psychology: A self-help guide. Wiltshire, The Crowood Press.

## ACADEMIC AND ATHLETIC MOTIVATION OF ITALIAN STUDENT-ATHLETES

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Introduction Academic institutions are interested in predicting the rate at which athletes make progress toward degree completion in college (Gaston-Gayles, 2005). Although academic and athletic motivations have been studied as predictors of academic success in American student-athletes (Simons et al., 1999), no data are available for European ones. Thus, the aim of the present study was to validate the Italian version of the Student Athletes' Motivation toward Sports and Academics Questionnaire (SAMSAQ; Gaston-Gayles, 2005). Methods Italian student-athletes ( $n=323$ ; age:  $19.4\pm 3.1$  yrs; 48.3% high school; 51.7% college) participated in this study. Participant's competition level accounted for: 23.2%, 49.8%, and 26.9% for provincial, regional, and national levels, respectively. The 30-item SAMSAQ was administered to verify the applicability of the three-factors model (Academic Motivation, AM; Student Athletic Motivation, SAM; Career Athletic Motivation, CAM) in Italy. Exploratory Factor Analysis (EFA; Oblique Rotation; Maximum Likelihood) and reliability estimates (Cronbach's alpha) were conducted to evaluate the factor structure and the internal consistency of the items on each subscale, respectively. For each subscale, differences ( $p<0.05$ ) for gender (male vs female), education level (high school vs college), and competition level (provincial vs regional vs national) were calculated. Results A strong two-factors model emerged, with acceptable Cronbach's alpha coefficients only for SAM (0.86) and AM (0.78). Factor structure loaded 12-items for SAM and 12-items for AM, whereas 7 items seemed to be unrelated both with SAM and AM. Regarding SAM, provincial level showed significant lower value with respect to both national ( $p=0.0029$ ) and regional ( $p=0.0154$ ) levels. Furthermore, college student-athletes showed a higher ( $p<0.0001$ ) AM with respect to high school counterparts. Discussion To our knowledge, this study is the first attempt to evaluate the academic and athletic motivation in Italian student-athletes. For Italian student-athletes, a two-factor (i.e., AM and SAM) model emerged instead of three, according to the literature (Willis, 2005). Considering that in the United States sport is organized within educational institutions and in Italy the two systems are separated, some items have to be reformulated. Further studies are needed to confirm the factorial structure of SAMSAQ, enlarging the sample under investigation. References Gaston-Gayles J. (2005). J College Student Develop, 46(3), 317-327. Simons HD, Van Rheeunen D, Covington MV (1999). J College Student Develop, 40(2), 151-162. Willis KJP (2005). PhD Dissertation. Florida State University.

## ATTITUDE TOWARDS PERFORMANCE-ENHANCING DRUGS IN SPANISH ROAD CYCLING NATIONAL TEAMS

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Introduction Doping has stained the world of competitive sport in the last years, especially in sports like Cycling and Athletics. To alleviate and mitigate this problem it has become necessary the roll of prevention working around attitudes towards doping at different levels (1), defending the education and formation at the earliest ages (2). The aim of the present study was to know and compare the attitudes towards performance-enhancing drugs (PED) in the cyclists that form the Spanish National road cycling teams. Methods A sample of 34 cyclists of the Spanish national teams (Junior men -J-, Under-23 men -U23-, Junior Women -JW-, and Elite Women -EW- categories) took part in the study that was divided into groups according to the competing category (9 J, 9 U23, 10 JW, and 6 EW). The subjects were taking part in an official training camp in Segovia (Spain) in January 2011. Descriptive design was carried out by means of a validated questionnaire (1) of 17 questions using a Likert scale from 1 (Strongly Disagree) to 6 (Strongly Agree) for different statements that supported the use of PED in sport. Mean value  $\pm$  Standard Deviation was obtained for each item and Mann Whitney test for independent variables with Bonferroni post hoc was carried out. Results In general, the score for the mean of all the items was  $2.06\pm 0.39$  (2=Through Disagree). The lowest score was observed for the item "Doping is not cheating since everyone does it" with  $1.09\pm 0.38$ , and the highest for "The media blows the doping issue out of proportion" with  $4.53\pm 1.48$  (4=Slightly Agree; 5=Agree). Just for two items ("The risks related to doping are exaggerated" and "There is no difference between drugs, fiberglass poles, and speedy swimsuits that are all used to enhance performance") significant differences were observed between J (3.00) and the other groups U23 (1.22), JW (2.40), and EW (1.17) -  $p=0.000$ -, and between J (2.22) and the other groups U23 (1.00), JW (1.10), and EW (2.00) -  $p=0.001$ -, for the two items respectively. For the rest items no significant differences between groups were observed. Discussion Results of the present study show that road cyclists of the Spanish national teams are not permissive with PED. Just the younger cyclists (J) are a bit less contrary towards the use of PED than the rest of the groups but in two items. This empowers the idea that information and education is needed since the earliest ages and psychosocial intervention programs are needed to educate cyclists as well as all the people around them. References Petroczi, A. & Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. Psychology of Sport and Exercise. 10. 390-396. Zabala, M.; Sanz, L.; Durán, J. & Morente, J. (2009). Doping and professional road cycling: Perspective of cyclists versus team managers. Journal of Sports Sciences and Medicine. 8 (11). 102-103.

**THE EMOTIONAL INTELLIGENCE SPORTS INVENTORY : A PRELIMINARY CROSS CULTURAL ANALYSIS**

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THE EMOTIONAL INTELLIGENCE SPORTS INVENTORY (ESI): A PRELIMINARY CROSS CULTURAL ANALYSIS Saunders, J. 1, Smith, K.1, Newman, M. 2, Rawlins, J. 3 1: Australian Catholic University (Melbourne, Aus), 2: RocheMartin Australia, 3: University College of Wales in Cardiff

**Introduction** The Emotional Intelligence Sports Inventory (ESI) (Newman, 2010) has been identified as a useful consultant instrument for work with elite international sportsmen and been used in the field for several years, with high degrees of client satisfaction being reported. It is based on a theoretically derived ten factor model of emotional intelligence related skills. There has however been no reported empirical validation of the instrument and this study represents part of an initial attempt to review its efficacy for sport related populations across a range of cultural settings

**Methods** A paper and pencil version of the ESI was administered under classroom conditions to undergraduate students in exercise and sport degree programs in Australia (N=93), and in Wales (N= 279). The instrument comprised 77 randomised positively and negatively worded items requiring a Likert type response on a five point. Some additional questions provided information about the respondents their levels of sport involvement and personal sporting history. All analyses were conducted using PASW Statistics Version 18 (SPSS, 2009) and EQS Version 6.1 (EQS, 2006)

**Results** For the purpose of this analysis the Welsh sample was broken down into those who had been brought up in Wales (134) and those who had come to the university from England (145). In terms of level of participation, around one third was competing at a national or international level in their sport. The Australian sample had a slightly higher proportion of casual/social participants than their English/Welsh counterparts. Preliminary analyses indicate few differences between the three national groups but greater differences between males and females on a number of subscales.

**Discussion** This initial analysis revealed that this ten factor construct of emotional sports intelligence may have some promise as a tool for discriminating between elements of mental approaches to sports performance. However more work is needed in refining the instrument and its scales if it is to be robust enough for use in a variety of cultural contexts. There were some differences in the reliability of the individual scales between the groups and this may reflect either simple semantic differences or more important underlying cultural frameworks. Further development of the instrument validated within a broader range of cultural frameworks is currently in process

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**Poster presentations****PP-SH13 Psychology: Mental Skills****THE INFLUENCES OF ANXIETY AND CONFIDENCE ON IMAGERY CONTENT AND PERCEIVED FUNCTION**

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**Introduction** A body of research has demonstrated that athletes use a range of image types to fulfil a range of functions. Callow & Hardy (2001) have suggested that it may not be what is being imagined (image content) that is critical to image outcome, rather the function of what is being imagined i.e. why the athlete is using that image. Present knowledge of the factors that influence an athlete's perception of the function of imagery is limited. Bernier and Fournier (2010) comment that the situation (including the psychological state) in which imagery occurs is likely to influence image content. The purpose of the present study is to examine the influence of confidence and anxiety on image content (the 'what') and perceived functions of that image content (the 'why').

**Methods** Participants are 121 male, semi-professional footballers from 7 teams competing in the League of Wales Premier Division. Participants were placed into one of four possible groups according to data collected using the Competitive Trait Anxiety Inventory (CTAI-2; Jones & Swain, 1992). The groups were High Confident/High Anxious, High Confident/Low Anxious, Low Confident/High Anxious, and Low Confident/Low Anxious. Data relating to image content and perceived image function was collated via a revised version of the Sport Imagery Questionnaire (SIQ-R; Short, Monsma & Short, 2004).

**Results** A profile analysis revealed a significant group affect ( $F = 6.416, p = 0.00$ ) indicating a significant difference in image content between groups. A secondary profile analysis examined the perceived functions of imagery for each group and also revealed a significant group effect ( $F = 30.415, p = 0.00$ ).

**Discussion** The findings of this study demonstrated that an athlete's image content (what they are imaging) and image function (why they are imagining it) is influenced by their predisposition to be confident or anxious. This further supports recent research trends that have examined image content and image function separately. Further research into the role of an athlete's psychological states in influencing imagery is justified to help gain a better understand of the reasons why an athlete engages in imagery.

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**A STUDY OF THE CO-RELATION BETWEEN SELF-EFFICACY AND FEAR OF SUCCESS AMONG PROFESSIONAL ATHLETES**

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A Study of the Co-relation between Self-efficacy and Fear of Success among Professional Athletes Islamic azad university Roudheh branch Ayazi, Karimi, Divkan, Shahbazi, Adeli Faculty member, Physical Education, Islamic Azad University at Roudheh Researcher, HooshAfzar Research Institute, Tehran Faculty member, Physical Education, Islamic Azad University at Tehran shargh PhD student of sport management, Shahid Rajaei Teacher Training University Master physical education

**Introduction** Self-efficacy which was presented by Bandura, is the nucleus of social cognition theory. self-efficacy are, fulfilling the functions successfully, vicarious experiences, social persuasion and physiological emotional situation (Bandura, 2000) Fear of success is one of the preventive factors on the way to success and progress (Campbell & Fleming 2000). fear of success generally reduces self efficacy (Carway et al. 2003). The goal of this research is to recognize the relation between self-efficacy and fear of success among professional athletes in individual sports.

**Methodology** 135



athletes with at least five years of championship athletic record were selected by random sampling. They filled in an athletes' self efficacy questionnaire (Bandura 2000), Cronbach's alpha of 0.90 and also athletes' fear of success questionnaire (Metzler & Conroy 2004) Cronbach's alpha of 0.91. Result The results show that there is a significant reverse correlation between social persuasion subscale and fear of success ( $P>0.05$ ,  $r = -0.54$ ), and between emotional status and fear of success ( $P>0.05$ ,  $r = -0.62$ ). There is a direct significant correlation between vicarious experiences and fear of success ( $P>0.05$ ,  $r = 0.30$ ). No significant correlation is reported between success in fulfilling functions and athletes' fear of success. ( $P<0.05$ ,  $r = -0.10$ ). General findings show that there is a significant reverse correlation between total score of self efficacy and fear of success variable ( $P>0.05$ ,  $r = -0.44$ ). Discussion The results agree with; Bandura, 2001; Millen, 2000; Caraway 2003. According to them social persuasion increases the chance of success, and accomplishment anticipation and assert self efficacy is a social skill, also competition has a significant role in fear of success. General results of the study show that as self efficacy increases, their fear of success decreases and success chance will hence rise. Reference Bandura, A. (2000). Self-efficacy: The foundation of agency. Control of human behaviour (pp. 17-33) Mahwah, NJ: Erlbaum. Campbell, D. B., & Fleming, J. (2000). Fear of success, racial identity, and academic achievement in Black male college students. Community Review, 18. Caraway,k.(2003)..self-efficacy,goal orientation,& fear of failure as predictors of school engagement in high school students.psychology in the schools,40,417-724. Metzler & Conroy .(2004), structural validity of the fear of success scale. Measurement in physical education and exercise science, 8(2),89-108.

## DEVELOPMENT OF A PSYCHOLOGICAL STRATEGIES SCALE FOR JAPANESE ATHLETES AND ITS FACTOR STRUCTURE

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Introduction A number of measures estimating athlete's mentality for the purpose of increasing competitive ability have been proposed so far. In Japan, there was no method particularly designed to evaluate an athletes' psychological strategies required in a competitive setting. Therefore, the aim of this study is to develop a measure, which is used for the evaluation of strategies increasing psychological skills. Identifying the effective mental training methods would benefit providing effective continuous psychological support for athletes. Methods Data were obtained from a sample of 537 athletes (male 339, female 198; Age  $20.3 \pm 2.10$  years) competing across a range of performance standards in a wide variety of sports. Based on "Test of Performance Strategies (TOPS)" by Thomas et al. (1999), a questionnaire was prepared which was consisted of 7 categories, including goal-setting, self-analysis, emotional control, imagery, concentration, positive thinking, and self-talk. Items were also collected from free writing, which were classified into 52 items that may represent each category. All athletes participated voluntarily in the study, the instrument typically taking between 20 and 30 min to complete. Results To examine the internal consistency of the items, we calculated the correlation coefficient between the summation of item scores in the scale and the rated scores in each item. As a result, a significant correlation was obtained in the range of  $r = .39-.78$  ( $p < .01$ ) in all items, which showed the internal consistency. Factor analysis (principal factor solution, promax method) was employed to detect factor structure of questionnaire items. For competitive situations, within the questionnaire 8 factors were derived from 35 items and named as follows: emotional control, self-talk, self-analysis, imagery, psych-up, routine, game plan and goal setting. Discussion Exploratory factor analysis of the psychological strategies yielded very clear factor structure. The findings of the factor analysis, together with the descriptive statistics presented for each subscale, clearly support previous literature (Vealey, 1988; Defrancesco and Burke, 1997; Thomas et al., 1999) in identifying the use of motivational (e.g. self-talk and goal setting), imaginal, and emotional control strategies as an important feature of athletes' psychological preparation for competition. References Defrancesco, C., & Burke, K. (1997). Performance enhancement strategies used in a professional tennis tournament. International Journal of Sport Psychology, 28, 185-195. Thomas, P., Murphy, S. & Hardy, L. (1999). Test of performance strategies: Development and preliminary validation of a comprehensive measure of athletes' psychological skills. Journal of Sports Sciences, 17, 697-711. Vealey, R. (1988). Future directions in psychological skills training. The Sport Psychologist, 2, 318-336.

## ATTENTIONAL ABILITIES, PROBLEM SOLVING SKILLS AND COPING STYLES IN HANDBALL PLAYERS

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Abstract In open skill sports, athletic performances aimed to strategic objectives must fit quickly to environmental changes. This kind of adjustments requires the shifting of attentional focus to select and process the informations useful for the performance. During the game, the handball player should consider his position, follow the opponents and – at the same time – evaluate speed and directions of the others players moving around him. The main purpose of our research is to analyse the relationship between coping and attentional styles in handball players and non-athletes, measuring attentional abilities, problem solving skills, and coping styles. Methods The aims of this research were: - the study of situational coping and coping styles in handball players: in particular we investigate the cognitive and emotional variables in stressful conditions contest-related; - the study of attentional styles in handball players; - the evaluation of attentional abilities, working memory and problem solving skills - and their relations with coping - in handball players. 40 athletes and 40 non-athletes, aged from 18 to 40 years and paired by gender, were involved. The instruments used were: - Test of Attentional and Interpersonal Style by Nideffer (1976) - Coping Orientation to the Problems Experiences, New Italian Version by Sica & al. (2008) - Attention and Concentration Test: reaction times, digit span, and shifthing by Di Nuovo (2000) - WAIS-R: Block design and Arithmetic tests by Wechsler (1981) Results and discussion The study identifies styles and cognitive factors involved in coping and attentional processes in handball players. These variables have not been studied in relation to coping and problem solving in handball players. Previous research has demonstrated that 'in sport such as soccer, basketball and tennis, the athlete is expected to alter attentional styles both in width and direction, occasionally quite rapidly' and 'as a result of an incompatible attentional styles, athletes may damage performance' (Tenenbaum & Bar-Eli, 2007). According to Nideffer's conclusions (1976), we will expect similar results in attentional styles, moreover the study analysed their relationships among with coping and problem solving. References Di Nuovo S. (2000) Attenzione e concentrazione. Erickson, Trento. Nideffer R.M.(1976) Test of Attentional and Interpersonal style. Journal of Personality and Social Psychology, 34, 394-404. Sica C., Magni C., Ghisi M., Altoè G., Sighinolfi C., Chiri L.R., & Franceschini S. (2008) Coping Orientation to Problems Experience: uno strumento per la misura degli stili di coping. Psicoterapia cognitiva e comportamentale, 14, 1, 27-53. Tenenbaum G. & Bar-Eli M. (2007) Personality and Intellectual capabilities in Sport Psychology. In Smith D. & Bar-Eli M. (Eds.) Essential Readings in Sport and Exercise Psychology. Human Kinetics, Champaign IL. Wechsler D. (1981) Scala d'Intelligenza Wechsler per Adulti-Riveduta. It.Tr.(1997) Giunti OS, Firenze.

### MENTAL SKILLS IN ELITE VOLLEYBALL PLAYERS

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**MENTAL SKILLS IN ELITE VOLLEYBALL PLAYERS** Delitala L., Fadda D., Migliaccio G.M., Loi, A. Italian National Olympic Committee (CONI) - Sardinia Introduction Psychological variables are very important for success in sports and affect both individual (self-efficacy and motivation), both team (cohesion and collective efficacy). Indeed for the same physical, techniques and tactics characteristics, some athletes or teams achieve excellent performance, while also fail to emerge. The purpose of this work is to study the mental skills of athletes engaged in high-level volleyball and compare them with those of less successful players. We investigated some psychological variables that, according to sports literature (Williams & Krane, 2001; Gould & Maynard, 2009), appear to be determining factors for peak performance: efficacy beliefs, cohesion, motivational orientation and personality traits. Methods In collaboration with the CONI we recruited a sample of 112 Italian volleyball players ( $F=58$ ;  $M=54$ ) aged between 14 and 38 ( $M=25.31$ ;  $SD=5.3$ ), divided into medium ( $n=54$ ) and high level ( $n=58$ ). They completed the following tests: Task and Ego Orientation in Sport Questionnaire (TEOSQ); Group Environment Questionnaire (GEQ); Big Five Adjective (BFA) and a new sport-specific test that assesses self and collective efficacy (Volleyball Efficacy Beliefs Scales-VEBS; Guicciardi, Fadda & Delitala). To evaluate the differences between the two sub-samples we conducted a multivariate analysis of variance (MANOVA) using level of competition and gender as independent variables, and the average scores of scales as dependent variables. In a subsequent analysis, we tested the influence of some variables related to the gaming experience (years of practice, sets played in a game). Results MANOVA showed that among the psychological skills considered, personal and collective efficacy beliefs differentiate elite from mid-level players. Important gender differences emerged: boys reported significantly higher scores in almost all scales. Moreover, the gaming experience seems to have a significant influence on the variables investigated for both levels. Conclusions This study has shown that there are significant differences in mental abilities depending on the level of competition, gender and gaming experience. The knowledge of the features of elite athletes may be useful to provide mental training programs relevant to successful performance. References Gould, D., & Maynard, I.W. (2009). Psychological preparation for the Olympic Games. *The Journal of Sport Sciences* (Special Issue). Vol 27, 1393-1408. Guicciardi, M., Fadda, D., & Delitala, L. (2010). Self and collective efficacy in volleyball. SPASS-The Sport Psychology and Sport Sciences Conference, Lignano Sabbiadoro (Italy), 5-9 September. Williams, J.M., & Krane, V. (2001). Psychological characteristics of peak performance. In J.M. Williams (Ed.), *Applied sport psychology: Personal growth to peak performance*. Mountain View, CA, USA-Mayfield.

### GOLFERS' USE OF IMAGERY AND SELF-TALK AS PROBLEM AND EMOTION FOCUSED COPING STRATEGIES DURING THE WALK TOWARDS, AND IMMEDIATE PREPARATION TO EXECUTE, GOLF STROKES UNDER STRESSFUL CONDITIONS.

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**Introduction** Golfers have been found to employ the use of imagery and self-talk as coping strategies during stressful situations. Both imagery and self-talk are widely recommended as emotion focussed coping strategies (Jones, 2003). However, there is limited understanding as to how imagery and self-talk are used as problem focussed coping strategies. In golf, the use of imagery and self-talk for this purpose is potentially useful given the problem-solving nature of the game. This study examined how golfers' of differing skill levels, used imagery and self talk as problem and emotion focussed coping strategies during the approach to, and immediate preparation to execute, golf strokes under stressful conditions. **Methods** Upon gaining ethical clearance from the School Ethics Committee (SEC) 145 competitive male golfers were recruited for the study. All golfers completed a purpose designed 8 item questionnaire ( $ICC = 0.85$ ) that assessed their use of imagery and self-talk as problem and emotion focussed strategies during the walk towards, and immediate preparation to execute, golf strokes under stressful conditions. Responses were made on a 5 point likert scale. Results Results from a mixed factorial ANOVA revealed that golfers used imagery and self-talk as problem focussed coping strategies more than emotion focussed coping strategies ( $P<0.005$ ). Moreover, golfers used imagery more as a problem focussed coping method than self-talk ( $P<0.05$ ). When golfers used imagery and self-talk as problem focussed coping strategies they reported externally planning how to play the golf stroke under stressful conditions rather than internally rehearsing its execution. No skill level differences were found in golfers' use of imagery and self-talk as problem and emotion focussed coping strategies. **Discussion** Results appear to suggest that golfers adopt a pragmatic approach to their use of imagery and self-talk when coping with golf strokes under stressful conditions. Instead of using imagery and self-talk to control their emotions golfers report using the strategies to plan how to play the golf stroke that they are presented with. It is likely that golfers make more use of imagery than self-talk for serving this function because although self-talk can be used to facilitate the planning of golf strokes, it does not have the dimension to it that imagery does in allowing players to estimate and imagine how the ball will react in the prevailing conditions. Additionally, in accordance with the multifunctional nature of imagery and self-talk, it may be possible that taking an active approach to a stressor itself may in turn suppress potentially negative emotions. References Jones MV. (2003) *The Sport Psychologist*, 17, 471 - 486

### MENTAL TOUGHNESS, STRESS, APPRAISAL & COPING IN ATHLETES

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**Mental Toughness, Stress, Appraisal & Coping in Athletes** Ingram, S.C.1; Carter, D.C.2; Polman, R.C.J.3; Taylor, J.A.4 IDH, University of Warwick, UK; 2. UK; 3. VU, Melbourne, Aus.; 4. UCLan, UK. Aims Mental toughness (MT) and the ability to cope with stress are regarded by many as important contributors to success in sport. Although there has been research examining the relationship between MT, coping and coping effectiveness, to date little attention has been paid to the role of MT in the appraisal of stressful events. Therefore this two part study examined the relationship between stress, appraisal and mental toughness. **Method** In study one, 90 (73 males, 17 female) athletes (50 cyclists and 40 rugby players) with an average age of 32.4 years completed the MTQ48. In study two, those who scored in the top ( $n=8$ ) and those in the lowest ( $n=8$ ) 10% on the MTQ48 engaged in a semi-structured interview where they were asked about a self-selected stressful event in their sport. The interviews addressed the appraisal of the stressor as well as the coping strategies employed and their effectiveness. **Results** Content analysis of the qualitative data showed that those high in MT reported more challenge appraisals compared to those in the low MT group, who were more likely to appraise the self-reported stressful event as a threat. Also, the athletes in the high MT group relied on either Problem Focussed Coping (PFC) or Emotion Focussed Coping (EFC) which they regarded as being effective. This was supported by the experience of positively toned affect e.g. relief, pride. In contrast, those in the low MT group relied on

avoidant coping which they did not regard as being effective. Those athletes perceived more in the way of negatively toned emotion such as anxiety and anger. This resulted in reduced enjoyment and performance. Conclusion Although similar stressors were reported by the participants, the way these stressors were appraised varied with the level of MT. This suggests that mentally tough individuals are more likely to perceive a stressful event as a challenge rather than a threat. Perceiving a stressor as a challenge is more likely to result in lower levels of perceived stress and more positively toned emotions. In addition this appears to be related to the use of effective coping strategies. This is in turn related to a more enjoyable experience and most likely to increased performance. Athletes with lower levels of MT were more likely to use avoidant coping strategies. Such strategies have been shown to be maladaptive, in particular in the long term. This research suggests that enhancing levels of MT or helping athletes with stress appraisal and the teaching of adaptive coping strategies could be beneficial for both enjoyment and performance. References Clough, P. J., Earle, K., & Sewell, D. (2002) Mental Toughness: the concept and its measurement. In I. Cockerill (Ed.), *Solutions in Sport Psychology* (pp. 32-43). London: Thomson Publishing.

### TEAM IDENTIFICATION AND MENTAL TOUGHNESS IN ELITE FOOTBALL PLAYERS

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**Introduction** In sport, team cohesion has been viewed as the most important small group variable. A considerable amount of research has investigated both antecedents and consequences of team cohesion and cohesion has a significant impact on athlete's attitude, motivation, behavior, and performance. Less attention in sport science has been related to the Social Identity Approach. Studies have demonstrated that team identification motivated team members to work for the team, and moreover it has a positive impact on team members' attitudes and behaviours. Mental Toughness (MT) in a sporting context has been defined as 'the ability to consistently perform toward the upper range of your talent and skills regardless of competitive circumstances' (Loehr, 1994, p. 5) and has been suggested as containing mental, emotional and bodily toughness (Mack & Ragan, 2008) that all relate to player attitude and behaviour in competition. The aim of this study was therefore to investigate the relationship between elite football player's identification with their team and their perceived mental toughness. **Methods** Seventy five footballers (mean age  $24.7 \pm 5.7$  years) from eight teams in the Norwegian premier league ( $n = 42$ ) and first division ( $n = 33$ ) completed a 6-item scale assessing team identity (TI; De Backer et al., 2010). The questions are scaled from 1 to 7, a higher score indicating a higher degree of social identification. The Mental, Emotional and Bodily Toughness Inventory (MeBTough, Mack & Ragan, 2008) contains 43 items measuring three toughness aspects; Mental Toughness (MT), Emotional Toughness (ET), and Bodily Toughness (BT). The questions are scaled from 1 to 4 with a higher score indicating a higher perception of toughness. Results TI (mean =  $5.6 \pm .94$ ,  $\alpha = .80$ ) was correlated with MT (mean =  $3.3 \pm .41$ ,  $\alpha = .79$ ,  $\rho = .36$ ,  $p < 0.01$ ), ET (mean =  $3.0 \pm .40$ ,  $\alpha = .83$ ,  $\rho = .34$ ,  $p < 0.01$ ) and BT (mean =  $3.1 \pm .41$ ,  $\alpha = .79$ ,  $\rho = .26$ ,  $p < 0.05$ ). **Discussion** The findings indicate that players' identification to the team was relatively strong and that their perceived level of toughness on each subscale was relatively high. The findings also indicate that team identity is positively related to Mental Toughness, Emotional Toughness and to a lesser extent Bodily Toughness but due to the cross sectional design of the study causality cannot be assumed. References De Backer, M., Boen, F., Ceux, T., De Cuyper, B., Høigaard, R., Callens, F., Fransen, K., Broek, G.V. (2010) Psych of Sp & Ex, doi: 10.1016/j.psychsport.2010.09.009 Loehr J.E. (1994) *The New Toughness Training for Sports: Mental, Emotional, and Physical Conditioning From One of the World's Premier Sports Psychologists*: Penguin Putnam, NY Mack, M.G. & Ragan B.G. (2008). *Journal of Athletic Training* 43(12), 125-132

### THE DEVELOPMENT OF SELF-REGULATORY PROCESSES IN YOUNG ELITE BASKETBALL PLAYERS

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**Introduction** Action control processes cover all those self-regulatory processes involved in implementing a purpose and holding on to that initiated action up to the point of goal-attainment. There are two self-regulation programs: action and state orientation. While in the first program, action orientation, all mental processes are geared to convert the actual into the target state, the second program, state orientation, focuses on analyzing a past, present and future situation. This study extends previous research on the action and state orientation in athletes (Beckmann, 1987) by investigating the development of self-regulatory processes in young elite Basketball players of different ages. **Methods** The questionnaire Action Control Scale in Sport (HOSP) was administered to young (12-20 years of age) German basketball talents in the course of the common research project "Basketball Talents" by the Federal Institute of Sport Science, the German Basketball Association and the Ruhr-University Bochum. The HOSP consists of three factors: failure related, decision related and performance related action orientation. A MANOVA with the factors sex and age was conducted for the three dimensions of the questionnaire. The sample consists of  $n = 599$  (female = 209, male = 390) athletes. Results For failure related action/state orientation, the MANOVA revealed a main effect for sex ( $F(1) = 9.602$ ,  $p < .01$ ) as well as for age ( $F(9) = 4.74$ ,  $p < .00$ ). The post-hoc test reveals significant differences between the groups of the ages 12-14 and the groups of the ages 15-18. **Discussion** The significantly stronger failure related state orientation of female players revealed in this sample so far cannot be reinforced by other findings. With increasing age, the basketball players show an increase in their state orientation after failure. An important point for this development seems to be the transition between the ages of 14 and 15 as the results show a significant difference between the age groups  $<14$  and  $>15$ . The performance related score, however, revealed an action orientation for all ages. These results corroborate the findings of Beckmann (1987), claiming the combination of failure related state and performance related action orientation to be common for elite athletes. It remains unclear whether this effect is due to selection or to socialization. With the help of a longitudinal design the following question could be explored: Do young athletes proceed to an elite level because they possess this combination of failure related state and execution related action orientation, or do they develop this successful combination over time? References Beckmann, J. (1987). Höchstleistung als Folge mißglückter Selbstregulation. In J.-P. Janssen, W. Schlichte & H. Strang (Hrsg.), *Handlungskontrolle und soziale Prozesse im Sport* (S.52-63). Köln: bps.

## Poster presentations

### PP-BN06 Biomechanics of Running and Kicking

#### INTER-ARM COORDINATION INFLUENCES LEG KICK AND IS CORRELATED WITH ENERGY COST IN FRONT CRAWL

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**Introduction** The aim of this study was to investigate the correlation between inter-arm coordination and energy cost in front crawl. We hypothesised that discontinuity between propulsive phases within stroke is likely to increase energy cost, eventually by increasing intra-cycle speed variability or drag. **Methods** 10 swimmers ( $18.0 \pm 4.5$  yr,  $176.6 \pm 5.9$  cm,  $66.3 \pm 7.1$  kg) performed in a 50-m indoor pool 2 separate sessions of 3 300-m trials at a constant submaximal intensity with 5-min rest in front crawl (Fc). The intensity was 80% of Fc 400-m personal bests. Each trial was performed randomly in a different coordination mode. The swimmers were asked to swim in a freely-chosen coordination mode (Co Free), in a catch-up mode (Co B) and in a superposition mode (Co C), quantified by the index of coordination (IdC) [1]. Leg kick (LK) and stroke rate (SR) were also recorded. Energy cost (EC) was calculated from gas exchanges measured by a portable system (K4b2, Cosmed, Rome, Italy) connected to a snorkel (Aquatrainer). **Results** The IdC of Co B was  $32.9 \pm 25.2\%$  lower ( $p < 0.001$ ) than the IdC of Co Free. There was no difference between IdC of Co C and IdC of Co Free. A correlation was found between IdC and LK ( $r = -0.42$ ,  $p = 0.02$ ) but not between IdC and SR ( $r = 0.17$ ,  $p = 0.37$ ). The partial correlation between EC and IdC controlling the effect of LK was significant ( $r = -0.57$ ,  $p = 0.001$ ) while the partial correlation between EC and LK controlling the effect of IdC was not significant ( $r = 0.16$ ,  $p = 0.42$ ). **Discussion** At moderate speed, the front crawl swimmers were able to decrease their IdC compared to the freely-chosen coordination but not to increase it. To maintain velocity despite a larger discontinuity between propulsive phases, the swimmers increased their LK without changing their SR. This increase in LK might improve the propulsion and keep a better horizontal body alignment, therefore reducing active drag [2]. Since EC was mainly affected by inter-arm coordination, one may speculate that the relative propulsive time is a determinant factor of economy in front crawl. **Bibliography** 1. Chollet, D., S. Chabies, and J.C. Chatard, A new index of coordination for the crawl: description and usefulness. *Int J Sports Med*, 2000. 21(1): p. 54-9. 2. Hollander AP, De Groot G, Van Ingen Schenau GJ, Kahman R, Toussaint HM. Contribution of the legs to propulsion in front crawl swimming. In: Ungerechts BE, Wilke K, Reischle K (eds). *Swimming Science V*. Champaign, IL: Human Kinetics Publishers, 1988: 39-44

#### KINEMATICS AND NEUROMUSCULAR RECRUITMENT OF VERTICAL TREADMILL RUNNING

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**Introduction** A vertical treadmill (VT) is being developed for the physical conditioning or rehabilitation of athletes. It requires a running action in a recumbent or supine position on a vertically hung, non-motorised treadmill whilst the limbs are supported with overhanging resistance cables. The aim of this study was to describe the kinematics and neuromuscular recruitment pattern of VT running. **Methods** Thirteen active males aged  $24.8 (7.1)$  years, height  $1.8 (0.1)$  m, body mass  $77.7 (8.8)$  kg undertook two familiarisation sessions to determine self-selected (SS) running speed. On a third visit, at the SS running speed, sagittal plane kinematics of the ankle, knee and hip were collected using a motion capture system (200Hz). Activation of major leg muscles was determined by synchronised electromyography. **Results** Participants adopted a SS running speed of  $2.12 (0.38)$  m/s and a cadence of  $150 (20)$  steps/min. with a stance phase of  $32.9 (6.6)\%$  of the gait cycle. Ranges of motion at the ankle, knee and hip were  $29.8 (3.6)$ ,  $38.9 (8.7)$  and  $34.8 (6.6)^\circ$  respectively. The hamstrings were active between 0-30% of gait cycle and again at 57-100%. Gastrocnemius (GA) were both active 0-49% and 68-100%. Tibialis Anterior was active 0-8% and 15-100%. Rectus Femoris (RF) was active between 10-83% of gait cycle. **Discussion** VT running elicits similar SS speed ( $2.25$  m/s, Koga et al. 2009) and stance phase (31.1%, Mann et al., 1980) to horizontal treadmill running. During VT running, the hamstrings pull the leg against the treadmill and resistance cables. RF initiates in stance to flex the hip and to control hamstring activity which ceases in late stance, thus hip hyperextension does not occur (peak extension  $0.3 (5.7)^\circ$ ) as observed in horizontal running (Mann et al., 1980). GA activity and peak plantarflexion ( $20.4 (4.9)^\circ$ ) after toe off indicate a propulsion phase seen in horizontal running (Mann et al., 1980). However, the muscular force is likely not as high due the absence of body mass loading. In swing, peak knee flexion ( $64.4 (8.1)^\circ$ ) was driven by the RF flexing the hip, not by hamstring activity. In late swing the RF extended the knee alone since the Vastii muscles were inactive. The results indicate that VT running targets muscles associated with the posterior chain that are essential for running performance and injury prevention (Askling et al., 2003). In conclusion, the VT shares many similarities with horizontal running without impact loading thus it might be appropriate for injury rehabilitation and physical conditioning for overground running. **References** Askling C, Karlsson J, Thorstensson A. (2003). *Scand J Med and Sci In Sport* 13(4):244 Koga P, Candelaria N, Tomaka J. (2009). *Sports Biom*, 8(1):52 Mann, R. Hagey, J. (1980). *Am J Sports Med*, 8:345

#### AGE-SPECIFIC NEUROMUSCULAR INTERACTION DURING HUMAN RUNNING

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**Introduction** The adaptations that occur in the motor system with advancing age cause a range of changes in motor performance. The question regarding the age-specific neural activation strategies during dynamic movements is very relevant, as it may explain better the difference in behavior of the muscle-tendon interaction during locomotion. The purpose of the present study was to examine whether the age-specific muscle activation profiles exist for the age-specific muscle-tendon interaction during running. **Methods** 12 elderly subjects run with a natural cadence ( $1.9 \pm 0.2$  m s<sup>-1</sup>) on a treadmill for approximately 30 seconds. Similarly, 12 young subjects of equivalent height and leg length run with the same speeds to the elderly. The fascicle length and muscle-tendon junction (MTJ) of gastrocnemius medialis (MG) during running were monitored by the high-speed ultrasonography. Simultaneously, the EMG activities of MG and tibialis anterior (TA) were recorded with the movement analysis by the VICON movement analysis system. The changes of Achilles tendon (AT) length was calculated from the changes of MTJ and the changes of the AT interaction on the calcaneus during running. **Results/discussion** The MTU length behavior during running did not show any significant differences between young and elderly. However, the activation profiles did not show similar between young and elderly. The EMG ratio of MG to TA activation was significantly greater in elderly than in young

during the pre 50ms phase before contact, but that was greater in young than in elderly during short latency reflex and braking phases. The EMG ratio of preactivation to braking phase of MG was significantly greater in elderly than in young. In contrast, that of TA was significantly greater in young than in elderly. In the muscle fascicle and tendon levels, the MG fascicle length at the contact was shorter in elderly than in young. In corresponding to the fascicle behavior, The AT length at contact was greater in elderly than in young, and thereby was stretched equally in both groups. These results suggest that elderly may increase the agonist MG preactivation in order to take up the slack of AT before contact, and thereby utilize the tendon elasticity. However, it is not clear why elderly can increase the antagonist TA activation during the braking phase and utilize the tendon recoil effectively during the push-off phase.

## LOWER EXTREMITY JOINT LOADING DURING WALKING WITH MBT SHOES IN ELDERLY MEN

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**INTRODUCTION:** Age-related impairments in neuromuscular function are often linked to a redistribution of mechanical loads in lower extremity joints during locomotion. As DeVita & Hortobágyi (2000) and Karamanidis & Arampatzis (2009) demonstrated, elderly have a distal to proximal shift in power production and an increase in medial knee joint loading while performing daily activities. Since rational footwear is supposed to provide functional control for aberrant loads in people with proprioceptive deficits (Buchecker et al. 2010), we hypothesized a readjustment of kinetic walking patterns in this age cohort when using MBT shoes. **METHODS:** Eight elderly ( $60.3 \pm 4.0$  yr) and eight young ( $27.0 \pm 5.0$  yr) men, all healthy and familiar with MBT, volunteered. Participants walked at  $5.4 (\pm 0.4)$  km/h for eight trials with standard and MBT shoes, respectively. Kinematic and kinetic measurements were conducted via a Vicon system using eight cameras (250 Hz) and an AMTI force platform (2000 Hz). An inverse dynamic approach was performed for the calculation of lower extremity joint moments and powers. Data were analyzed over the stance phase of the right leg by a two-way repeated measures ANOVA (group x shoe), followed by t-tests as post-hoc procedure when appropriate. Statistical significance was set a priori at  $\alpha < 0.05$ . **RESULTS:** Main effects of shoe revealing decreases of joint moments and powers for the MBT situation were found (all  $P < 0.05$ ,  $\eta^2 > 0.14$ ). Both groups demonstrated reduced concentric and eccentric work at the ankle joint as well as decreased plantarflexor impulses with MBT (all  $P < 0.05$ ). In contrast to young adults, walking with MBT produced less positive and negative work at the knee and diminished concentric hip work in elderly (all  $P < 0.05$ ). Similar results were seen for peak external knee adduction moments and for knee and hip extensor impulses during initial half of stance, showing no differences for the young (all  $P > 0.05$ ), but decreases for the elderly (all  $P < 0.05$ ) when using MBT. However, high variability in the young made it difficult to detect significant interactions. **DISCUSSION:** Data suggests MBT shoes create different locomotor strategies among age groups, with the more systematic effects provoked in the elderly. Present results highlight that wearing MBT may be a beneficial option for this group of people in changing the mechanical environment for the knee and hip joint. Therefore, using MBT shoes might positively impact preventive efforts to reduce the age-associated increased risk of falls and/or development of knee osteoarthritis. **REFERENCES:** Buchecker et al. (2010) SJMSS, epub DeVita & Hortobágyi (2000) JAP, 88 Karamanidis & Arampatzis (2009) ABME, 37

## FRONTAL AND SAGITAL PLANE PERTURBATIONS DURING WALKING EVOKE SPECIFIC RESPONSES OF CALF MUSCLES

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Introduction Slips are common experiences during daily activities and sports, which require immediate responses from the neuromuscular system in order to regain the balance. Although several studies about balance loss have been conducted on backward perturbations, little is known on balance loss by the frontal plane perturbations. Therefore, the aim of this study was to compare initial changes in ankle kinematics and electromyography (EMG) during slips in the sagittal (backward) and frontal planes (leftward and rightward). **Methods** Eight healthy men were asked to walk along a 7-m walkway, stepping with the right foot on a moveable platform [1] in the middle of this path. The protocol included no perturbation trials (BASE) and four classes of perturbations (10 cm translations): foot displacement forward (FW), backward (BK), leftward (LF) and rightward (RI). Right ankle joint angles in the frontal (eversion/inversion, ANK-F) and sagittal (flexion/extension, ANK-S) planes as well as EMG from peroneus longus (PER), gastrocnemius lateralis (GL) and tibialis anterior (TA) were collected. Ankle joint angles and EMG at BASE were subtracted from FW, LF and RI trials (BK were excluded), such that thresholds were defined based on the individual's movement variability within the BASE trials. Onset latencies for EMG and changes in joint angle were determined and normalized to one gait cycle (%GC) starting at touch-down of the perturbed foot. **Results** One-way ANOVA revealed ANK-S onset during FW (mean $\pm$ SE:  $9 \pm 1.3\%$ GC) were significantly faster ( $p < 0.05$ ) when compared to LF and RI (FW:  $20 \pm 4$ ; RI:  $18 \pm 3.2\%$ GC, respectively), while ANK-F (FW:  $12 \pm 3$ ; LF  $8 \pm 1$ ; RI:  $10 \pm 2\%$ GC) showed no significant differences. TA EMG onsets for FW ( $11.8 \pm 2\%$ GC) were significantly faster ( $p < 0.05$ ) when compared to LF and RI (LF:  $20 \pm 4$ ; RI:  $25.2 \pm 3\%$ GC, respectively). On the other hand, GL onsets for LF ( $6 \pm 1\%$ GC) were significantly faster ( $p < 0.05$ ) when compared to FW and RI (FW:  $13 \pm 2$ ; RI:  $18.2 \pm 2\%$ GC, respectively). PER (FW:  $4 \pm 1$ ; LF  $9.4 \pm 2$ ; RI:  $8.9 \pm 2\%$ GC) showed no significant differences ( $p = 0.06$ ). **Discussion** EMG activity during FW shows increased TA and PER activity, providing stability immediately during slipping, in order to stabilize the ankle joint in the sagittal plane, while plantar flexors (as GL) are likely to be inhibited by reflex components related to TA muscular length [2]. On the other hand, during LF and RI slips there are faster muscular reactions for GL and especially PER, which may be a mechanism to stabilize the ankle during these faster kinematic changes in ANK-F regardless the direction. In this way, there are specific muscular requirements depending on the perturbation direction, for which maintaining ankle stability in the frontal plane requires more complex interactions of ankle muscles. **References** 1 - Van Doornik J, Sinkjaer T. (2007) IEEE Trans. Biom Eng. 54: 1696-1702. 2 - Tang P-F, Woollacott MH, Chong RKY. (1998) Exp Brain RE. 119: 141-152.

## THE EFFECTS OF SHOCK-ABSORBING INSOLES ON GRF CHARACTERISTICS DURING UPHILL WALKING AND RUNNING IN MILITARY BOOTS

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**Introduction** Despite the fact that stiff military combat boots has been associated with muscle fatigue and reduction in joint mobility (Scully & Besterman, 1982), there is still limited research in this area. Moreover, shock-absorbing insoles have been used extensively by military personnel in an attempt to reduce the magnitude and rate of impacts generated during walking and running. The aim of this study was to measure ground reaction force (GRF) characteristics during walking and running while wearing running shoes and military boots, with and without commercial insoles. **Methods** Seven trained males ( $24 \pm 2.6$  years) walked at 5 km/hr and ran at 10 km/hr with a 5% gradi-

ent on a Kistler h/p/Cosmos Gaitway treadmill. The participants completed three trials with different footwear conditions at each speed. The conditions were the participants' own running shoes, a military boot with no insole, and the military boot with a pair of Lonsdale performance EVA insoles. The sampling rate was 1000 Hz and data were recorded for 30 s during the fourth minute of each trial. GRF variables such as impact peak force and push-off rate were determined. A one-way ANOVA was conducted on each set of data with Tukey post hoc tests; alpha was set at 0.05. Results During walking, peak impact force was lower when participants wore their own running shoes ( $0.11 \text{ BW} \pm .08$ ) than when wearing the military boots either with ( $0.41 \text{ BW} \pm .03$ ) or without the insoles ( $0.43 \text{ BW} \pm .04$ ) ( $p < .001$ ). No differences for peak impact force were found during running. Push-off rate during the propulsion phase in walking was found to be significantly lower when wearing the insoles ( $9.9 \text{ BW/s} \pm 0.6$ ) compared to both the no insole condition ( $10.5 \text{ BW/s} \pm 0.9$ ) and the running shoes ( $10.5 \text{ BW/s} \pm 0.5$ ) ( $p = .011$ ), but once again no difference was found when running. No differences were found between shoe conditions for either walking or running in terms of impact loading rate. Discussion The cushioning properties of the running shoes led to a reduced peak impact force compared with the two military boot conditions during walking. Surprisingly, the use of combat boots with insoles did not lead to greater shock absorption than the use of the boots without insoles. The lower rate of force development during propulsion for the insoles might mean less energy is required to maintain a given walking pace. The absence of significant differences when running suggests that the boots are suitable for short military running activities with regard to GRF variables. In summary, the use of insoles did not improve the shock absorption capacity of the military boots. References Scully TJ, Besterman G. (1982). *Milit Med*, 147(4), 285-287.

## THE IMPACT OF INDIVIDUALLY FITTED CARBON INSOLES ON SPRINT PERFORMANCE IN COMPETITIVE CYCLISTS

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Introduction In modern cycling, the spotlight is increasingly being put on the interfaces between man and machine. In this study, the transmission of power from the foot to the pedal by dint of Solestar carbon cycling insoles was optimized. A special active principle, which supports and guides the foot during the entire pedaling cycle. An optimized ergonomics reduces the symptoms of physically overstraining specific to this particular movement and raises the performance brought to the pedal. It was examined whether an improvement of the average performance in a sprint for a period covering eight seconds can be achieved by dint of individually fitted carbon insoles. Methods Each test person ( $n=25$ ) completed three sprint tests of eight seconds each with the standard soles of his own racing bike shoes. After a standardized warm-up phase of ten minutes, a total of three sprints lasting eight seconds each were performed in intervals of five minutes (recovery phase). The performance measurement was done on the test person's own bicycle using a standardized Cyclus 2 gauge from the manufacturer RBM elektronik-automation GmbH. The maximum values and the average sprint performance covering eight seconds were measured in watt during all the sprints. Subsequently, each test person was equipped with suitable Solestar carbon insoles fitted individually to his foot and racing bike shoe. After a phase of getting accustomed to the insoles lasting two weeks, the sprint test (see above) was repeated. Within these two weeks, the test persons completed merely training units in basic endurance without sprint intervals so as to avoid performance-enhancing adjustment effects. Results We examined a total of 25 test persons (5 women, 20 men; average age:  $30.4 \pm 10.87$  years old; a range from 17 to 45 years old, average weight:  $70.05 \text{ kg} \pm 10.82 \text{ kg}$ ). The average sprint performance covering 8 seconds rose from  $896.9 \pm 167.3 \text{ W}$  to  $958.7 \pm 183.0 \text{ W}$  ( $p < 0.001$ ; paired t-test; 95% confidence interval of the change  $48.8 \text{ W} - 75.0 \text{ W}$ ) by  $61.9 \text{ W}$  (around 6.9%). Discussion A jump of the sprint performance in cycling in terms of the complete duration of a sprint covering eight seconds can be effected by dint of individually fitted carbon insoles. The optimization of transmission of power by an even distribution of power over the entire midfoot axis and the support of the arch using individually fitted carbon insoles for racing bike shoes is apparently the decisive factor for these results. References Anderson JC, Sockler JM. (1990) Effects of orthoses on selected physiologic parameters in cycling. *J Am Podiatr Med Assoc*;80(3):161-6. Baumgartner R, Stinus H. (2001). Die orthopädietechnische Versorgung des Fußes, Thieme, Stuttgart Glaister M, Stone MH, Stewart AM, Hughes MG, Moir GL. (2007). The influence of endurance training on multiple sprint cycling performance. *J Strength Cond Res*, 21(2):606-12 Jarboe NE, Quesada PM. (2003). The effects of cycling shoe stiffness on forefoot pressure. *Foot Ankle Int*. 24(10):784-8.

## ANALYSIS OF PLANTAR PRESSURE DISTRIBUTION DURING TYPICAL TECHNICAL GESTURES IN WOMEN BASKETBALL PLAYERS

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ANALYSIS OF PLANTAR PRESSURE DISTRIBUTION DURING TYPICAL TECHNICAL GESTURES IN WOMEN BASKETBALL PLAYERS Pau, M. and Caggiari, S. Department of Mechanical Engineering, University of Cagliari (Italy) Introduction In basketball, ankle and foot are anatomical sites characterized by high incidence of game-related injuries (35 to 40% of total, Borowski et al., 2008). Since the assessment of the magnitude and location of the maximum stresses at the body-ground interface is important in preventing injuries or reducing their seriousness (Guettler et al., 2006), this study intends to investigate plantar pressure distribution modification occurring during typical actions such as layup, free throws, three-point shots and jump shots. Methods Ten elite regional women basketball players were recruited for the study and asked to perform five repetitions of long and short distance shots and layups, while standing (or jumping and landing) barefoot on a pressure plate. The instrument was set to acquire contact pressure data for 5 seconds (at 200 Hz frequency) divided into 1000 temporal events. Raw data were then post-processed by means of a custom routine developed in the Matlab environment. On the basis of the analysis of the force-time curves, 10 frames (representative of the whole movement) were selected to extract plantar pressure distribution and calculate location and magnitude of the pressure peak in forefoot, midfoot and rearfoot. Results Generally speaking, absolute values of plantar pressure were found to be higher in the forefoot for the three-point shot (768 kPa) and layup (818 kPa), while lower values were observed in the case of free throws and jump shots (483 and 450 kPa respectively). The rearfoot appeared to be generally less stressed (121 kPa for three-point and 76 for free throws) and none of the players practically exploited rearfoot support during jump shots. For layup actions, a 520 kPa peak in rearfoot was estimated. Nevertheless, when the pressure values are expressed in terms of change with respect to basal conditions, three-point shots represent the most challenging condition, as pressure increases about 8-fold in the forefoot, while in layups only 4-fold. Discussion Most gestures investigated required a transfer of body load and push action from the lower limbs to the forefoot, and this resulted in extremely high pressure peaks typically located in the metatarsal region. Although short-distance shots require a minor effort, the pressure increases still remained noteworthy (up to six times higher than basal). Layup originated completely different patterns of pressure distribution as all the plantar subregions underwent significant increases, and thus the whole foot appeared to contribute to the jump action. References Borowski LA, Yard EE, Fields SK, Comstock RD (2008). *Am. J. of*

Sport Med., 36 (12), 2328-2335 Guettler JH, Ruskan GJ, Bytomoski JR, Brown CR, Richardson JK, Moorman CT (2006). Am. J. of Orth, 35 (11), 532-536

## **RUNNING IN TRADITIONAL RUNNING SHOES VS MINIMALIST RUNNING FOOTWARE: A KINEMATIC COMPARISON.**

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**Background.** Since the running boom in the 1970's and the injuries that followed, there has been an interest in developing running shoes that can help reduce the incidence of injury. Recently, one of the emerging philosophies in this area is that allowing the foot to move more naturally could help reduce the incidence of running injury. Recently a number of shoe manufactures developed shoes that allowed the joints of the foot more movement than the typical running shoe. The media has reported on this topic and much can be found online. Most of the material that can be found is based on testimonials and speculation. It is important to examine the differences and fill in the scientific information to determine if the minimalist running footwear has the potential to help lower the incidence of running injuries. To help build a collection of data on this topic, we analyzed running kinematics in 7 runners wearing both minimalist footwear and their normal running shoes. **Purpose.** To examine the kinematic differences between running in traditional running shoes vs minimalist running footwear at different velocities. **Methods.** Seven healthy recreationally runners were ask to run on the treadmill at 3 different speeds for 5 minutes at each speed, in both their normal running shoe and a pair of minimalist shoes. The first speed was a comfortable jog and the next 2 speeds were 0.22 and 0.45 m/s faster. Kinematic data was captured using the Vicon motion capture system. Data was collected during the last minute of each 5 minute interval when the subjects had reached steady state, as controlled using a metabolic cart. The following variables were analyzed: type of foot strike (forefoot or rearfoot), stride length, stride frequency. Additionally the interaction between running speed and these variables was also evaluated. **Results.** Of the 7 subjects 5 were heel strikers and 2 were forefoot strikers for all velocities in the normal running shoes. Of the 5 heel strikers under baseline conditions, 3 became forefoot strikers while running in the minimalist shoes. The 2 forefoot strikers remained as forefoot strikers. Stride length and frequency was lesser and greater respectively in the minimalist running shoes for 4 subjects, while the other 3 subjects showed mixed results that were velocity dependent. In subjects with mixed results the differences tended to emerge at the faster velocities. **Discussion.** The results show that wearing minimalist footwear while running can cause changes in running technique. This was expected, as one of the main differences between the two types of shoes is that the minimalist running shoes do not have a heavily padded heel and therefore a heel strike can be uncomfortable in minimalist footwear. It is not yet known what effect these changes have on injury.

## **EFFECTS OF SLIGHTLY-WEIGHTED-SHOE INTERVENTION ON LOWER LIMB MUSCLE MASS AND GAIT PATTERNS IN THE ELDERLY: A RANDOMIZED CONTROLLED TRIAL**

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**Introduction** Flexed-knee locomotion is one of the gait characteristic in the elderly (Ostrosky et al 1994, Begg and Sparrow 2006). This may be partly due to the age-related decline of lower limb muscle mass (LM). Browning et al. (2007) reported that distal leg loads increase lower limb muscle electromyographic activity during walking. The purpose of this study was to investigate the effects of 12-wk slightly-weighted-shoe intervention under the free living on LM and gait patterns in older people. **Methods** A total of 29 healthy participants who had walking habits were randomized to a slightly-weighted-shoe (WS: 493g for each) or normal-shoe (NS: 293g for each) intervention groups. The participants were instructed to maintain their daily physical activity (PA) during 12-wk intervention. Segmental intracellular water (ICW) and muscle thickness (MT) were measured as an index of LM. Gait data were acquired by two-dimensional motion analysis. Participants instructed to walk with their usual speed, and performed a walking task alone or walking with cognitive task (subtracting serial 3s). Walking stability was assessed as a standard deviation of vertical fluctuation of whole-body center of mass (COM fluctuation). The daily PA was monitored by a uni-axial accelerometer and activity record. **Results** The participants did not change their PA during intervention. However, significant increases in the ICW in the upper leg and muscle thickness of rectus femoris (RF) were observed after intervention in the WS group only ( $p < 0.01$ ). For the gait parameters, COM fluctuation during walking under dual-task was significantly reduced in the WS group ( $p < 0.05$ ). In addition, knee joint angle during single-leg standing phase was significantly extended more in the WS group ( $p < 0.05$ ). **Discussion** The WS intervention increased LM, and knee joint angle was extended more during single-leg standing phase. The participants did not change their PA, and thus, the results of this study are likely due to the weighted shoes. The previous study indicated that walking with distal leg loads increase lower limb muscle activities including RF (Browning et al. 2007). The present study demonstrated that slightly-weighted-shoe (plus 200g) interventions may be able to increase LM and change gait patterns in the healthy elderly. **References** Ostrosky KM et al. Physical Therapy. 74: 637-644, 1994. Begg RK and Sparrow WA. J Med Eng Technol. 30: 382-389, 2006. Browning RC et al. Med Sci Sports Exerc. 39: 515-525, 2007.

## **Poster presentations**

### **PP-BN07 Sports Biomechanics 2**

## **THE ANTERO-POSTERIOR MOVEMENT OF THE SACRUM AS AN INDICATOR OF THE ANTERO-POSTERIOR MOVEMENT OF CENTER OF MASS IN RUNNING**

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**THE ANTERO-POSTERIOR MOVEMENT OF THE SACRUM AS AN INDICATOR OF THE ANTERO-POSTERIOR MOVEMENT OF CENTER OF MASS IN RUNNING** Halvorsen K.1,2, Eriksson, M.1, Nilsson, J.3, Tinmark, F.3, Gullstrand, L.4 1: KTH (Stockholm, Sweden), 2: UU (Uppsala, Sweden), 4:GIH (Stockholm, Sweden), 3: RF-EIC (Lidingö, Sweden) **Introduction** The antero-posterior velocity of Centre or Mass (CoM) fluctuates over a step cycle in running, due to air resistance and to the ground forces acting on the foot of the athlete. The fluctuation is a basic charac-

teristic of a runner's technique, and is believed to influence running performance (Nummela et al. 2007; Støren et al. 2010). The vertical movement of the sacrum has previously been found to well describe the vertical movement of CoM (Gullstrand et al 2009). Can it also be used for the antero-posterior movement? Methods Fourteen male athletes ran on a treadmill at velocities of 10, 12, 14, 16, 18, 20 and 22 km/h. With a motion capture system, the centre of mass was calculated from 40 reflective markers with a model consisting of 13 rigid body segments. At each velocity, 10s of data was used for further analysis. The difference between the minimum and maximum velocity and displacement in the antero-posterior direction was calculated for CoM and the sacrum for each step. The relation between the movement of the sacrum and that of the CoM was assessed using linear regression with data from all velocities. Results The horizontal displacement of the sacrum (median 3.9cm) was almost three times that of the CoM (median 1.4cm). The sacrum displacement increased with running velocity, but CoM displacement did not. The linear regression showed a significant slope (0.34,  $p < 0.001$ ), but small effect size (adjusted R-squared 0.22), meaning that the displacement of sacrum is a limited predictor for CoM displacement. The relation between variation in sacrum velocity (median 0.83m/s) and the variation in CoM velocity (median 0.24m/s) showed better predictive power (adjusted R-squared 0.41), with a clearly significant ( $p < 0.001$ ) slope of 0.15. Discussion The displacement of the sacrum is not a good predictor for CoM displacement in the antero-posterior direction, but variation in sacrum velocity can be useful with the regression coefficients found here. However, due to the moderate R-squared value, average values over several steps should be used. The change in velocity of the sacrum is an interesting measure for real-time feedback to the runner, but it should be noted that the feedback may induce a change in the correlation between the sacrum and CoM velocity without inducing a desired change in CoM velocity. References Gullstrand L, Halvorsen K, Tinmark F, Eriksson M, Nilsson J (2009). G & P, 30, 71-75. Nummela A, Keränen T, Mikkelsen LO (2007). Int J Sports Med, 28, 655-661. Støren Ø, Helgeland J, Hoff J (2010). J Str Cond Res, 25, 117-123.

## A STUDY OF THE STEP LENGTHS IN VELOCITY TEST IN ELITE SOCCER PLAYERS

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Introduction Because its importance, Soccer players regularly practice sprints (Stolen et al., 2005; Gregorat, 2008). Running 20 m with a standing body Start Posture (SP) evaluates acceleration and Maximum Cyclical Velocity (MCV) (Grosser and Starischka, 1989). The first push-off at start is stepping backwards with the leading foot, giving power in a shorter time and increasing acceleration (Kraan et al., 2001). The maximum velocity depends on step length (SL) and step frequency, and for experienced soccer players step frequency is what mostly contributes to their velocity (Grosser, 1991). Methods Sixteen male elite soccer players (height  $1.77 \pm 0.04$  m; weight  $73.84 \pm 5.20$  kg and age  $28 \pm 5$  years) were tested in 20 m sprints. The times and velocities were measured with a fully automatic system (Foto Finish, Hy-Tek's Meet Manager) at exactly 5 m and 15 m from the starting line. The sagittal sequences were taped to determine SL at SP and at MCV. The degree of linear dependency (Pearson,  $r$ ) has been calculated ( $p < 0.05$ ). The null hypothesis is that there is no relation between the SL involved at SP and at MCV. Results The calculated data (mean  $\pm$  SD): A. Distance between leading foot toes and rear foot toes at SP ( $0.71 \pm 0.094$  m) B. Step backwards ( $-0.11 \pm 0.079$  m). C. First step ( $0.91 \pm 0.098$  m). D. Rear foot first step length ( $1.61 \pm 0.094$  m). E. Time registered to the 5 meters ( $1.49 \pm 0.038$  s). F. First step length in MCV ( $1.42 \pm 0.072$  m). G. Second step length in MCV ( $1.48 \pm 0.080$  m). H. Step frequency ( $4.66 \pm 0.370$  steps / second). I. Time registered to the 15 meters ( $2.84 \pm 0.073$  m). J. Individual's height / stride length\* 100 ( $61.23 \pm 2.574$  %). The significant values are: A-C  $r = -0.518$ , C-D  $r = 0.524$ , F-G  $r = 0.711$ , F-J  $r = -0.777$ , G-H  $r = -0.694$ , H-I  $r = -0.600$ , H-J  $r = 0.655$ , E-I  $r = 0.870$ , F-H  $r = -0.858$ , and G-J  $r = -0.899$ . The other variables are not connected. Discussion The faster individual almost do not step backwards and those that were not between the 10 faster players, step back  $> 20$  cm. A greater step frequency with a greater percentage of the relation stature / stride correspond to a first step SL  $< 1.5$ m. The players with the greatest step frequency ( $> 5$  steps/s) are between the faster players, and are also those with large stature / stride relation. At the MCV, the individuals with the longest stride are between the slowest players, and vice versa. In this study the results indicate that there is no relation between the SL involved in the sprint start and in the MCV. References Gregorat J. (2008). PubICE Standard. Pid: 1064. Grosser M. (1991). Schnelligkeitstraining: Grundlagen, Methoden, Leistungssteuerung, Programme. München. BLV. Grosser M, Starischka S. (1989). Test de la condición física. Ediciones Roca, S.A. México. Kraan GA, van Veen J, Sijnders CJ, Storm J. (2001). Starting from standing; why step backwards?. J Biomech 34, 211-215 Stolen T, Chamari K, Castagna C, Wisloff U. (2005). Physiology of Soccer –An Update. Sports Medicine 35(6), 501-536

## SYMMETRY OF SUPPORT SCULL IN VERTICAL POSITION IN SYNCHRONIZED SWIMMING

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SYMMETRY OF SUPPORT SCULL IN VERTICAL POSITION IN SYNCHRONIZED SWIMMING Dubiel-Wuchowicz K., Rutkowska-Kucharska A. Department of Biomechanics, University School of Physical Education, al. J. Paderewskiego 35, 51-612 Wrocław, Poland Introduction Biomechanical description of the specific movement structure in synchronized swimming is one of the most important research problems of technique (Hall, 1996, Homma 2008). One of the most difficult technical elements of synchronized swimming is maintaining a vertical position. The performance of this position is made possible by the specific technique of underwater arms movements called support scull. The symmetry of support sculling movements determines the stability of the vertical position and has a large impact on the sport results. Very often the research on symmetry in swimming concerns the techniques of competitive swimming where the spatial symmetry reflects the high-class swimmers (Aujouannet et al. 2004). The aim of the present study is the observation for the symmetry of support scull of right and left upper extremities swimmers with different levels of sport's abilities. Methods Two synchronized swimmers with different levels of sport's abilities (A and B) were filmed under the water while performing 8 cycles of sculling movements. Three-dimensional motion analysis was supported by the SIMI Motion Software. Optical axes of both cameras were arranged perpendicularly to each other. On the basis of three markers set, the angles of wrist elbow and shoulder joints in both upper extremities were computed. The coefficients of variation of time parameters (time of the abduction phase and the adduction phase) and angular spatial parameters were obtained. The dynamical asymmetry index  $DAI(t) = \frac{|Xr(t) - Xl(t)|}{0.5(Xr(t) + Xl(t))}$  was then acquired which is the relative difference between the range of motion of the right and left joint angle. Results Asymmetry characteristics of DAI for the shoulder-elbow-wrist angle (SEW), shoulder-elbow fingers angle (SEF) and elbow-wrist-fingers angle (EWF) for both swimmers are shown. All DAI characteristics are synchronized in time. The dynamical asymmetry index DAI and the coefficients of variation (V) vary between synchronized swimmers. The ability to perform more symmetrical support scull movements characterises the better swimmer. The coefficients of variation of time of abduction and adduction of the right and left limb are: A)  $V_{prawa} = 0.15\%$ ,  $V_{2prawa} = 0.05\%$ ,  $V_{lewa} = 0.15\%$ ,  $V_{2lewa} = 0.09\%$  and B)  $V_{prawa} = 0.2\%$ ,  $V_{2prawa} = 0.12\%$ ,  $V_{lewa} = 0.26\%$ ,  $V_{2lewa} = 0.2\%$ . References Hall S.J (1995). Proceedings XIII International Symposium on Biomechanics in Sport, Lakehead University, Thunder Bay, Ontario, Canada, 44-47. Homma M, Homma Ma (2008). I International Scien-



tific Conference of Aquatic Space Activities, Tsukuba, Japan, 110-115. Aujouanet Y, Bonifazi M, Hintzy F, Rouard A (2004). Proceedings IX Annual Congress of the ECSS, Clermont-Ferrand, France.

## THE EFFECTS OF FOLLOW-THROUGH ON UPPER AND LOWER LIMBS PERFORMANCE DURING STATIONARY TEE BASE-BALL HITTING

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**Introduction** The follow-through in baseball hitting has dual intention of reducing the risk of injury and preventing interference with the application of force to the ball (Hay, 1993). In addition, sometime coach would suggest hitter to extend follow-through after bat-ball contact to provide more accuracy swing trajectory when hitting. Nevertheless, it is unknown how baseball hitting performance change in difference follow-through, such as comparing a normal follow-through to a extend follow-through. Therefore, the purpose of the current study was to compare baseball hitting performance between a normal follow-through and a extend follow-through. **Methods** One Minor League Baseball (MiLB) athlete subject was enrolled into the study. The Motion Analysis System (Eagle Cameras; Motion Analysis, Inc., Santa Rosa, CA., USA) with 8 infrared rays cameras (200Hz) were used for captured the baseball hitting movement from stationary batting tee. Preceding data collection, 44 reflective markers was placed on the hitter, bat, and ball (Escamilla et al., 2009a, 2009b; Welch et al., 1995). The two best line drive hits were used for data in this study. Dependent t tests were employed to test for differences in kinematic and temporal parameters between the normal follow-through and extend follow-through. **Results** The temporal acceleration phase parameter of normal follow-through (0.18 s) was significantly less time than extend follow-through (0.218 s). There were no significant differences between using normal or extend follow-through in upper and lower extremity angular displacement parameters, stride length, and bat linear velocity at bat-ball contact. Compared with using the normal follow-through (178 deg/s), using the extend follow-through (202 deg/s) resulted in significantly greater peak left knee extension angular velocity. **Discussion** In the current study, upper and lower extremity angular displacement were similar at four events (lead foot off ground, lead foot contact with ground, hand started to move forward, bat-ball contact). Moreover, the result showed no difference in stride length, and bat linear velocity at bat-ball contact. Therefore, the pattern of follow-through would not affect the angular displacement of limbs, linear displacement and velocity parameter. The tendency of some result was similar to hitting biomechanics data presented in previous studies (Escamilla et al., 2009a, Welch et al., 1995). The acceleration phase was significantly spend more time with the extend follow-through. Therefore, subject must start the swing movement early when using extend follow-through in real game baseball hitting. **References** Escamilla R, Fleisig G, DeRenne C. Taylor M, Moorman C, Imamura R, Barakatt E, Andrews J. (2009a). J Appl Biomech, 25(3), 203-209. Escamilla R, Fleisig G, DeRenne C. Taylor M, Moorman C, Imamura R, Barakatt E, Andrews J. (2009b). J Appl Biomech, 25(3), 210-218. Hay J. (1993). The Biomechanis of Sports Techniques, 221. Welch C, Banks S, Cook F, Draovitch P. (1995). J Orthop Sports Phys Ther, 22(5), 193-201.

## BIOMECHANICAL ANALYSIS OF DIFFERENT INCREMENTAL SWIMMING PROTOCOLS. A CASE STUDY

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Incremental protocols are being commonly used as a standard procedure for swimming aerobic performance assessment. As different step durations of the incremental protocols seems to impose different results, we aimed to evaluate and compare the stroking parameters, swim efficiency, and arm coordination during three incremental and intermittent protocols with different step durations. **METHODS:** An European level triathlete (age: 19yrs; weight: 69kg, height: 175cm) performed 6x200m, 6x300m and 6x400 intermittent incremental protocols ,with 30s rest intervals, being the swimming velocity (v) controlled by a visual pacer (TAR.1.1, GBK-electronics). All protocols were videotaped and images were digitized using the APASystem. Two complete arm stroke cycles of the last 50m lap of each step were analysed. V and stroke length (SL) were calculated using the right hip point as the marker and the stroke rate (SR) was assessed of the ratio v by SL. Swimming efficiency was obtained through the intracycle velocity variations (IVV, assessed by the v coefficient of variation), and the arm stroke efficiency ( $\eta_F$ , calculated through the underwater phase only, Zamparo et al., 2005). The arm coordination was assessed using the index of coordination (IdC, Chollet et al., 2000). **RESULTS:** The SR increased (from 0.44Hz to 0.81Hz) and SL decreased (from 2.65m to 1.99m) throughout all the incremental protocols with a similar behavior. The IVV presents a constant behavior along the steps, with similar results between protocols (comprehended between 0.25 e 0.31) The  $\eta_F$  appear to decrease throughout the incremental steps of each protocol. The IdC values were negative (-11.3%,-19.1%) in the three protocols, presenting an increase at higher swimming intensities, and a slight tendency to be more negative in 6x200m protocol. **DISCUSSION:** The different step durations of the incremental protocols seems to do not to affect the stroking parameters behavior since the SR and SL combination was not modified and is in accordance with the literature. Despite the  $\eta_F$  decreased as the swimmer reach higher swimming intensities, he seems to be able to adapt his stroke technique to maintain IVV (as seen by Seifert et al., 2010). The arm coordination (IdC) presented a slight tendency to be more discontinuous in the 6x300m and 6x400m protocols, which might indicate that the swimmer was in a higher fatigue state (Alberly et al., 2005) as compared 6x200m that is the incremental protocol mostly used by coaches and researchers. **REFERENCES** Alberly, M et al. (2005). Int J Sports Me, 26(6), 471-475. Chollet, D. (2000). Int J Sports Med, 21(1), 54-59. Zamparo, P. et al. (2005). Eur J Appl Physiol, 94, 134-144. Seifert el al. (2010). Human Mov Sci, 29(3), 426-439. Acknowledgement FCT PTDC/DES/101224/2008 grant:

## ASSESSMENT OF POWER STRENGTH IN ELITE SOCCER PLAYERS BY MEANS OF VERTICAL JUMP

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**Introduction** Implementation of a vertical jump is usually evaluated in three types of execution. Reiser (2006) describes three types of vertical jump. The first type is with knees bent with the help of the upper limbs – countermovement jump – free arms (CMJ-F), the next is with knees bent without the support of the upper limbs – countermovement jump (CMJ) and the squat jump without the help of the upper limbs – squat jump (SQJ). The squat jump without the help of the upper limbs starts from a static position and movement initialization is only in the vertical direction upwards (Bobbert et al , 2005). **Methods** The observing group was composed from top level players (n=30; age=26,4±5,3 years; height=183±4,8 cm; weight=79±7,5 kg). The lower limbs strength was scanned by Kistler Force platform (KISTLER Instrumente AG, Switzerland). Participants performed three types of a vertical jump, T1 – CMJ-F, T2 – CMJ, T3 – SQJ and three successful trials of each type of the jump. The best performed trial was chosen for the evaluation. **Results** The maximum height of the jump was

achieved in the first type when  $h_1 = 0,441 \pm 0,049$  m. This result was better by 12,2% (0,054 m) compared to the jump from standing position without the arm support (T2) and by 21% (0,093 m) higher than the squat jump without the arm support (T3). Variance between the best and worst performance, i.e. jump height (h) was comparable in all types of jump implementation ( $T1var = 0,18$  m,  $T2var = 0,16$  m,  $T3var = 0,17$  m). Decelerating impulse (I1) reached the highest mean value in test T2 ( $I1T2 = 130,3$  N.s), which is higher by 19 % (24,8 N.s) in comparison to test T1. Strength impulse in the take off phase (I2) was highest in T1 ( $I2 = 263,8 \pm 23,9$  N.s), the lower value was in test T3 ( $238,2 \pm 22,1$  N.s). Discussion In the monitored group these mean values ranged T1  $h = 0,441$  m, T2  $h = 0,387$  m and T3  $h = 0,347$  m. In comparison to basketball players, for instance, they are lower; in the study (Ziv and Lidor 2010) there are values of T1  $h = 0,61$  m, T2  $h = 0,439$  m and T3  $h = 0,398$  m. In all types of the vertical jump we noticed shorter times of the braking phase (t1) compared to the time needed for individual the take off (t2). In the case of the braking phase, variance was  $t1varT1 = 0,16$  s and in a reflective phase  $t2varT2 = 0,18$  s. Similar intraindividual variability was found in test T2 at both phases of the take off ( $t1varT2 = 0,11$ , i.e.  $t2varT2 = 0,16$  s). Highest variance was found in the reflective phase in the squat jump without the help of arms, when  $t2varT3 = 0,21$  s. This project was supported by GACR P407/11/P784 and MSM 0021620864. References Bobbert et al., *Med Sci Sports Exerc*, 37(4), 440-446, 2005. Reiser et al., *Strength and Conditioning Journal*, 28(4), 70-80, 2006. Ziv et al., *J Sci Med Sport*, 13, 332-339, 2010.

## RUNNING IN TRIATHLON: THE EFFECT OF PREVIOUS RUNNING EXPERIENCE ON STRIDE PARAMETERS AND KINEMATICS

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UNIVERSITY OF BIRMINGHAM

**Introduction** The sport of triathlon combines swimming, cycling and running. However, the movement patterns associated with these disciplines are vastly different from one another and substantial training in any one of these disciplines may have a detrimental effect on the others. Cycling has been proposed to be the underlying cause of the differences in running technique between triathletes and runners (Connick and Li, under review). In order to maximise aerodynamics, cycling is often conducted in an extremely flexed posture; this position requires the hips and knees to be maintained in a flexed position for long durations, which may cause a shortening of the hip flexors. **Methods** In order to investigate adaptations to cycling, running technique of 9 pure triathletes, 9 triathletes with a running background, 9 runners and 9 cyclists were explored using 3D kinematic data collected via a 13 camera Vicon system. All participants carried out 2 minute bouts of treadmill running at randomly assigned velocities (13, 15 and 17km/h). Prior to running measures, static hip flexibility measures were collected using the Modified Thomas Test. **Results** There was a significant main effect of running background on stride length (SL) ( $F(3, 32)=6.67$ ,  $p=0.001$ ); thigh extension ( $F(3, 32)=10.35$ ,  $p=.001$ ) and pelvic tilt ( $F(3, 32)=6.68$ ,  $p=.001$ ). Post hoc measures showed runners exhibited significantly longer SL than cyclists ( $p<0.001$ ) and pure triathletes ( $p=0.004$ ). Cyclists had significantly shorter strides than triathletes with a running background ( $p=0.03$ ). There was no significant difference between pure triathletes and cyclists ( $p=0.24$ ). Runners exhibited greater thigh extension than pure triathletes ( $p=0.005$ ), triathletes with a running background ( $p=0.026$ ) and cyclists ( $p=0.001$ ). Cyclists displayed significantly less thigh extension than triathletes with a running background ( $p=0.003$ ) and triathletes ( $p=0.017$ ). Runners also exhibited significantly greater pelvic tilt than cyclists ( $p<0.001$ ), triathletes with a running background ( $p=0.010$ ) and pure triathletes ( $p=0.008$ ). No significant differences we found between cyclists and triathletes with a running background ( $p=0.105$ ) or pure triathletes ( $p=0.127$ ). No significant differences were found between the triathlete groups in any of the measures. **Discussion** Cyclists exhibit running kinematics that differ most from runners. As these occur in the same parameters as when triathletes are compared to runners, it is likely that the volume of cycling undertaken by triathletes is the causal factor. Triathletes from a running background also exhibit differences in running kinematics when compared to runners but not in comparison to triathletes. It seems that increased running ability when starting out in triathlon levels out when cycling is undertaken as part of triathlon training. **References** Connick, M.J. and Li, F-X. (under review). The effect of running velocity on stride parameters and kinematics in runners and triathletes.

## TREADMILL FATIGUE TILL EXHAUSTION DOES NOT ALTER SOCCER KICKING PERFORMANCE IN FEMALE PLAYERS

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**Introduction** The design of effective training protocols requires an understanding of how technique may change when the player is fatigued, as frequently occurs within a game. Although female soccer is in growth (Ekblom, 1994) few studies have examined kick biomechanics in females (Barfield et al., 2002; Clagg et al., 2009), especially under fatigue conditions. Therefore, the purpose of the present study was to examine the effects of fatigue on the biomechanical characteristics of instep soccer kick in female players. **Methods** Ten female amateur soccer players (age:  $24.4 \pm 4.2$  yrs, height:  $169.7 \pm 5.71$  cm, mass:  $61.8 \pm 5.1$  Kg, training age:  $10.7 \pm 3.1$  yrs) performed 3 consecutive instep kicking trials of a stationary ball prior to and after the implementation of a fatigue protocol, where players had to run on a treadmill until exhaustion (Abdul-Aziz et al., 2005). Three-dimensional kinematics (6-camera Vicon motion analysis system, 120 Hz) including the duration of the kick, ball speed, ball-to-foot speed ratio, linear velocities of the ankle, knee and hip were collected pre and post fatigue. Ground reaction forces were also analyzed using a Bertec platform. An independent two-tailed Student's t-test was used for comparisons between the two kicking conditions. **Results** The results indicated a non-significant effect of fatigue on kicking performance ( $P > 0.05$ ). Particularly, the duration of the kicking trials ( $918 \pm 131$  vs  $876 \pm 90$  msec), ball speed values ( $18.4 \pm 1.5$  vs  $17.4 \pm 1.9$  m/sec), linear velocity of the hip ( $0.7 \pm 0.2$  vs  $0.6 \pm 0.3$  m/sec), the knee ( $2.1 \pm 0.5$  vs  $1.8 \pm 0.4$  m/sec) and the ankle ( $11.3 \pm 1.4$  vs  $10.8 \pm 0.8$  m/sec), vertical ( $756.4 \pm 292.4$  vs  $668.2 \pm 351.1$  N), anteroposterior ( $28.2 \pm 16.3$  vs  $44.1 \pm 21.3$  N) and mediolateral ( $219.5 \pm 92.6$  vs  $181.1 \pm 140.9$  N) ground reaction forces at impact did not differ after the implementation of the fatigue protocol ( $P > 0.05$ ). **Discussion** The results of the present study showed that fatigue did not affect kicking performance. Contrary results have been reported in the literature (Appriantono et al., 2006; Kellis et al., 2006). However, previous studies have examined male players and applied different protocols, thus making the comparisons difficult. The present study suggests that female players under fatigue conditions can perform a maximum kick as fast as before the game. **References** Abdul-Aziz R., Tan F. & Teh K. (2005). *J Sports Sci Med*, 4, 105-112. Appriantono T., Nunome H., Ikegami Y. & Sano S. (2006). *J Sports Sci*, 24, 951-960. Barfield W.R., Kirkendall D. & Yu B. (2002). *J Sports Sci Med*, 3, 72-79. Clagg S., Warnock A. & Thomas J. (2009). *Sports Biom*, 8, 141-152. Ekblom B. (1994). *Football (soccer)*. Blackwell Scientific Publications. Kellis E., Katis A. & Vrabas IS. (2006). *Scand J Med Sci Sports*, 16, 334-344.

## INTRAINDIVIDUAL BIOMECHANICAL VARIABILITY IN BACKHANDSPRING IN DIFFERENT LEVELS OF EXPERTISE

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**Introduction** Gymnastics is characterized by closed skills motor tasks that require consistent movement patterns with minimal variations. As movement variability decreases with practice (Shumway-Cook and Woollacott, 2007), repeated practice is largely used by gymnasts to obtain movement consistency. The hypothesis for this study was that movement variability decreases as level of expertise increases. Thus, the purpose was to compare intra-individual biomechanical variability in the execution of the back handspring on the floor between two female gymnasts at different competition levels. **Methods** Two female gymnasts volunteered in the study. The gymnasts competed respectively in pre-junior (L2) and junior (C2) categories. Kinetics data from a Kistler force platform (1000 Hz) of the dominant hand were collected during six trials of back handsprings for each gymnast. The hand contact time, average vertical force, impact peak, time to impact peak and impulse were compared between the gymnasts by using the Mann Whitney test. Intra-individual variability was calculated by using %RMSD. Results Average vertical force and impact peak resulted to be significantly different between the gymnasts. The intra-individual variability recorded were 13%L2 and 6%C2 for the hand contact time, 7%C2 and 2%L2 for average vertical force, 12%C2 and 5%L2 for impact peak, 18%C2 and 25%L2 for time to impact peak and 19%C2 and 5%L2 for the impulse. **Discussion** Lack of significant differences in temporal variables showed that coordination level was not improved at a higher level of expertise. Similar findings were obtained by a previous study focus on variability among baseball pitchers (Fleising et al, 2009). On the contrary, the significant differences found in kinetics measures in this study contrasted with the results reported by Fleising et al (2009). The significant difference in the impact peak could represent an increased risk of injuries for the pre-junior gymnast. The pre-junior gymnast had a greater intra-individual variability in all the variables in comparison to the junior gymnast with the exception of the time to impact peak. The variability that characterized the pre-junior gymnast's performance was a random variability caused by a reduced ability to control the task. The variability showed by the junior gymnast was a functional variability that represented a personal strategy used to complete the motor task (Barlett et al 2007). A better understanding of the biomechanical intra-variability associated with different level of expertise in closed skills sport can effectively contribute to accelerate the learning process and reduce the risk of injuries. **References** Bartlett R, Wheat J, Robins M. (2007). *Sports Biom* 6 (2), 224-243. Shumway-Cook A, Woollacott MH (2007). Fleising G, Chu Y. Weber A, Andrews J. (2009) *Sports Biom* 8(1) 10-21.

## STRIDE RATE AND RUNNING MECHANIC IN TRIATHLETES

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**Introduction** The aim of our study is to assess relationship between the kinematic running variables in competition and the differences in these variables between low and high stride rate. **Methods** The work was conducted in competitive conditions with 17 triathletes (14 men and 3 women) of age group competitive level in Sprint and Olympic distance. The competition recording were held in a sagittal plane with a Canon digital camera to 25 Hz at the middle of the first running segment, using a reference system of 4-points, to obtain the kinematic parameters was used the Dartfish Connect 5.5 software, which allows make an analysis in two dimensions, calculating several variables relating to joint angles and distances. Running speed was calculated from the stride rate (SR) and stride length. The kinematic parameters were calculated in 5 key positions following the standards of Leskinen researches (2009) and our own standard: First contact with the ground, hip at the level of support, foot last contact with the ground, maximum knees separation and landing. We used the mechanical model of the human body of 14 segments. Pearson correlations were performed between each variable obtained from each triathlete. Also we studied the effect of SF on this variables, therefore following the observations of Daniels (2005) that good runners have a SR bigger than 90 cycles · min<sup>-1</sup>, the sample was divided in 2 groups, low frequency (LF; n=7; less than 90 cycles · min<sup>-1</sup>) and high frequency (HF; n=10; more than 90 cycles · min<sup>-1</sup>) assessing the average differences between both groups of each variable with an independent t-test. Statistical significance was established at 0.05 in both methods. **Results** We found significant correlations between speed and stride length ( $r = 0.96$ ), the maximum knees separation and speed ( $r = 0.89$ ), maximum knee flexion in support and knee angle landing ( $r = 0.82$ ), the strength index (propulsive distance / (stride length - landing distance)) and the knee angle in the recovery phase ( $r = 0.78$ ), anterior thigh angle to the vertical at the time of knees maximum separation and speed ( $r = 0.70$ ),  $p < 0.05$ . We found significant differences between HF and LF in vertical oscillation ( $6.11 \pm 1.66$  vs.  $7.84 \pm 2.29$  cm;  $t(15) = 1.81$ ;  $p < 0.05$ ), knee angle landing ( $158.99 \pm 4.90$  vs.  $163.83 \pm 5.54$ ;  $t(15) = 1.90$ ;  $p < 0.05$ ). **Discussion** Triathletes with a SR of more than 90 cycles · min<sup>-1</sup> have less vertical oscillation and knee angle landing. Also high values of knee angle at the time of first contact with the ground relate to high values in maximum knee flexion angle in support. The most correlated variables with running speed in competition are stride length and maximum knee separation. **References** Daniels, J. (2005). Daniels' Running formula. Leeds: Human kinetics. Leskinen, A., Häkkinen, K., & Virmavirta, M. (2009). Comparison of running kinematics between elite and national-standard 1500-m runners. *Sports Biomechanics*, 8(1), 1-9.

## ELECTROMYOGRAPHIC ANALYSIS OF TRUNK MUSCLES DURING THE GOLF SWING PERFORMED WITH TWO DIFFERENT CLUBS

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FACULTY OF HUMAN KINETICS – TECHNICAL UNIVERSITY OF LISBON

**Objective:** The objective of this study was to compare the EMG patterns of trunk muscles during the different phases of the golf swing performed with two different clubs: a pitching wedge and a 4-iron club. **Methods:** Ten male golfers (handicap range 5-20) performed five swing shots with the pitching wedge and five swings with the 4-iron, in a random sequence. Surface electromyography (sEMG) was recorded from trunk muscles of both sides: rectus abdominis (RA), external (EO) and internal oblique (IO), erector spinae (ES) and gluteus maximus (GM). The sEMG signals were normalized using the sEMG of the maximal voluntary contraction (MVC) as reference. The average sEMG signal during each phase of the golf swing was determined. For delimitation of golf swing phases the swing was filmed with four high speed video cameras (100 Hz). Descriptive statistics were reported as mean  $\pm$  SD. Data were tested for normality with the Shapiro-Wilk test. Paired t-tests were performed to assess differences between club types (pitch and 4-iron). The significance level was set at 5%. **Results:** In most of the cases and phases trunk muscles showed higher mean values of EMG activation when the swing was performed with the 4-iron club. Nevertheless, significant statistical differences were found only in some cases. This is probably due to the high degree of variability between subjects. Significant differences ( $p = .026$ ) were only found during backswing phase on the left IO that showed a slight increase (1% MVC) in the level of activation when the swing was performed with the 4-iron. During Forward Swing phase,

significant differences between clubs were found, with higher levels of activity with the 4-iron club, for the left RA ( $p=.029$ ) and right IO ( $p=.014$ ) representing differences of 2 and 3% MVC, respectively. No significant differences between clubs were found for any studied muscle during the Acceleration phase. During Early Follow-Through the right ES was the only muscle that showed significant differences ( $p=.032$ ) between clubs, with an increase of 3% MVC when the swing was performed with the 4-iron club. During Late Follow-Through the IO showed significant differences between the two types of club in both sides, left ( $p=.003$ ) and right ( $p=.02$ ), with increases of 11% and 3% MVC, respectively, when the swing was performed with the 4-iron club. Significant increase was also observed in the left EO ( $p=0.04$ , 5% MVC) and in the left RA ( $p=0.009$ , 1% MVC). Conclusion: Comparing the EMG activation of trunk muscles during the golf swing performed with a pitching wedge and a 4-iron club, we can conclude that as a general tendency, trunk muscles were recruited with higher EMG activation when the swing was performed with the 4-iron club.

## 16:15 - 17:45

### Oral presentations

#### OP-SH04 Anticipation, Skill and Identity

##### ANTICIPATION OF DECEPTIVE SOCCER PENALTY KICKS

SMEETON, N.J.1, WILLIAMS, A.M.2,3

1 UNIVERSITY OF BRIGHTON, CHELSEA SCHOOL, UK 2 THE UNIVERSITY OF SYDNEY AND 3 LIVERPOOL JOHN MOORES UNIVERSITY, UK

**Introduction** When attempting to anticipate deceptive actions a different mode of visual perception may be evoked compared to making judgments on actions containing no deception. The use of exaggeration in the deceptive movement is thought to change visual perception from a 'direct' to a more 'indirect' or conscious mode of functioning (Jackson et al., 2005). This transformation is typically evidenced by a change from under to over estimation of confidence in the accuracy of the decision as well as a stronger correlation between confidence and accuracy (Runeson et al. (2000). **Methods** Skilled and less skilled soccer players were required to make anticipation judgments while watching filmed footage of deceptive, non-deceptive, and non-deceptive-exaggerated penalty kicks that were occluded at 5 time points ranging from 240 ms before ball foot contact to 80 ms after ball-foot contact in 80 ms intervals. Anticipation accuracy and decision confidence were measured. **Results** The levels of confidence were 3.2% and 10.3% greater than the actual accuracy scores when facing non-deceptive-exaggerated and deceptive penalty kicks respectively up to the -80 ms time point. This over confidence fell to 0.7% and -0.6% for the non-deceptive-exaggerated and deceptive penalty kicks respectively in the period up to ball foot contact. In addition, significant relationships between their confidence ratings and accuracy were found only in the less skilled players up to -80 ms before ball-foot contact in the deceptive ( $r=.59$ ) and non-deceptive-exaggerated ( $r=.54$ ) conditions, but not the non-deceptive condition ( $r=.28$ ). Significant relationships were found in the deceptive ( $r=.65$ ) and non-deceptive-exaggerated ( $r=.59$ ) and non-deceptive ( $r=.71$ ) conditions at the ball contact occlusion time point. **Discussion** This pattern of result suggests that exaggeration, which was common to both deceptive and non-deceptive-exaggerated conditions, caused the kicks to be perceived in a cue-base mode in the time period up to 80 ms before ball foot contact. However, the significant relationships in all three kick conditions as well as no evidence of under or over confidence at the ball foot contact time period suggests this effect is isolated to the -80 ms time period. **References** Jackson, R. C., Warren, S., & Abernethy, B. (2006). Anticipation skill and susceptibility to deceptive movement. *Acta Psychologica*, 123(3), 355-371. Runeson, S., Juslin, P., & Olsson, H. (2000). Visual perception of dynamic properties: Cue heuristics versus direct-perceptual competence. *Psychological Review*, 107(3), 525-555.

##### DYNAMIC AND ECOLOGICAL IMPLICATIONS FOR SELF-REGULATION: USING MULTI-METHOD AND EMERGENT RE-SEARCH DURING A THREE-DAY ADVENTURE RACE

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Buchanan, N.I., Ollis, S.I. 1: University of the West of Scotland (Hamilton, Scotland) **Introduction:** There is considerable desire to understand adaptability in sporting and performance domains (Hatano and Inagaki, 1986; Ollis et al., 2005). The importance of self-regulation, and its consequential ability to change and stabilize, in this topic area is key (Zimmerman and Cappillo, 2006; Karoly et al., 2005). Therefore, the aim of this study was to analyse the contributions of adaptability, transition, change, and regulative capability in a complex and real world domain. **Methods:** An exploratory case study methodology was adopted using mixed method design of a 3-day adventure race team ( $n=6$ ). The mixed methods were used in conjunction with emergent and flexible research principles (Yin, 1998; Wolcott, 1999). As such, the researcher and research assistants conducted a micro-ethnography of a three day mountain marathon and sailing adventure race which adopted video analysis, biofeedback, behaviour analysis, semi-structured interviews, field notes, focus groups and questionnaires. The analysis was conducted using interpretational paradigm over a two week period reviewing and sense-making all data. **Results:** The findings suggested the ability to adapt and regulate to such a challenging, complex and real-world event is dynamic, iterative and multi-faceted. Accordingly, results could only be offered in consideration to a model which was multi-disciplinary, multi-level and multi-phasic. Data was correlated to show a relationship towards a dynamic model of self-regulation. **Discussion:** In a real world and complex environment there is a tack to take a more real world systemic worldview of self-regulation. As such, present findings accord that self regulation and adaptability in complex, dynamic and challenging contexts have to be researched and applied with consideration to the synergy of self as a personal, relational and collective entity which affords alternating understandings at multiple time scales. Indeed, we propose that understanding self regulation and adaptability from the perspective of the complexity sciences may prove advantageous. With consideration to methodology, the adoption of the emergent and flexible research design was deemed as highly challenging, fruitful and fulfilling. **References:** Hatano, G., Inagaki, K. (1986). Child development and education in Japan (pp.263-272). Freeman and Co, London. Karoly, P., Boekaerts, M., Maes, S. (2005). *Applied Psychology: An International Review*, 54(2), 300-311. Ollis, S., Macpherson, A. Collins, D. (2005). *Journal of Sport Sciences*, 20(3), 309-322. Wolcott, H.F. (1999). *Ethnography: A way of seeing*, AltaMira Press, Walnut Creek. Yin, R.K. (1998). *Case Study Research: Design and Methods*. Sage, London. Zimmerman, B. J., & Campillo, M. (2003). *The Psychology of Problem Solving* (pp. 233-262). Cambridge University Press, Cambridge.

## KINEMATIC PARAMETERS OF MODERN DANCE SKILLS THAT INFLUENCE AESTHETIC PERCEPTION IN NON-EXPERT OBSERVERS

TORRENTS, C.1, CASTAÑER, M.1, JOFRE, T.2, MOREY, G.2, REVERTER, F.3

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**Introduction** Certain kinematic and biomechanical parameters can influence the subjective aesthetic perception of the modern dance audience. Neave et al. (2010) reported 11 movement variables in non-expert male dancers, showing a significant positive correlation with perceived dance quality. Using three-dimensional motion-capture technology the aim of the present study was to identify the kinematic parameters of expert dancers' movements that influence the subjective aesthetic perception of observers in relation to specific skills of modern dance. **Methods** Four experienced modern dancers performed three repetitions of four dance-related motor skills (turn, balance, jump and displacement) in a space measuring 3m x 4m x 2.5m. Retro-reflective markers were attached to defined locations of the dancers' anatomy, as defined by the PlugInGait marker set (VICON). This allowed us to obtain animated stick figures and to calculate several kinematic parameters. Motion was captured by a VICON-MX system (Oxford Metrics, Oxford) with ten cameras operating at 125 Hz. The PlugInGait calculations and custom-written MATLAB (The Mathworks Inc., Massachusetts) routines were used to obtain the parameters. The resulting 48 animations were observed by 100 participants, who judged their beauty using a semantic differential scale based on theories regarding the existence of an underlying general factor in aesthetic perception. The data were then analysed using a multiple factor analysis (MFA), working with data tables in which a set of individuals is described by several sets of variables. **Results** The MFA of the turning skill suggested that the maximum angular velocity of the pelvis around the Z (vertical) axis is the most influential parameter as regards achieving high beauty scores. The perception of beauty for the balance skill (arabesque) seems to be more affected by the opening angle of the legs, while for jumps the most influential variables are the height of the jump and variables related to the amplitude of the movement (such as the maximum motion amplitude of the centre of mass in the Z axis, or the maximum inclination of the body at the moment of maximum height). Beauty also seems to be mostly affected by the amplitude of the movement when it comes to appraising displacements. **Discussion** The overall results suggest that non-expert observers are influenced by the most basic characteristics of dance skills, such as the speed of turning, the height of jumps or the amplitude of movement. Subsequent studies will focus on detecting differences among expert observers about which relevant kinematic parameters may influence aesthetic judgement in modern dance. **References** Neave N, McCarty K, Freynik J, Caplan N, Hönekopp J & Fink B Biol. Lett. 2010

## A POSSIBLE EXPLANATION OF THE ANTICIPATION SKILL OF DEFENDERS IN A QUICK CHANGE OF RUNNING DIRECTION, BASED ON THE INVERTED PENDULUM MODEL

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1: KYOTO UNIVERSITY (KYOTO, JAPAN), 2: UNIVERSITY OF ALBERTA (ALBERTA, CANADA)

**Introduction** In 1-on-1 situations in a ballgame, defenders must anticipate and stop the advance of attackers. In this study, we first investigated when a defender is able to make a decision on an attacker's final running direction. Defenders' decision-making time occurred so early that the actual displacement of the attacker's centre of mass (CoM) is unlikely to be a relevant cue. Instead, we tested the hypothesis that defenders simulate the future trajectory of the attackers' CoM and make decisions based on the result of the simulation by using the inverted pendulum model (IPM). **Methods** Seven ballgame players participated in this study as attackers, and ten as defenders. The attackers performed a quick change of running direction, which was filmed head-on. To investigate when defenders were able to make a decision, the defenders watched attackers' motion on a life-size screen, and employed a whole body reaction. The defender's decision-making time was estimated by subtracting a simple choice reaction time from the reaction time. To test the hypothesis, the attacker's CoM and foot displacement were first captured (300 Hz). Then we created the software that calculated the future CoM trajectory, by substituting the position and velocity information of CoM and foot position, as initial values, into the equation of inverted pendulum motion. The software determined the timings of the relevant cue as the time of the initial values when estimating the CoM position was over the lateral threshold (IPM-based cue), or as the time when the actual lateral displacement of the CoM exceeded the threshold (CoM-based cue). In all timing analyses, 0 ms was defined as the foot contact of direction change by the attackers. **Results** The reaction time tasks demonstrated that the defenders made a decision at  $-340 \pm 26$  ms and reacted at  $-40 \pm 30$  ms. The simulation of the IPM revealed that the IPM-based determined time ( $-245 \pm 145$  ms) was earlier than the CoM-based determined time ( $110 \pm 52$  ms). Furthermore, the earlier a defender's decision-making time, the earlier was the IPM-based determined time (Spearman's  $\rho = .795$ ). **Discussion** First, the results of the reaction time tasks indicated that under real-time constraints, defenders could make decisions very early and could therefore stop the attackers' advance. Second, the hypothesis was supported. This suggested that defenders in a ballgame may need to look not only at attackers' CoM (approximated by trunk) but also at their feet. Finally, the strong correlation between the defender's decision-making and the IPM-based determination suggested that the defenders may make decisions by portraying the attackers as IPM.

## ATHLETIC IDENTITY IN ENGLISH PROFESSIONAL YOUTH TEAM FOOTBALLERS

MITCHELL, T., RICHARDSON, D., NESTI, M.S., LITTLEWOOD, M.A.

LIVERPOOL JOHN MOORES UNIVERSITY

**Athletic Identity in English professional youth team footballers** Mitchell, T.O, Richardson, D., Nesti, M.S. & Littlewood, M.A. **Research Institute for Sport & Exercise Sciences Liverpool John Moores University, UK** **Introduction** Athletes with a strong Athletic Identity may be more motivated and committed in their sporting endeavours (Brewer, Van Raalte & Linder, 1993). Conversely such a focus may render athletes with one-dimensional sense of self which may have negative psychological consequences e.g. experiences of discomfort when not training (Werthner and Orlick, 1986). Nesti (2004) and Nesti and Littlewood (2009) report that elite footballers with a multi-dimensional sense of identity possess a more solid base for the demonstration of their talent. The aim of this study is to identify levels of Athletic Identity in youth team footballers as a function of level of play, living arrangements & year of apprenticeship. **Method** One hundred and sixty eight youth team footballers from 12 professional football clubs across four professional leagues (Premier League, Championship, League 1 & League 2) completed the Athletic Identity Measurement Scale (AIMS) (Brewer & Cornelius, 2002). **Results** A one-way ANOVA and post hoc analyses with level of play as a function indicated no significant differences in total AIMS score. PL players reported significantly ( $p < 0.05$ ) higher levels of Exclusivity than L2 players. An independent sample t-test showed Y1 apprentices possessed significantly ( $p < 0.05$ ) higher levels of Social Identity than Y2's. Those living away from home displayed significantly ( $p < 0.05$ ) higher levels of Exclusivity than those living at home. **Discussion** Level of play does not appear to be a factor in the development of AI suggesting the working environment may be more on an influence in AI development. Year of apprenticeship affects Social Identity with a decrease in year two

possibly due perceived difficulties in gaining professional status. Living arrangements affect levels of Exclusivity suggesting that those living away may develop a more one-dimensional sense of self. Key words: Athletic Identity, Youth team football References Brewer BW, Van Raalte J, Linder DE. (1993) Athletic identity: Hercules' muscles or Achilles heal. *Int J Sport Psych*;24,237—54. Brewer BW & Cornelius AE. (2002) Norms and factorial invariance in the athletic identity measurement scale (AIMS). *The Acad Athletic J* ;15,103—13. Nesti, M.S. (2004). *Existential Psychology & Sport: Theory & Application*. (London: Routledge) Nesti, M.S. and Littlewood, M. (2009) Psychological preparation and development of players in premiership football: practical and theoretical perspectives. In *International Research in Sciences & Soccer*. (eds) Riely, T., Williams, A.M., & Drust, B. London: Routledge Wertner, P & Orlick, T. (1986) Retirement Experiences of successful Olympic Athletes, *International Journal of Sports Psychology*, 17,337-363

## Oral presentations

### OP-PM50 Physiology: Reproductive Hormones

#### SEX DIFFERENCES IN FUNCTIONAL HAMSTRING/QUADRICEPS RATIO AND THE EFFECT OF JOINT ANGLE AND MOVEMENT VELOCITY

DE STE CROIX, M., ELNAGAR, Y.O., JAMES, D.V.B.

UNIVERSITY OF GLOUCESTERSHIRE

SEX DIFFERENCES IN FUNCTIONAL HAMSTRING/QUADRICEPS RATIO AND THE EFFECT OF JOINT ANGLE AND MOVEMENT VELOCITY De Ste Croix, M.B.A; Elnagar, Y.O; and James, D.V.B. University Of Gloucestershire, Department of Sport and Exercise, Gloucester, UK. Introduction Females are at greater relative risk of non-contact ACL injury compared with males (Faude et al., 2005). Dynamic knee stability is an essential component required to reduce relative risk of injury to the knee joint. The ability of the hamstrings to co-contract eccentrically to counter the torque produced concentrically by the quadriceps action during knee extension is important in stabilising the knee. The purpose of the present study was to explore sex differences in the functional hamstring to quadriceps ratio (F-H/Q ratio) whilst taking into account joint angle and movement velocity. Methods Participants (n = 110; 55 males and 55 females) provided written informed consent to participate in the study. Prone isokinetic torque was determined sequentially at velocities of 60, 120, 240°/s with the hip flexed at 10°. Knee joint range of movement was 90° with 0° determined as full volitional extension. Torque was determined from concentric (CON) actions using CON/CON cycles followed by eccentric (ECC) flexion cycles. Torque was gravity corrected and filtered to only include constant velocity periods. F-H/Q ratio was determined at joint angles of 15, 30, 45° and the angle of peak torque (PT) for each velocity. A 2 (sex) x 3 (velocity) x 4 (joint angle) ANOVA was performed with subsequent post hoc analysis using Bonferroni correction. Results F-H/Q ratio ranged from 55% to 114% across joint angles and velocities. Significant main effects ( $p < 0.05$ ) for both joint angle and velocity were observed, with a greater F-H/Q ratio closer to full knee extension and at faster velocities. A significant main effect ( $p < 0.05$ ) for sex was demonstrated with the F-H/Q ratio higher in males compared with females at all joint angles and movement velocities. The difference between males and females increased with increasing joint angular velocity. Discussion Irrespective of sex, the F-H/Q ratio increases with joint extension and velocity to improve knee stability thereby counteracting high shear forces. The lower F-H/Q ratio in females and the increasing sex difference as velocity increases, along with the lower F-H/Q ratio close to full knee extension, predisposes females to increased knee injury risk due to impaired dynamic knee stability. References Faude O, Junge A, Kindermann W, Dvorak J. (2005). *Amer J Sports Med*, 33(1), 1-7.

#### THE ANABOLIC STEROID METHANDIENONE TARGETS THE HYPOTHALAMIC-PITUITARY-TESTICULAR AXIS AND MYOSTATIN SIGNALLING IN A RAT TRAINING MODEL

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Introduction There is increasing evidence that the biological activity of Myostatin (MSTN), a member of the transforming growth factor- $\beta$  family of proteins (TGF- $\beta$ ) is affected by training but also anabolic steroids. To further study molecular mechanisms of the training induced adaptation of skeletal muscle, the aim of this study was to analyse effects of the frequently abused anabolic steroid methandienone (Md) on the hypothalamic-pituitary-testicular axis and on MSTN signalling in an animal model simulating the situation of abusing athletes. Methods Male Wistar rats performed a 4-week treadmill-based exercise protocol in combination with Md treatment. Effects on the hypothalamic-pituitary-testicular axis and androgen sensitive tissues were determined and correlated to the expression of members of the MSTN signalling cascade (MSTN, MyoD, Smad7 and Follistatin) in gastrocnemius and soleus muscle. Results Treatment with Md resulted in a significant stimulation of the weight of levator ani muscle. This effect was enforced by training. Prostate and seminal vesicle weights decreased after Md treatment. Hormone concentrations of LH and testosterone were significantly decreased after Md treatment. Interestingly also training decreased serum testosterone, while no effects on LH and FSH could be observed. MSTN, Smad7 and MyoD mRNA expression in gastrocnemius muscle were reduced by training but not after Md treatment. In contrast the mRNA level of the MSTN inhibitor Follistatin (FST) was significantly reduced in gastrocnemius muscle by training and Md. In soleus muscle MSTN and FST mRNA expression was not affected by training but it was increased after Md treatment in combination with training. No changes of FST protein expression in serum were detected. Conclusion In summary our data demonstrate that Md treatment of intact rats results in anabolic effects which are increased by training. These anabolic effects correlate to changes in the expression patterns of genes involved in MSTN signalling in the soleus and gastrocnemius muscle but do not effect FST concentrations in the serum. In contrast Md treatment decreased the weight of androgen sensitive tissues like the prostate. Our data provide evidence that this effect is caused by a suppression of endogenous testosterone synthesis via the hypothalamic-pituitary-testicular axis. These observations provide insights into the molecular mechanisms of skeletal muscle adaptation and may be helpful to develop new test systems to detect the abuse of anabolic steroids.

### THE EFFECT OF ANDROGEN DEPRIVATION THERAPY AND STRENGTH TRAINING ON HEAT SHOCK PROTEINS IN MUSCLE IN ADT TREATED PROSTATE CANCER PATIENTS.

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Introduction and aim Prostate cancer growth is stimulated by the presence of androgens (testosterone). Therefore androgen deprivation therapy (ADT) is an effective treatment in these patients. However, testosterone is involved in regulation of several processes in skeletal muscle, and a reduction of muscle mass in ADT treated patients has been reported (1). Testosterone also regulates heat shock protein synthesis (2), which is involved in cellular responses to exercise induced stress, and possibly daily maintenance, in skeletal muscle. Consequently, the aim of this part of the Physical Exercise and Prostate Cancer study (PEPC) was to investigate the effect of ADT alone or combined with strength training on the content of heat shock proteins in m. vastus lateralis. Methods PEPC is a randomized controlled trial with a strength training group (STG) (n=10) and a control group (CG) (n=10), following standard care, in ADT treated patients. After six to nine months on ADT the STG performed three strength-training sessions per week, where two of the sessions were supervised and consisted of 1 to 3 6-10 RM sets, and one sub maximal session. The training consisted of squat, leg press, standing calf raises, leg curl, leg extension, chest press, seated rowing, shoulder press and biceps curl. Muscle biopsies were obtained pre-intervention assessment and after the 16 weeks of intervention (post-intervention assessment). The biopsies were homogenized and divided into cytosolic, cytoskeletal, nuclear and membrane fractions. The homogenate were then analyzed by Western blot using a monoclonal antibody against HSP 70 and a monoclonal antibody against  $\alpha$ B-Crystallin. Results Preliminary results from 8 patients (4+4) indicate a reduction of both HSP70 and  $\alpha$ B-Crystallin in the membrane fraction in STG, but no alterations in the cytosolic fraction. Final results will include analysis of biopsies from 10 and 9 subjects in the CG and STG, respectively. Discussion An increase in HSP levels has been shown after strength training in young subjects. However, a decreased expression of HSP70, and no change in  $\alpha$ B-crystallin, has been reported in the cytosolic fraction, leaving the membrane fraction unchanged, in elderly following strength training (3). Further analysis will reveal whether the initial levels of HSP, and response to strength training, differs between ADT treated patients and healthy controls. Reference List 1. Boxer et al. Journal of the American Geriatrics Society 53: S71-S72, 2005. 2. Gonzalez et al. J Steroid Biochem Mol Biol 74: 63-71, 2000. 3. Schaad (Master thesis). University of Bern, 2011.

### EFFECTS OF QUASI-FOLLICULAR AND QUASI-LUTEAL PHASE-BASED ENDURANCE TRAINING ON MUSCLE CELL PARAMETERS IN SUBJECTS WITH ORAL CONTRACEPTION

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Purpose: : Monophasic oral contraceptives (OC) contain fixed doses of estrogen (E) and progestogen (P) which are taken for 21 days, followed by 7 days of OC break, leading to more or less constant concentrations of blood estradiol and progesterone during the first 21 days. The regulation of other interacting hormones like IGF-1, testosterone and DHEAs, all of them possible anabolic hormones on the level of the muscular cell during endurance training, is not clear so far in OC users. Therefore, we investigated effects of "quasi follicular phase-based" versus "quasi luteal phase-based" endurance training on fiber composition, fiber diameter and cell nuclei to fiber ratio of skeletal muscle in OC users. Methods: Five healthy untrained or moderately trained women using OC completed endurance training on a bicycle ergometer for each leg for 3 menstrual cycles (12 weeks). The subjects trained one leg mainly in quasi-follicular phase (qFT) and the other in quasi-luteal phase (qLT). Muscle fiber composition (F%no: relative fiber number, F%area: relative fiber area), muscle fiber diameter (Fdm) and cell nuclei to fiber ratio (N/F) were determined in skeletal muscle biopsy samples of both legs (m. vastus lateralis) prior to and after training intervention using histochemical analysis (ATPase and HE staining). Results: After endurance training intervention, mean values of F%no and F%area showed reductions (by  $6.9 \pm 11.5\%$  and  $6.6 \pm 10.6\%$ ) in type I fiber after qFT whereas there were increases (by  $4.0 \pm 5.9\%$  and  $4.4 \pm 9.4\%$ ) in type I fibers after qLT. However, deviation of values was large among the 5 subjects. We could not demonstrate any relevant changes in Fdm of type I and type II fibers neither after qFT ( $-0.5 \pm 4.3$  and  $-1.0 \pm 5.0$ ) nor after qLT ( $+0.2 \pm 6.4$  and  $-0.5 \pm 6.4$ ). N/F also showed no relevant change after qFT ( $+0.4 \pm 0.4$ ) and qLT ( $+0.1 \pm 0.1$ ). Conclusions: Within a small sample of 5 subjects, we were not able to demonstrate any relevant differences between the two endurance training modes concerning adaptation of skeletal muscle. Further studies in larger samples will have to confirm this finding, which might be explainable by the artificially constant hormone levels in OC users. The confirmation of this finding would suggest that untrained or moderately trained OC users could perform endurance training independently from the phases of menstrual cycle.

### THE EFFECT OF ANABOLIC STEROIDS ON MYONUCLEAR NUMBER

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THE UNIVERSITY OF OSLO

Introduction Until recently, it was believed that myonuclear number was reduced under atrophy conditions. We have shown that myonuclear number is not reduced after denervation or inactivity in mice (Bruusgaard, 2010). Furthermore, since the effects of testosterone on skeletal muscle are mediated via androgen receptors expressed both in myonuclei and in the nuclei of satellite cells (Kadi, 2008), we wanted to examine if the use of anabolic steroids would lead to an increased number of myonuclei as well as investigate if these newly acquired myonuclei are permanent. Methods Pellet containing testosterone propionate (TP) (0.005 mg/g/day) or placebo were operated into the neck of female NMRI mice (20-30g). In order to overload the m. soleus, 2/3 of the m. gastrocnemius was excised. For in vivo nuclear imaging of nuclei, single soleus fibers were injected with 5'-FITC-labelled phosphorothioated oligonucleotides as described previously (Bruusgaard, 2003). Fiber segments of 250-1000 mm were analyzed as described before (Bruusgaard, 2010). For fiber area measurements and counting of nuclei, cryo-sections were stained with anti-dystrophin and DAPI. In the first set of experiments mice were randomly assigned into four groups: 1) Placebo, 2) TP, 3) Placebo overload, 4) TP overload. After 14 days the soleus muscle were analyzed first with in vivo imaging of single fibers and then the soleus muscle were excised and frozen for immunohistochemical analysis. Results The number of nuclei increased with 28%, 22% and 67% compared to placebo in TP, placebo overload and TP overload respectively (n=3). The fiber cross-sectional area increased with 28%, 22% and 62% compared to placebo in TP, placebo overload and TP overload, respectively (n=3). Discussion Our data show that use of anabolic steroids during overload hypertrophy leads to an increase in fiber size and myonuclear number more extensive than TP treatment only or overload only. Anabolic steroid treatment itself leads to an increase in fiber cross-sectional area and a higher number of myonuclei than overload induced hypertrophy. The use of anabolic steroids is widespread among athletes, and if the induced changes in skeletal muscle are permanent or long-lasting it might have consequences for the

exclusion period given to doping offenders. References Bruusgaard JC, Johansen IB, Egner IM, Rana ZA, Gundersen K. (2010). *Proc Natl Acad Sci*, 107(34), 15111-6. Bruusgaard JC, Liestøl K, Ekmark M, Kollstad K, Gundersen K. (2003). *J Physiol*, 551(Pt 2), 467-78. Kadi, F. (2008). *Br J Pharmacol*, 154(3), 522-8.

### **REPEATED MUSCLE BIOPSIES THROUGH A SINGLE SKIN INCISION DO NOT ELICIT MUSCLE SIGNALING, BUT IL-6 MRNA AND STAT3 PHOSPHORYLATION INCREASE IN INJURED MUSCLE.**

GUADALUPE GRAU, A., GÓMEZ-CABRERA, M.C., PÓNCE-GONZÁLEZ, J.G., MARTINEZ-BELLO, V.E., GUERRA, B., FEIJOO, D., SANTANA, A., SEBASTIA, V., VIÑA, J., CALBET, J.A.L.

UNIVERSITY OF LAS PALMAS DE GRAN CANARIA, UNIVERSITY OF VALENCIA.

To determine if muscle biopsies can be repeated using a single small (5-6 mm) skin incision without inducing immediate MAPK activation or inflammation in the non-injured areas, the phosphorylation of ERK1/2, p38-MAPK and c-Jun NH2-terminal kinases (JNKs), IκBα, IKKα, and signal transducer and activator of transcription 3 (STAT3) was examined concurrent with IL-6 mRNA in six muscle biopsies obtained from the vastus lateralis of five men. Four biopsies were obtained through the same incision (5-6 mm) from the right leg (taken at 0, 30, 123 and 126 minutes) and another two each from new incisions performed in the left leg (at 31 and 120 minutes), while the subjects rested supine. The first three biopsies from the right leg were taken approximately 3 cm apart from pre-biopsied areas. The last biopsy was obtained from the same point from which the second biopsy was sampled. The three biopsies performed through the same skin incision from non-injured muscle areas showed similar levels of ERK1/2, p38-MAPK, JNK, IKKα, IκBα and STAT3 phosphorylation, and similar IL-6 mRNA content. There were no significant differences in the levels of ERK1/2, p38-MAPK, JNK, IKKα, and IκBα phosphorylation between the mean of the three biopsies obtained from the same incision and the sixth biopsy obtained from an injured area. STAT3 phosphorylation was increased by approximately 3.5-fold in the sixth biopsy compared to the mean the three biopsies obtained from the same incision ( $P < 0.05$ ) and IL-6 mRNA content by 1.8-fold ( $P < 0.05$ ). In summary, repeated muscle biopsies can be performed through a single 5-6 mm skin incision without eliciting muscle signaling through cascades responding to cellular stress, inflammation or muscle damage. STAT3 phosphorylation is an early event in the healing response to muscle injury, likely mediated by the autocrine production of IL-6. Acknowledgements This study was supported by grants from the Ministerio de Educación y Ciencia (DEP2010-21866 and FEDER) and DPS2008-06968, SAF2010-19498, ISCIII2006-RED13-027

## **Invited symposia**

### **IS-PM06 Novel Quantitative Approaches to Combat Doping**

#### **RANDOMIZED RESPONSE ESTIMATES FOR DOPING AND ILLICIT DRUG USE IN ELITE ATHLETES**

STRIEGEL, H., SIMON, P., NIESS, A., ULRICH, R.

UNIVERSITY OF TÜBINGEN

Randomized response estimates for doping and illicit drug use in elite athletes Introduction: In contrast to fitness sports, there are no reliable estimates for the percentage of unknown cases of doping and illicit drug use in elite sports. Due to the familial atmosphere in elite sports, it is problematic to get reliable epidemiological estimates of deviant or illicit behaviour questionnaires and surveys. Methods: 1394 athletes were questioned using an anonymous questionnaire (SQ), and 480 athletes were interviewed using randomized response technique (RRT). All athletes were subject to doping controls as members or junior members of their respective national teams. A two-sided z-test was used to compare the SQ and RRT results with the respective official German NADA data on the prevalence of doping. Results: Official doping tests only show 0.81% ( $n = 25,437$ ; 95% CI: 0.70–0.92%) positive test results, while RRT shows 6.8% ( $n = 480$ ; 95% CI: 2.7–10.9%) positive responses to having practiced doping ( $z = 2.91$ ,  $p = 0.004$ ). 7% illicit drug use was shown by both SQ and RRT, but due to the fear of being recognized by their answers SQ failed to indicate a realistic prevalence of doping (0.20%; 95% CI: 0.02–0.74%). Discussion: The data from official doping tests underestimate the true prevalence of doping in elite sports. In our study, we found an 8-fold higher doping prevalence using RRT compared to the results of official doping tests. Therefore, implementing RRT before and after anti-doping measures could be a promising method for evaluating the effectiveness of anti-doping programs.

#### **DETECTING NEW SUBSTANCES AND METHODS OF DOPING USING BIOANALYTICAL APPROACHES**

THEVIS, M.

GERMAN SPORT UNIVERSITY COLOGNE

The dynamic nature of the pharmaceutical market and the continuously increasing number of emerging drugs represents a considerable challenge to sports drug testing authorities and laboratories. Besides new structural and, thus, physicochemical properties to be considered in analytical methods, their metabolism to urinary degradation products is commonly unknown. In the presentation, new drug candidates potentially or evidently representing a threat to the integrity of sport will be presented, and options to measure and determine the active compound as well as metabolites will be discussed.

#### **LONG-TERM AND DIRECT DETECTION OF MUSCLE-DIRECTED GENE TRANSFER IN CONVENTIONAL WHOLE BLOOD SAMPLES**

SIMON, P.

JOHANNES GUTENBERG-UNIVERSITY

The abuse of gene transfer technology in sport is perceived as an upcoming danger for elite sports. So called 'gene doping' using sophisticated gene transfer technology delivering human DNA sequences for the purpose of doping is supposed to be undetectable. This talk will present a molecular biological approach that is able to directly detect transgenic human DNA derived from gene doping with high specificity and ultra-high sensitivity on the single molecule level. The technique is based on a novel single copy PCR procedure called spiPCR and has so far been optimized for the inexpensive and robust detection of gene transfer for all relevant splice variants of IGF1, VEGFa, VEGFc, hGH, FST and EPO in conventional whole blood samples. The procedure is an effective tool to monitor the faith of tran-



scripts within the body following gene therapeutic applications. The technical features of the procedure, its potential applicability for doping analysis and its potential pitfalls are discussed.

## Oral presentations

### OP-BN02 Sports Biomechanics 1

#### THE EFFECT OF DIFFERENT CLIMBING SPECIFIC HOLDS ON FINGER FORCES AND FORCE SHARING AMONG THE FINGERS

WERNER, I., GEBERT, W.

*INSTITUTE OF SPORT SCIENCE*

**Aim of the study** The decrease of particular finger strength when acting with two or more fingers at the same time and force sharing among fingers has been studied for a long time. Referring to sports climbing Quaine et al. (2003) simulated climbing specific finger postures measuring the vertical force when pressing on a force platform or crushing the fingers in a vertical position (Vigouroux et al. 2008). In order to study finger forces in a climbing specific context an apparatus was constructed offering the possibility to compare different shapes of holds including the adjustment to finger length. The aim of this study was to compare maximal finger forces on different holds arranged in a straight-line position or adjusted to finger length. **Methods** Finger forces were measured for each finger separately with strain gauges orthogonal to the support surface of the finger tips with a measurement accuracy of 0.2 N. Holds were wooden and covered with synthetic resin and quartz sand. Twelve climbers (average age 25y, 5.11c level on sight) volunteered for the study. Subjects sat on a chair, the measure device fixed between the axilla and the finger tips. Subjects pulled twice with maximal effort. The best trial was analysed. Retest-reliability approved to be high ( $r > 0.90$  each) in all combinations of holds and fingers acting. Maximal finger forces and force sharing was observed when acting with the middle finger, index finger and ring finger in various combinations on a ledge (crimp grip), a convex hold (slope grip) and a concave hold (slope grip) with and without adjustment to finger length. Analysis of repeated measures (SPSS 15.0,  $p < 0.05$ ) was calculated to detect differences. **Results** The highest values of finger forces were observed for the concave hold. The middle finger revealed strongest. Acting with the index finger the middle finger achieved about 90% of its maximum force, acting with the ring finger only 75%, combining all three fingers about 70%. The sum of force production differed significantly in the single maximum condition, straight-line hold position (altogether) and adjusted hold position (altogether). In the latter the force of the middle finger increased, the force of the index finger and ring finger decreased compared to the straight-line condition. Percentage of maximum individual finger force production did not differ whether the holds were adjusted to finger length or not, but differed significantly between the three forms of holds (crimp grip  $> 90\%$ , slope grip 75%). **Discussion** Crimp grip seems to activate a higher percentage of maximal strength. This is likely due to the unstable finger position in the one finger act. Holds adjusted to finger length showed no advantage to force production because of limitations in muscle excitation. **References** Quaine, F., Vigouroux, L., Martin, L. (2003), Clin Biomech, 18 (5), 385 - 388 Vigouroux, L. et al. (2008) Hum Mov Sci, 27, 396-407

#### LUMBO-PELVIC LATERAL FLEXION MOTION AND KINETICS DURING FAST BOWLING IN CRICKET

CREWE, H.1, CAMPBELL, A.2, ELLIOTT, B.1, ALDERSON, J.1

1: UNIVERSITY OF WESTERN AUSTRALIA (PERTH, AUSTRALIA), 2: CURTIN UNIVERSITY OF TECHNOLOGY (PERTH, AUSTRALIA)

**Introduction** Stress fractures of the lumbar pars interarticularis (spondylolysis) are common in sports involving repetitive flexion-extension and rotation of the trunk[1], such as fast bowling in cricket. Recent work has indicated that lateral flexion, too, places significant stress on the pars[2] and that fast bowlers move the trunk through an extreme range of lateral flexion towards the side contralateral to the dominant arm[3]. It has been found that spondylolyses occur more frequently on the contralateral side of the vertebra in fast bowlers[4] and that the quadratus lumborum muscle, a lateral flexor of the lumbar spine, is often enlarged on the bowler's dominant side[5]. **Methods** The current study aimed to investigate lumbo-pelvic lateral flexion motion and kinetics in 14 right-arm fast bowlers (mean age 16.5 years), using a novel biomechanical model. **Results** During bowling, each subject reached a peak left lateral flexion angle that was greater than the peak angle measured during a standing maximum active range of motion trial (mean  $8.6^\circ \pm 2.7$ ). Large left lateral flexion moments ( $13.5 \text{ Nm.kg}^{-1} \cdot \text{m}^{-1} \pm 2.6$ ) and peak power ( $-7090.1 \text{ W} \pm 3983.9$ ) were recorded. **Discussion** Extreme lumbo-pelvic lateral flexion and large moments during the delivery stride may contribute significantly to the loading of the pars interarticularis and therefore the high incidence of spondylolysis in fast bowlers. Negative joint power in right-arm bowlers indicates that left lateral flexion of the lumbar segment relative to the pelvis is a controlled motion resisted by the right lateral flexor muscles. This is the first study to provide a potential biomechanical mechanism for the increased cross-sectional area of the dominant side quadratus lumborum seen in many fast bowlers and is part of a larger prospective trial that will examine the relationship between bowling technique, lumbo-pelvic biomechanics and injury. **REFERENCES** 1. Brukner P, Kahn K. Clinical Sports Medicine. Third ed. Sydney: McGraw-Hill; 2007. 2. Chosa E, Totoribe K, et al. A biomechanical study of lumbar spondylolysis based on a three-dimensional finite element method. J Orthop Res. 2004;22(1):158-63. 3. Ranson CA, Burnett AF, et al. The relationship between bowling action classification and three-dimensional lower trunk motion in fast bowlers in cricket. J Sports Sci. 2008;26(3):267 - 76. 4. Elliott B, Hardcastle P, et al. The influence of fast bowling and physical factors in radiologic features in high performance young fast bowlers. Sports Medicine Training and Rehabilitation. 1992;3:113-30. 5. Engstrom CM, Walker DG, et al. Quadratus lumborum asymmetry and L4 pars injury in fast bowlers: a prospective MR study. Med Sci Sports Exerc. 2007;39(6):910-7.

#### THE EFFECT OF Q FACTOR ON CYCLING PERFORMANCE

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**Introduction** The term Q Factor on a bicycle describes the horizontal width between pedals, measured from the outside face of the crank, to the corresponding outside face on the opposite crank. The Q Factor of a crank determines where the foot is laterally positioned throughout the pedal stroke. Due to manufacturing constraints, no production bicycle has a Q Factor lower than 135mm and a typical Q Factor ranges from ~150mm for a road bicycle, up to ~180mm for a mountain bicycle. In the past, a number of world champion cyclists have used custom made bicycles with narrow Q Factors in order to improve performance. One of the rationales for this strategy is that

the pedaling action would be more efficient, as force to the pedal would be applied closer to the plane of the crank. To date, there have been no scientific studies that explore the effect of manipulating Q Factor and its effect upon the cyclist. The aim of this study is to determine whether narrowing the Q Factor has a beneficial effect upon cycling performance variables and muscular activation. Methods 13 trained cyclists (6 male, 7 female; Age  $22.5 \pm 5.2$ ;  $\text{VO}_{2\text{max}}$   $56.7 \text{ ml.kg.min}^{-1} \pm 5.0$ ) volunteered for the study. Subjects pedaled at 60% of peak power output (PPO) for periods of 5min at 90 revolutions per minute (rpm), using Q Factors of 90, 120, 150 and 180mm (q90, q120, q150, q180). Each Q Factor was used twice for a total of 8 stages. Power output and expired gas data were collected and muscular activity data of the gastrocnemius (GM), tibialis anterior (TA), vastus medialis (VM) and vastus lateralis (VL) were measured using surface EMG sensors. Gross mechanical efficiency (GME) was calculated from the expired gas and power output data, and root mean square (RMS) muscular activity data were calculated over a time period of 30 pedal cycles during each stage. Results There was an overall significant difference for GME ( $F(1,3)=9.19$ ,  $p=.001$ , effect size  $=.43$ ). Post hoc comparison showed that GME for q90 was significantly higher (19.5%) than q150 and q180 (18.9 and 19.0%). All subjects reported a dislike of q180, and preferred either q120 or q90. There was no significant difference in RMS muscular activity of the GM, TA, VM and VL between the different Q Factors. Discussion The aim of this study was to explore the effect of Q Factor on cycling performance at submaximal intensity. The data show that narrower Q Factors (q90 and q120) result in higher GME than wider Q factors (q150 and q180), supporting the hypothesis. However, the level of muscular activation between Q Factors in the muscles analysed (GM, TA, VM and VL) did not change. Therefore, the increase in GME with narrower Q Factors may be due to a) a change in activation of stabilising muscles (besides those measured in this experiment), and/or b) a more optimal application of force during the pedal stroke.

## PEDALING TECHNIQUE AND ENERGY COST IN CYCLING

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Introduction: Because cycling is an extreme endurance sport, energy saving and therefore efficiency is of importance for performance. It is generally believed that gross efficiency (GE) is affected by pedaling technique. A measurement of pedaling technique has traditionally been done using force effectiveness ratio (FE; ratio of effective force and total force). The aim of the present study was to investigate the relationship among GE, FE, and a new technique parameter, dead center size (DC) in competitive cyclists. Methods: Twenty-one competitive cyclists cycled for 10 min at approximately 80%  $\text{VO}_{2\text{max}}$  at a racer bike on a roller (simulating free cycling) at a freely chosen cadence (FCC). GE was calculated using oxygen consumption (Jaeger Oxycon Pro). FE and DC were calculated using propulsive force recordings from 2D force cells (Revere) mounted in the pedals and 3D kinematics (Pro-reflex). The lowest work rate (average of top and bottom dead center work rate) divided by the average work rate was defined as DC. Thus, this is a parameter describing the evenness of work rate generation (100% indicates a perfect circular work rate generation whereas 0 % indicates that the work rate at the dead center equals zero). Results: Mean work rate was 279 W, mean FCC was 93.1 rpm, and mean GE was 21.7%. FE was 0.47 and 0.79 after correction for inertial forces; DC was 27.3% and 25.7%, respectively. DC was not affected by inertial forces and size correlated better with GE ( $r = 0.75$ ) than with the FE ( $r = 0.50$ ). Multiple regressions revealed that DC was the only significant ( $P = 0.001$ ) predictor for GE. Interestingly, DC and FE did not correlate with each other. Discussion: For these cyclists DC is a parameter more closely related to energy cost than FE when cycling at FCC on a regular racing bike. Generating power evenly around the whole pedal revolution may be an energy saving trait, which is essentially different from applying forces effectively (FE). DC is not affected by inertial forces and also therefore may be a better measure than FE. However, preliminary results from another study using an ergometer (instead of a regular bicycle) at three cadences around FCC do not replicate these findings. Future research should be directed toward the mechanisms behind DC, how DC is affected by cadence and work rate and if it differentiates between cyclists at different performance levels.

## MODELLING THE TRAINING-PERFORMANCE RELATIONSHIP IN ELITE SWIMMERS

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Introduction Mujika et al. (1996) and Hellard et al. (2006) used a mathematical model, original proposed by Banister (1991), to quantify the training and performance relationship of elite swimmers. Considering alternative methods because of unsatisfactory results in goodness of fit, Hellard et al. (2006) referred to the PerformancePotential-Model (PerPot), a dynamic model developed by Perl (2001). The PerPot helps to simulate the relationship between training and performance by using a state-event-model with adaptive delays. In training studies PerPot showed better results for model fit and prediction accuracy (Pfeiffer, 2008). We intend to determine whether PerPot can be used to validly analyse the training effects on performance in elite swimmers. Methods Six national and international level German swimmers (S1 to S7) were studied during a 12-week period. All training performed in water and dry-land was quantified daily according to Mujika et al (1996). In addition, a semi-tethered swimming test (20m without start) consisting of three repetitions (resistance increased trial by trial) was conducted to determine the swimming performance (mean velocity). To model the training-performance relationship the PerPot was used. Mean relative deviation (RD), Intraclass Correlation Coefficient (ICC) and Coefficient of Determination ( $R^2$ ) between modelled and real performances were calculated for each subject to estimate model goodness of fit. Results The following results could be achieved: S1 (N=15, RD=1.7%, ICC=.83,  $R^2 = .99$ ), S2 (N=10, RD=1.1%, ICC=.80,  $R^2 = .99$ ), S3 (N=10, RD=1.0%, ICC=.80,  $R^2 = .99$ ), S4 (N=9, RD=2.5%, ICC=.68,  $R^2 = .99$ ), S5 (N=10, RD=1.0%, ICC=.55,  $R^2 = .99$ ), S6 (N=10, RD=2.3%, ICC=.51,  $R^2 = .99$ ). Discussion Our findings show considerably better results for model fit as reported e.g. by Mujika et al. (1996) and Hellard et al. (2006). The results confirm that PerPot could successfully model the training effect on performance in middle-term adaptation. References Banister, E. W. (1991). Modeling elite athletic performance. In H. J. Green, J. D. McDougal & H. Wenger (Eds.), *Physiological Testing of Elite Athletes* (pp. 403-424). Champaign, IL: Human Kinetics Publishers. Hellard, P., Avalos, M., Lacoste, L., Barale, F., Chatard, J. C. & Millet, G. P. (2006). Assessing the limitations of the Banister model in monitoring training. *J Sports Sci*, 24(5), 509-520. Mujika, I., Busso, T., Lacoste, L., Barale, F., Geyssant, A. & Chatard, J.-C. (1996). Modeled responses to training and taper in competitive swimmers. *Med Sci Sports Exerc*, 28(2), 251-258. Perl, J. (2001). PerPot: A metamodel for simulation of load performance interaction. *Europ J Sport Sci*, 1 (2), 1-13. Pfeiffer, M. (2008). Modeling the Relationship between Training and Performance - A Comparison of Two Antagonistic Concepts. *Int J Comp Sci Sport*, 7 (2), 13-32.

## Oral presentations

### OP-PM03 Brain and Exercise

#### MOTOR AND PREFRONTAL CORTEX OXYGENATION EVALUATED BY NIRS DURING CONSTANT STRENUOUS CYCLING EXERCISE

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UNIVERSITÉ MONTPELLIER 1

**Introduction** Strenuous physical exercise, involving large muscle masses, is known to stress the oxygen transport system and may present significant threat to cerebral oxygenation patterns (Subudhi et al.). Regions of the brain that regulate the central motor drive should cope with fatigue development during such challenging exercises. To date, cerebral oxygenation adaptation patterns during prolonged strenuous exercise, over multiple brain regions, are not known (Rooks et al.). Therefore, the aim of this study was to investigate the cerebral and muscle oxygenation time courses during a constant strenuous cycling exercise. We hypothesized that dissociation occurs between cerebral and muscle oxygenation in order to maintain constant power output. **Methods** Ten healthy male subjects participated on two separate days. On the first day, they performed an incremental exercise test on a braked cycle ergometer to determine maximal oxygen consumption (VO<sub>2</sub>max, 30W/min until exhaustion). Gas exchanges at the mouth were monitored using a metabograph (ZAN680, Oberthulba, Germany) and cardiac output (Qc) was continuously measured throughout the tests via thoracic bio-impedance (Physioflow PF-05, Manatec Biomédical, Macheren, France). At least 24h later, subjects underwent a constant cycling exercise for 20min at an intensity based on the 30% difference between the first ventilatory threshold and VO<sub>2</sub>max. In addition to the apparatus described earlier, subjects were instrumented with several pairs of fNIRS optical probes (Oxymon Mark III, Artinis, The Netherlands) to monitor oxygenation levels in cerebral (left motor and prefrontal cortices) and muscle (right vastus lateralis) tissues. **Results** All subjects maintained the required intensity (240 ±40W) for 20 minutes. Mean VO<sub>2</sub> at steady state was 86 ±7% of VO<sub>2</sub>max (50 ±6ml/min/kg) and mean Qc at steady state was 94% of Qcmax (26 ±6l/min). Relative oxyhemoglobin increased both in the prefrontal cortex (+38.6 ±6.5μM) and in the motor cortex (+15.7 ±5.2μM) while a classical activation pattern was found for the vastus lateralis oxygenation dynamics. Time to plateau in oxy- and deoxyhemoglobin concentration changes in the cortical areas was 4 to 6 min, while at the muscular level; the plateau was reached earlier (2 to 4 min) as well as for VO<sub>2</sub> steady state achievement. **Discussion** These particular time courses suggest that cortex hemodynamics progressively shift during strenuous whole body exercise in order to maintain constant muscle output. The nonparallel changes in the signals between the muscle and the brain suggest a decoupling of the two signals which may be underlain by neural mechanisms adapting to muscle fatigue. Rooks, CR., Thom, NJ., McCully, KK., Dishman, RK. (2010). Effects of incremental exercise on cerebral oxygenation measured by near-infrared spectroscopy: a systematic review. *Prog Neurobiol* 92, 134-150. Subudhi, AW., Miramon, BR., Granger, ME., Roach, RC. (2009). Frontal and motor cortex oxygenation during maximal exercise in normoxia and hypoxia. *J Appl Physiol* 106, 1153-1158.

#### EFFECTS OF ACUTE EXERCISE ON CORTICAL BRAIN ACTIVITY AND COGNITIVE PERFORMANCE IN 5-YEAR OLD CHILDREN

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**Introduction** The effects of acute exercise on cortical brain activity and brain function have been reported in several studies. However, most of them examined adults and in some cases school children or the elderly. To the best of our knowledge there have been no studies which investigate such effects in pre-school children although this age-group is characterized by a particularly high plasticity of the central nervous system. **Methods** 8 male, pre-school children participated in the study (5.6±0.5 yrs; 122.4±4.2 cm; 22.1±2.7 kg). In a balanced cross over design participants either completed an exercise session (EXE) of 45 min duration or a control condition (CON) where they were allowed to paint and/or to talk to their parents. The exercise session consisted in 3 out of 5 different movement games (10 min each) that were introduced in a counterbalanced order and a soccer match (15 min) at the end of the session. Heart rate (HR) was recorded continuously before, during and after exercise as a measure of physical demand. The experiment started at 3 pm with two (eyes closed and eyes open) 1 min resting electroencephalographic (EEG) recordings. EEG data was Fourier transformed to provide estimates for absolute power in 8 frequency bands (delta to gamma), and analysed in 4 regions across the scalp. After the EEG, participant's reactive stress tolerance, attention and reaction speed (RT) in situations requiring continuous, swift and varying responses to rapidly changing visual and acoustic stimuli was assessed for 5 min using the children's version of the well-established determination test (DTKI, VIENNA TEST SYSTEM). EEG and DTKI were repeated approximately 20 min after the intervention, when heart rate returned to baseline values (POST). Both, median RT and EEG band power were expressed as a percentage of the PRE value, thus reducing interindividual and day-to-day variations. **Results** Average HR during the exercise session was 150.2±15.8 1/min. The median RT in the DTKI was significantly lower in EXE compared to CON (p<0.001). Lower-1 alpha power was reduced for CON compared to EXE (p<0.05) in the eyes open condition. Furthermore, beta1 and beta2 power were significantly lower in the frontal cortex for EXE compared to CON (p<0.001). **Discussion** The results of the present study suggest that acute exercise can improve children's cognitive performance. This effect could be mediated by exercise-induced neural efficiency which is reflected by decreased desynchronisation in the widespread lower-1 alpha band when the eyes are open and reduced beta1 and beta2 power in the frontal cortex after exercise.

#### EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON MAXIMAL VOLUNTARY ISOMETRIC STRENGTH AND MUSCLE ENDURANCE OF THE ELBOW FLEXORS

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EDITH COWAN UNIVERSITY

**EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON MAXIMAL VOLUNTARY ISOMETRIC STRENGTH AND MUSCLE ENDURANCE OF THE ELBOW FLEXORS** Kan, B.1, Dundas, J.E.2, Nosaka, K.1 1 Edith Cowan University (AUSTRALIA), 2 University of Western Australia (AUSTRALIA) **Introduction** Transcranial direct current stimulation (tDCS) is a way of altering cortical excitability using low intensity (1-2 mA) direct current delivered to the scalp overlying a target region of the brain via electrodes connected to a controlled current unit. Cogiamanian et

al. (1) reported that a 10-min tDCS treatment (2 mA) attenuated the decrease in the time to failure (TTF) of an isometric muscle endurance task at 35% of maximal voluntary isometric contraction (MVC) strength of the elbow flexors from pre to post treatment test separated by 60 min. It should be noted that the TTF decreased in the post-treatment tests by 25% (tDCS) or 40% (control) in their study; however, our pilot study showed no decrease in TTF with a 60-min rest. The present study investigated the effects of tDCS on MVC strength and TTF of the elbow flexors, when the TTF was expected to be similar between the pre and post treatment tests in control condition. Methods Fifteen healthy men (18-50 y) participated in the study after providing the informed consent. MVC strength and TTF at 30% MVC were measured before and immediately after a 10-min tDCS or sham treatment set at 50 min after the baseline measures on three separate occasions. On two occasions, direct current (2 mA) was delivered through a pair of electrodes soaked in saline solution placed on the scalp of the right hemisphere motor cortex controlling the left arm (anode) while the cathode placed over the right shoulder. One occasion was a sham treatment where no current was delivered. The order of the conditions was blinded to the subjects and randomised. Changes in MVC strength and TTF from pre to post treatment were compared between tDCS and sham treatments by a two-way repeated measures ANOVA. Results The two tDCS conditions showed similar responses. No significant difference in the baseline MVC strength was evident between the tDCS and sham treatments. MVC strength decreased by ~5.9 % ( $P < 0.05$ ) from pre to post measurements, but no significant difference in the changes was evident between treatments. TTF did not change significantly from pre to post, and no significant difference was found between treatments. Discussion The present study did not find significant effect of tDCS treatment on MVC strength and TTF, thus the previous study finding (1) was not replicated. The discrepancy between the present and previous study's results may be due to a difference in the TTF task (force task vs. position task). It seems that the effect of the tDCS treatment on cortical excitability in the present study was not strong enough to affect MVC strength and TTF. References 1) Cogiamanian F et al. (2007) *Eur J Neurosci* 26:242-9

## EXERCISE, COGNITION AND INTELLECTUAL DISABILITY – A NEUROPHYSIOLOGICAL APPROACH

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Introduction The relevance of exercise on health promotion is well accepted and has been addressed in several neuropsychological investigations (2, 4). These studies were mainly set up for healthy individuals. However, the benefits of exercise, such as general well being, physical and cognitive health enhancements (2) are becoming more important for everybody, thus for intellectually disabled individuals, too (3). Yet, there is no study investigating the neuropsychological correlates of exercise on intellectually disabled individuals. Therefore this study aimed to investigate the effects of exercise on neurophysiological correlates, underlined by cognitive processing in intellectually disabled individuals. Method Following a 30 min run (mean HR 154.50  $\pm$  14.43 bpm), 12 intellectually disabled participants (5) underwent a visual recognition and reaction time task using the evaluated Vienna Test System (control conditions without exercise). Before and after exercise a 3 min resting EEG was recorded on 32 positions according to the international 10-20 system (4). Data was analysed using standardized low-resolution electromagnetic tomography (sLORETA). Results sLORETA analysis revealed a significant decrease ( $p < 0.05$ ) in beta activity in the frontal lobe. Even though visual recognition as well as reaction time revealed no significant changes compared to control conditions, a decrease of activity in frontal lobe regions was found to be positively correlated with the cognitive tasks ( $p < 0.05$ ). Discussion With respect to a transient hypofrontality hypothesis (1) a decrease of (prefrontal) lobe activity can be regarded as the rearrangement of cortical activity, which coincides with cognitive states (1), such as decision-related processes. As to the literature our findings give reason to believe that exercise affects frontal lobe activity, related to cognitive processing in intellectually disabled individuals. References (1) Dietrich A (2006). Transient hypofrontality as a mechanism for the psychological effects of exercise. *Psychiatry Res.* 145(1): 79-83 (2) Hillmann CH, Pontifex MB, Raine LB, Castelli DM, Hall EE, Kramer AF (2009). The effect of acute treadmill walking on cognitive control and academic achievement in preadolescent children. *Neuroscience.* 159(3): 1044-54 (3) Hutzler Y, Korsensky O (2010). Motivational correlates of physical activity in persons with an intellectual disability: a systematic literature review. *J Intellect Disabil Res.* 54(9): 767-86 (4) Schneider S, Brümmer V, Carnahan H, Kleinert J, Piacentini MF, Meeusen R, Strüder HK (2010). Exercise as a countermeasure to psycho-physiological deconditioning during long-term confinement. *Behav Brain Res.* 211(2): 208-214 (5) WHO (1997). The International Classification of Impairments, Activities and Participation (ICIDH-2), Geneva

## CORTICAL REPRESENTATION OF SELF-PACED TREADMILL WALKING

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Introduction Walking is a complex process that involves an accurate interaction between supraspinal centers, central pattern generators and multi-sensory peripheral sources. For gait rehabilitation purposes and the successful implication of brain-computer-interfaces, it is of great importance to know and understand the course of movement-related cortical potentials (MRCPs) during complex movements such as human gait. In this study the use of active electroencephalography (EEG) electrodes combined with source localization techniques (sLORETA) respond to the challenges often seen during EEG registration (e.g., movement artifacts) and allow for the assessment of MRCPs and active brain regions related to self-paced treadmill walking in healthy subjects. Methods Three men and 7 women (mean age 28.2  $\pm$  4.1 years) participated in this study. Thirty-two channel EEG data were recorded during 20 minutes of treadmill walking. Heelstrike (HS) of the left leg was detected by a foot contact sensor. EEG data were segmented into epochs of 1000 msec around HS and averaged to one MRCP for each subject. Individual waveforms were averaged to a single grand average MRCP for each channel. The averaged MRCPs for each subject were imported and statistically analyzed into sLORETA in order to compute cortical sources of activity. Results EEG traces over the motor cortex show a slow decrease in brain potential, which starts around -240 msec in relation to HS. From this point until -140 msec prior to HS a readiness potential window can be defined, followed by a fast increase in EEG negativity (the negative slope). A plateau tendency appeared between -60 and -20 msec, indicating the motor potential window. The maximum EEG activity is reached within the first 20 msec following HS. This negative potential is rapidly followed by a positive potential, creating the movement-monitoring potential following HS. sLORETA shows the greatest negativities of the MRCPs over the left sensorimotor cortex. Discussion This is the first study that uses EEG to define MRCPs and active brain regions during self-paced treadmill walking. EEG registration during gait exposes gait-related cortical potentials in the motor cortex around the moment of HS. The greatest negative potentials during walking can be found in the left hemisphere. This points out that bilateral coordination preferentially recruits the left hemisphere and the left hemisphere probably regulates limb position and posture during human walking (Serrien et al., 2006). Moreover, as in the study of Gwin et al. (2010), we found that cortical activity in the left sensorimotor cortex is more pronounced for ipsilateral heel-strike. References Gwin JT, et al. (2011). *NeuroImage*, 54(2), 1289-96. Serrien DJ, et al. (2006). *Nat Rev NeuroSci*, 7, 160-67.

**EFFECTS OF END-TIDAL PCO<sub>2</sub> CLAMPING ON BRAIN BLOOD FLOW AND MAXIMAL EXERCISE CAPACITY IN HYPOXIA**

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**Introduction** During heavy exercise, hyperventilation-induced hypocapnia leads to cerebral vasoconstriction, resulting in a reduction in cerebral blood flow (CBF). In hypoxia, a reduction in CBF would impair cerebral O<sub>2</sub> delivery and potentially account for the reduced exercise performance in hypoxia. We tested the hypothesis that PETCO<sub>2</sub> clamping in hypoxia exercise would prevent the hypocapnia-induced reduction in CBF during heavy exercise and improve exercise capacity. **Methods** We measured end-tidal PCO<sub>2</sub> (PETCO<sub>2</sub>) and PO<sub>2</sub> (PETO<sub>2</sub>), ventilation (VE), middle cerebral artery velocity (MCAv; index of CBF), peripheral O<sub>2</sub> saturation (SpO<sub>2</sub>) and cerebral O<sub>2</sub> supply index (MCAv times SpO<sub>2</sub>) in ten healthy men (age 24±3 yrs; VO<sub>2</sub>max 57.4±10.9 ml/min/kg; mean±SD) during incremental cycling to exhaustion (0.5 W/s) in normoxia and hypoxia (FIO<sub>2</sub> = 0.10) with and without PETCO<sub>2</sub>-2 clamping. PETCO<sub>2</sub> clamping was achieved by increasing FICO<sub>2</sub> whilst keeping FIO<sub>2</sub> constant. In normoxia we increased PETCO<sub>2</sub> to 43±2 mmHg. In hypoxia we aimed PETCO<sub>2</sub> values similar to those observed in normoxia (40±2 mmHg). **Results** During normoxia, PETCO<sub>2</sub> clamping elevated resting PETCO<sub>2</sub>, PETO<sub>2</sub>, VE, MCAv and cerebral O<sub>2</sub> supply index by 7±2 mmHg, 20±4 mmHg, 12.7±4.5 L/min, 33±10% and 26±17% respectively (P<0.001), while SpO<sub>2</sub> was unchanged (P>0.05). PETCO<sub>2</sub> clamping in hypoxia elevated resting PETCO<sub>2</sub>, PETO<sub>2</sub>, VE, MCAv, SpO<sub>2</sub> and cerebral O<sub>2</sub> supply index by 8±3 mmHg, 10±4 mmHg, 12.0±6.6 L/min, 34±16%, 6±4% and 33±27% respectively (P<0.001; P<0.001; P<0.001; P<0.05; P<0.01; P<0.01). During normoxic exercise, PETCO<sub>2</sub> clamping elevated PETCO<sub>2</sub> by 7±3, 6±3, 6±3, 10±4, 17±4 mmHg at 20, 40, 60, 80 and 100%Wattmax respectively (P<0.001), while MCAv was elevated by 19±19, 21±18, 26±20, 33±21, and 49±20% at these exercise intensities (P<0.05). During hypoxic exercise, PETCO<sub>2</sub> clamping elevated PETCO<sub>2</sub> by 12±3, 12±2, 14±2, 16±3 and 20±3 mmHg at 20, 40, 60, 80 and 100%Wattmax respectively (P<0.001), while MCAv was elevated at 100%Wattmax only (by 19±12%; P<0.05). PETCO<sub>2</sub> clamping did not alter maximal exercise capacity in either normoxia or hypoxia (P>0.05). At peak exercise, the cerebral O<sub>2</sub> supply index was similar in normoxia and hypoxia in the unclamped condition (P>0.05). PETCO<sub>2</sub> clamping elevated the cerebral O<sub>2</sub> supply index at peak exercise by 46±25% during normoxia (P<0.001), but no change was observed during hypoxia (P>0.05). No differences were observed in power output, PETO<sub>2</sub>, VE and SpO<sub>2</sub> with PETCO<sub>2</sub> clamping at peak exercise during either normoxic or hypoxia conditions (P>0.05). **Discussion** In hypoxia PETCO<sub>2</sub> clamping did not change cerebral O<sub>2</sub> supply index at peak exercise despite elevated CBF. Despite normalization of PETCO<sub>2</sub> to normoxic values we did not observe an improvement in exercise capacity, thus refuting our hypothesis.

**Oral presentations****OP-PM05 Exercise: Signalling****COSTAMERIC FOCAL ADHESION KINASE ORGANISES LOAD-DEPENDENT P70S6K SIGNALLING IN SKELETAL MUSCLE**

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**Introduction:** Skeletal muscle mass shows pronounced load dependence but the organization of the signalling processes relaying mechanical loading with anatomical changes in muscle is not known. We hypothesized that sarcolemmal adhesion sites of muscle fibres (costameres) are implicated in the load-dependent regulation of p70S6K signalling towards protein synthesis. **Methods:** Focal adhesion kinase (FAK) was overexpressed alone or in combination with its inhibitor, FRNK, in rat soleus muscle (Durieux 2009). Loading of rat soleus muscle was modified with hindlimb suspension and reloading or bilateral tenotomy of the achilles tendon. Loading to human vastus lateralis muscle was modified by bedrest and resistance exercise. Gamma- and meta- vinculin and FAK and p70S6K kinase were assessed by immunoblotting in total homogenates of muscle samples. Pre post changes were compared with a paired T-test. **Results:** Overexpression of focal adhesion kinase (FAK) in rat soleus muscle upregulated the content of the costamere components, gamma- and meta- vinculin (+153%), p70S6K protein (+40%), and ribosomal transcripts. The expression of p70S6K (-83%), gamma- (-39%) and meta- vinculin (-49%) was reduced with hindlimb unloading and raised again within 24 h of reloading (p70S6K: 10x; vinculin: 1.5x) in corresponded to activated FAK (Y397 phosphorylation). Similarly, 24 h of soleus muscle overload increased the content and activation status of FAK and p70S6K. 1 h after overload the phosphorylation of p70S6K, AKT and 4E-BP1 was elevated. At this point the content of activated FAK was reduced but was re-established with co-overexpression of FAK and FRNK, in co-relation with p70S6K content (r=0.74). Changes in muscle loading to human vastus lateralis muscle by bedrest and resistance training reproduced the relationships between FAK, FAK-pY397 and meta-vinculin. **Discussion:** The observations indicate that remodelling of costameres via FAK is coupled to the load-dependent control of protein synthetic capacity in vertebrate muscle. This supports the concept that signalling pathways themselves demonstrate use-dependent plasticity. **References:** Durieux AC, D'Antona G, Desplanches D, Freyssenet D, Klossner S, Bottinelli R, Flück M. (2009), J Physiol. 587(Pt 14): 3703-17. Financial support from the EU FP7 Myoage Project (Contract No 223576) is acknowledged

**FUNCTIONAL ANALYSIS OF THE 3'-UTR OF THE COL5A1 GENE: IMPLICATIONS FOR 'EXERCISE-RELATED PHENOTYPES'**

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**Introduction** COL5A1 encodes the α1 chain of type V collagen, a minor fibrillar collagen that regulates fibrillogenesis within non-cartilaginous connective tissues. We have shown that a common C to T single nucleotide polymorphism (rs12722) within the COL5A1 3'-untranslated region (UTR) is associated with a number of sports injuries (such as Achilles tendinopathy; AT) and performance related phenotypes. To provide functional evidence for these genetic associations, the aim of this study was to determine the biological function of the COL5A1 3'-UTR. **Methods** The entire COL5A1 3'-UTR from four AT patients and three controls were cloned, from genomic DNA using nested PCR, within the pGL3-Promoter vector, substituting the poly (A) signal of the firefly-luciferase reporter gene. The constructs were transiently co-transfected with an internal control HT1080 cells. The normalised results were expressed as relative luciferase activity. Based on the functional data we propose that musculoendoneous unit stiffness is the underlying mechanism that explains our reported genetic associations. **Results** There was statistically significantly higher activity in the luciferase activity of the AT clones (87.5±14.3%) when compared to the control clones (67.6±20.0%, p=0.007). Two major forms of the COL5A1 3'-UTR were identified when all the cloned 3'-UTRs were sequenced. One form (WT-allele) was predominantly identified in the controls, while the second form (TEN-allele) was pre-

dominately identified in AT subjects. The luciferase activity of the WT-allele was also significantly lower than the TEN-allele ( $68.3 \pm 24.9\%$  vs  $86.0 \pm 18.5\%$ ,  $p < 0.001$ ). Conclusion Two major COL5A1 3'-UTR alleles were identified; one from the AT patients and the other from the asymptomatic controls. There was an overall increase in mRNA stability for the TEN-allele. These results demonstrate that the COL5A1 3'-UTR may play an important regulatory role which could result in susceptibility to musculoskeletal soft tissue injuries and other phenotypes. We therefore hypothesize that this results in an increased type V collagen content, which will alter fibril assembly, decrease fibril diameter and thus biomechanical properties. These changes may result in the observed associations with injury and performance phenotypes. Evidence for this hypothesis is supported by clinical features, such as joint hypermobility, and the biochemical architecture of connective tissue within patients with classic Ehlers-Danlos syndrome (EDS) and a col5a1 knock-out mouse model.

### THE COL3A1, COL5A1 AND COL6A1 GENES AND EXERCISE ASSOCIATED MUSCLE CRAMPS AMONG IRONMAN TRIATHLETES

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Introduction EAMC is a common condition seen in participants of endurance events such as ultra-marathons and triathlons. Despite its high prevalence, little is known about the aetiology of EAMC (Schwellnus, 2009). The altered neuromuscular control hypothesis suggests that genetic predisposition may play a role in the aetiology of EAMC (Schwellnus, 2009). We propose variants within the COL3A1, COL5A1 and COL6A1 genes may modulate risk of developing EAMC, since these genes are known to exert effects on soft-tissue, including tendons, ligaments and muscles. Methods Two hundred and ninety eight participants with self-reported history of EAMC within the last 12 months prior to the event were included as cases in this study (hEAMC group). One hundred and fifty nine participants with no self-reported history of EAMC were included as controls (CON group). All participants were genotyped for the COL5A1 BstUI restriction fragment length polymorphism (RFLP), the COL3A1 E30+2209 G/A and COL6A1 IVS32-29 T/C polymorphisms. Results When participants  $\geq 35$  yrs were analysed, the COL5A1 BstUI CC genotype was significantly associated with development of EAMC ( $p = 0.006$ ). Specifically the COL5A1 BstUI CC genotype was significantly under-represented (OR = 2.9, 95% CI 1.4–5.9;  $p = 0.003$ ) in the hEAMC group (CC genotype 11.0%) when compared to CON group (CC genotype 26.4%). No significant genotype differences were found for the COL3A1 E30+2209 G/A ( $p = 0.731$ ) and COL6A1 IVS32-29 T/C ( $p = 0.986$ ) polymorphisms between the hEAMC and CON groups. Conclusion This study identified, for the first time, the COL5A1 gene as a potential marker for the development of EAMC. These effects may be mediated through the effects that type V collagen exerts on the mechanical properties of musculoskeletal soft tissues. References Schwellnus M. (2009). Br J Sports Med, 43, 401-408.

### SIGNALLING RESPONSES OF HUMAN SKELETAL MUSCLE TO HIGH-INTENSITY INTERVAL RUNNING VERSUS MODERATE-INTENSITY CONTINUOUS RUNNING

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Introduction We recently demonstrated that high-intensity interval (HIT) running is perceived as more enjoyable than moderate-intensity continuous (CONT) running (Bartlett et al. 2011). Such data have implications for improving exercise adherence and long-term health, especially considering that HIT cycling is a more time-efficient training stimulus than CONT cycling for improving skeletal muscle oxidative capacity (Gibala et al. 2006). Despite running being the most readily available form of exercise to the general population, comparable data for this exercise mode are lacking. The aim of this study was to therefore test the hypothesis that acute HIT running is a more potent exercise stimulus than CONT running for activating key signal transduction pathways associated with mitochondrial biogenesis. Method Muscle biopsies (vastus lateralis) were obtained from six active men who performed two running protocols consisting of HIT or CONT in a randomized manner separated by 7-days. HIT consisted of 6 x 3 min at 90 %  $\text{VO}_{2\text{max}}$  interspersed with 3 min recovery periods at 50 %  $\text{VO}_{2\text{max}}$ , plus a 7 min warm-up and cool down at 70 %  $\text{VO}_{2\text{max}}$ . CONT consisted of 50 min of continuous running exercise at 70 %  $\text{VO}_{2\text{max}}$ . The protocols were matched for energy expenditure, average intensity, average heart rate, duration and distance ran (Bartlett et al. 2011). Results Phosphorylation (P-) of p38MAPKThr180/Tyr182 increased after both trials ( $P < 0.05$ ), but the increase in HIT ( $2.2 \pm 0.1$ -fold) was greater than CONT ( $1.5 \pm 0.2$ -fold) ( $p < 0.05$ ). Similarly, P-AMPKThr172 increased immediately after exercise ( $P < 0.05$ ), with a tendency for the change to be greater in HIT vs CONT ( $1.8 \pm 0.3$  vs  $1.4 \pm 0.1$ -fold;  $P = 0.07$ ). Exercise did not change the total protein content of PGC-1 $\alpha$  or GAPDH in either condition ( $p > 0.05$ ). Discussion These preliminary data suggest that HIT running may be a more potent stimulus than CONT running for activating key signaling kinases involved in stimulating mitochondrial biogenesis. Despite both protocols being matched for work done, our data suggest that it is the variations in exercise intensity as opposed to energy expenditure per se which ultimately determines the metabolic responses of skeletal muscle. The precise mechanisms underpinning the enhanced p38MAPK phosphorylation remain unknown and biopsy samples are currently being analysed for markers of metabolic and oxidative stress and downstream markers linked to mitochondrial biogenesis. References Bartlett JD, Close GL, McLaren DPM, Gregson W, Drust B, Morton JP. J Sport Sci, In Press. Gibala MJ, Little JP, van Essen M, Wilkin GP, Burgomaster KA, Safdar A, Raha S, Tarnopolsky M. (2006). J Physiol, 575(3), 901-911.

### INCREASED FOCAL ADHESION KINASE IN ELDERLY HUMAN SKELETAL MUSCLE AFTER 12 WEEKS RESISTANCE TRAINING

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Introduction Focal adhesion kinase (FAK) is one of the component enzymes of sarcolemmal focal adhesion complexes, which convert mechanical stimuli into intracellular signalling. Increased FAK protein content and phosphorylation with loading is associated with hypertrophy in animal skeletal muscle, while unloading is associated with atrophy and a reduction in FAK. In humans a reduction in habitual physical activity contributes to the loss of skeletal muscle mass and strength with age. Therefore, we used immunofluorescence microscopy to test the hypothesis that a 12 week progressive resistance training program would increase FAK content and phosphorylation in skeletal muscle fibres of previously untrained elderly men. Methods Nine healthy, insulin sensitive elderly males ( $73 \pm 6$  y;  $26.8 \pm 3.7$  kg/m $^2$ ) completed a 12 week resistance training program with percutaneous vastus lateralis muscle biopsies collected pre- and post-training. Cryosections were incubated with FAK antibodies for visualisation in muscle fibres and plasma membrane. Anti-myosin heavy chain type

I was used for fibre type differentiation. Muscle sections were also incubated with wheat germ agglutinin-350 for identification of the plasma membrane. Fibre type differences in the intensity of FAK immunofluorescence were determined using image analysis software. Results At baseline, mean type I muscle fibre area was significantly higher than type II fibres ( $P=0.009$ ) but type II fibre area increased after training ( $P=0.016$ ). In both fibre types, a greater FAK immunoreactivity was detected at the (sub)sarcolemmal regions compared with deeper areas of the myofibre, particularly in type I fibres. However, there was no difference in myofibre FAK content pre-training between type I and type II fibres. Following training, a strong (sub)sarcolemmal FAK immunoreactivity was detected in both fibre types, especially in type II fibres. There was no change in type I fibre FAK content ( $P=0.07$ ) but there was a 29% increase in type II fibres ( $P=0.016$ ) respectively. This resulted in significantly more FAK in type II than type I fibres ( $P=0.013$ ). There was also an 18% increase in the plasma membrane FAK content post-training ( $P=0.024$ ). Conclusion We show for the first time that previously untrained elderly individuals completing a resistance training program can increase FAK in type II muscle fibres and the plasma membrane. These data suggest FAK may play an important role in the adaptation to resistance training in elderly individuals.

## Oral presentations

### OP-PM32 Physical Activity and Health 1

#### PHYSICAL ACTIVITY AND LEISURE TIME HABITS IN SCHOLARS AGED 9-16: DIFFERENCES BY GENDER

VIUDA-SERRANO, A., RUIZ-VICENTE, D., THEIRS RODRÍGUEZ, C.I., PÉREZ, B., PARDO, R., SALINERO, J.J., GARCÍA-APARICIO, A.  
UNIVERSIDAD CAMILO JOSÉ CELA

PHYSICAL ACTIVITY AND LEISURE TIME HABITS IN SCHOLARS AGED 9-16: DIFFERENCES BY GENDER Viuda-Serrano, A.; Ruiz-Vicente, D.; Theirs Rodríguez, C.I.; Pérez, B.; Pardo, R.; Salinero, J.J.; García-Aparicio, A. Universidad Camilo José Cela INTRODUCTION Evidence strongly demonstrates that physical fitness and health status of children and youth are substantially enhanced by frequent physical activity (1), however recent studies in our country are discouraging. In the enKid study it was observed that 19.8% of boys and 30% of girls aged 10-13 never do sport activities (2). National Health Survey showed that less than 30% of the children between the ages of 6 and 15 are active (3). OBJECTIVE To analyze differences in physical activity and leisure habits between boys and girls aged 9-14 from schools that actively promote sports. METHOD 870 subjects (boys=443, girls=427), aged 9-16 (boys=12.2±1.8; girls=12.1±1.7) answered a modified version of the Assessment of Physical Activity Level Questionnaire (4). Descriptive statistics, contingency tables and contrast of means were used to analyze differences between boys and girls. RESULTS Significant gender differences were observed in the Physical Activity Index ( $t=7.765$ ;  $p=.000$ ) as well as in regulated sport activities participation ( $U=70,628$ ;  $p=.000$ ), recreational activities ( $U=77,659$ ;  $p=.042$ ), moderate and vigorous physical activity (MVPA) ( $U=67,920$ ;  $p=.000$ ) and participation in competitive sport ( $U=71,005$ ;  $p=.000$ ). 52.3% of boys did MVPA more than 2 hours a week, while only 29% of girls did so. 23.6% of boys and 37.1% of girls never played any organized sport. It was observed a significant relationship between gender and items such as "reading" ( $\chi^2=19.21$ ;  $p=.000$ ), "housework participation" ( $\chi^2=8.75$ ;  $p=.003$ ) or "family time" ( $\chi^2=7.75$ ;  $p=.021$ ) that were practiced by girls to a greater extent; whereas "playing with computer or video games" ( $\chi^2=15.59$ ;  $p=.000$ ), "going to sport events as spectator" ( $\chi^2=19.26$ ;  $p=.000$ ) or "playing sports" ( $\chi^2=44.51$ ;  $p=.000$ ) were wider practiced by boys. CONCLUSIONS They have been showed differences between boys and girls in the practice of physical and sport activities, as well as in other leisure-time activities. A reduced percentage of subjects reported a lack of sport practice, which confirms the importance given to sport in these schools. REFERENCES 1. Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, 2008. Washington, DC: U.S. Department of Health and Human Services, 2008. 2. Roman B, Serra L, Ribas L, Pérez-Rodrigo C. Actividad física en la población infantil y juvenil española en el tiempo libre. Estudio enKid (1998-2000). *Apunts Medicina de l'sport*. 2006;151:86-94. 3. Lasheras L, Aznar S, Merino B. Factors associated with physical activity among Spanish youth through the National Health Survey. *Preventive Medicine*. 2001;32:455-64. 4. Ledent M, Cloes M, Piéron M. Les jeunes, leur activité physique et leurs perceptions de la santé, de la forme, des capacités athlétiques et de l'apparence. *Sport*. 1997;159/160:90-5.

#### INFLUENCE OF PHYSICAL ACTIVITY INTENSITY AND PHYSICAL SELF-PERCEPTIONS ON WEIGHT STATUS AMONG 10-11 YEAR CHILDREN: THE CHANGE! PROJECT

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Background: Child overweight is an established risk factor for cardiometabolic disorders. Increased prevalence of overweight and obesity in developed countries has prompted interest in the influence of physical activity as a preventative intervention (Gutin, 2011). Children's physical self-perceptions are often associated with physical activity (Fairclough & Ridgers, 2010) but the influence on weight status of these related constructs is under-researched. The study purpose was to examine associations between children's physical activity intensity, physical self-perceptions, and weight status. Methods: Data were obtained from 274 children (154 girls) aged 10-11 years. Standard anthropometric measurements were used to establish BMI and maturity offset values. Children were categorised as normal-weight (NW), or overweight/obese (OW) using the IOTF BMI cutpoints. Habitual physical activity was assessed using accelerometry, and children completed the Children and Youth version of the Physical Self-Perception Profile. Sex-specific logistic regression adjusted for age and maturation assessed associations between different physical activity intensities, physical self-perceptions, and weight status. Results: For boys moderate physical activity (MPA) was positively associated with OW (OR = 1.01 [1.01, 1.19],  $p = 0.024$ ), while an inverse association was observed for vigorous physical activity (VPA; OR = 1.33 [1.06, 1.67],  $p = 0.011$ ). Among girls OW was positively associated with perceived strength (OR = 4.97 [1.46, 16.94],  $p = 0.01$ ), and inversely associated with perceived attractiveness (OR = 4.55 [1.67, 12.5],  $p = 0.003$ ). Physical self-perceptions did not predict weight status in boys, while in girls being OW was not associated with sedentary time or physical activity. Conclusions: Boys' engagement in VPA may be a stronger predictor of being OW than MPA, as VPA has previously been shown to associate with body composition (Gutin, 2011) and cardiorespiratory fitness (Parikh & Stratton, in press). Physical self-perceptions had a stronger predictive influence on girls' weight status among girls physical activity. Physical activity and physical self-perceptions influence boys' and girls' weight status differently. References Fairclough, S. J., & Ridgers, N. D. (2010). *J Sports Sci*, 28, 1-9. Gutin, B. (2011). *Int J Obesity*, 35, 29-32. Parikh, T., & Stratton, G. (in press). *Sports Med*.

## ASSESSMENT OF PHYSICAL ACTIVITY BY QUESTIONNAIRES AND ACCELEROMETERS

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**Introduction** The determination of the degree of physical activity in the population and various sub-groups is essential for answering questions on health sciences, e.g. for the identification of target groups for health-related interventions. In general, the level of activity in the population is diagnosed on survey inventories. What quality is determined in this way data is largely unknown (Wagner & Singer, 2003). Aim of the present study was to compare subjective self-report data with objective accelerometer. **Methods** The physical activity level of 45 adults, 23 Men and 22 Females (23-59 years, M= 33,3 years, SD=10,6 years) were recorded for over a week via physical-activity diary, accelerometer (Personal Activity Monitor, PAM) on the modified physical activity questionnaire (Baecke et al., 1982, Wagner & Singer, 2003). The data from the accelerometer as well as the with the diary data calculated metabolic equivalent were averaged for the inquiry period and compared with activity indices (Complete, Working, Exercise, Leisure-Time). **Results** Significant positive correlations have been found between the data from the PAM and the MET's ( $r=.38$ ,  $p<.05$ ) as well as between the PAM data and the Baecke-Index ( $r=.43$ ,  $p<.01$ ). Slightly positive correlations with the Leisure-Time-Index and the Working-Index have not been significant. The Working-Index correlates positive with the MET-data ( $r=.42$ ,  $p<.01$ ). Furthermore there have been significant differences of the PAM data regarding the regularity of exercising ( $p<.05$ ,  $F=3,24$ ). **Discussion** The correlation between the self-reported data and the PAM data are similar to existing validation studies (Cust et al., 2008). An additional validation and review/revisal is recommended for decisions and interventions based on self-reported physical activity data. **References** Baecke JA, Burema J, Frijters JE (1982) Am J Clin Nutr, 36, 936-942. Cust AE, Smith BJ, Chau J, van der Ploeg HP, Friedenreich CM, Armstrong BK, Bauman A (2008). Int J Behav Nutr Phys Act, 5, 33. Wagner P, Singer R (2003). Sportwissenschaft, 33, (4), 383-397.

## WITHIN DAY VARIABILITY OF OBJECTIVELY MEASURED PHYSICAL ACTIVITY DURING WEEKDAYS AND WEEKEND DAYS IN PRESCHOOL CHILDREN

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**Introduction** There is inconclusive evidence for a causal link between physical activity (PA) and health outcomes in preschool children. Despite the common perception from practitioners that preschool children are receiving sufficient PA, data suggest they do not meet the PA recommendations (O'Dwyer et al. 2011). It is important to increase PA however evidence concerning the timing of successful preschool interventions remains inconclusive. The aim of this study was to explore within day variability of PA during weekdays and weekend days. **Methods** Participants ( $n=240$ ; 52% male, Mage =  $4.4\pm0.6$  years) were randomly selected from 12 schools in North West England. PA was measured using the GT1M Actigraph uniaxial accelerometer for 7 consecutive days every 5 seconds, and analysed using age-specific cut points. For inclusion in the analyses, participants were required to have worn the monitors on 3 days (including one weekend day). School attending days and weekend days were segmented into before school (07:00-09:00), during school (09:00-15:00) and after school (16:00-19:00) and morning (08:00-11:00), daytime (12:00-16:00) and evening (17:00-20:00), respectively. A two way between groups analysis of variance was conducted to explore the impact of gender and age moderate-to-vigorous physical activity (MVPA) across different segments of weekdays and weekend days. **Results** Preschoolers spent 6.9% (average: 42.3 minutes) of the day in MVPA while 81.5% (average: 642.5 minutes) was time spent sedentary. During preschool attending days (09:00h-15:00h), boys accumulated more MVPA than girls ( $p=.014$ ). During the weekend day (12:00h-15:00h) boys engaged in more MVPA ( $p=.008$ ). There were no age and gender differences found for the other segments of the day. **Discussion** Boys were more active during specific segments of the school day and weekend day. It may be potentially beneficial to incorporate PA interventions into preschool attending hours specifically for girls. Patterns of physical activity in preschool children appear to be consistent across both weekdays and weekend days though evidence of within day variability was found. Periods of the day susceptible to the improvement of PA were also revealed. Patterns of PA during preschool attending hours demonstrated that schools and childcare settings can play an important role in the promotion of PA, yet the home environment should also be targeted given the low levels of PA in this population. **References** O'Dwyer M.V., et al. (2011) Physical activity in non-overweight and overweight children: Preliminary findings and methods of the Active Play Project. Science and Sports, doi:10.1016/j.scispo.2011.01.006

## PHYSICAL ACTIVITY LEVELS, PREFERENCES AND IMPAIRMENTS AMONG PORTUGUESE COLLEGE STUDENTS

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1UBI (COVILHÃ, PORTUGAL), 2CIDESD (PORTUGAL), 3NECE (COVILHÃ, PORTUGAL)

**Introduction** Many health behaviors are established during late adolescence and early adulthood, so the decline in physical activity in adolescence and young adulthood, when many attend college, is a disturbing trend (Buckworth & Nigg, 2004). Recent research suggests that a significant percentage of college students do not get adequate physical activity (PA) (Staten et al. 2005; Irwin, 2007). Therefore, the aim of this study is to identify PA levels of a cohort of college students, along with motivational factors that affect it. **Methods** The study included a randomly recruited sample of 200 subjects (31% males; 69% females), age  $20.4\pm3.31$  years old. PA was assessed by IPAQ. A survey was designed to (1) evaluate participation in physical activities; (2) identify main reasons not to participate in PA; (3) evaluate perceptions on importance of PA for health and (4) identify preferences over different physical activities. Descriptive statistics were used to analyze data. **Results** IPAQ found 22.5% of students LOW; 55.5% MODERATE and 22.0% HIGH, regarding PA. Most students don't participate in PA in university (82.0%) nor outside the campus (70.5%). Lack of time (63%), activities schedule (40%), price (24.0%) and distance (22.0%), were the main reasons found for low participation in PA. Disease prevention (82%); stress management (54.5%); have fun (44.5%) and improve body beauty (43.5%) are the main benefits perceived of PA. **Results** identify collective sports, with friends (64.4%); cycling (63.4%) and group outdoor activities (54.1%) as preferred activities. **Discussion** Almost a quarter of interviewed college students are physically inactive. Existing physical activities may not meet students' preferences; leading to low participation level. Similar results were reported by Behrens & Dinger, (2003). In order to design effective PA offer it is necessary to understand college students' patters of participation and causes for no participation, together with their preferences. **References** BEHRENS, TK & Dinger, MK (2003). A preliminary investigation of college students' physical activity patterns. AJHS, 18(2), 169-172. BUCKWORTH, J (2001). Exercise adherence in college students: Issues and preliminary results. Quest, 53, 335-345. FERRARA, C (2009). The college experience: physical activity, nutrition, and implications for intervention and future research JEPonline; 12(1): 23-35 IRWIN, J (2007). The Prevalence of Physical Activity Maintenance in



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## Oral presentations

### OP-PM14 Training and Testing: Soccer

#### THE RELATIVE AGE EFFECT IN EUROPEAN PROFESSIONAL FOOTBALL: A 10 YEAR FOLLOW-UP STUDY

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**Introduction** The relative age effect (RAE) refers to an asymmetry in the distribution of birth dates favouring players born early in the selection year and discriminating participants born in the last months of the selection year (Helsen et al., 2005). In this study, a follow-up study compared the distribution of the birth dates of both the players and the coaches in ten European countries in the 2000-01 and 2010-11 competitive seasons. Methods Kolmogorov Smirnov tests assessed differences between observed and expected birth-date distributions. Chi square goodness-of-fit tests were used to compare differences between the observed and expected birth-date distributions across the quarters of the selection year. Regression analyses were used to determine if there was a negative correlation between the number of players and the month which they were born in. Results On average, the percentage of home country players decreased from 66.5% in the 2000-01 season to 56.6% in the 2010-11 season, while the percentage of foreigners increased from 33.5% to 43.4%, respectively. The results also indicated a relative age effect in both seasons ( $P < 0.01$ ) with an over-representation of players born in the first quarter (29.3% in 2000-01; 31.9% in 2010-11) and an under-representation of players born in the last quarter (19.8% in 2000-01; 18.4% in 2010-11). There was no RAE for the coaches. Discussion Previous studies indicated that children born early in the school year have a greater chance on success in education than children born late in the school year (Barnsley et al., 1992). The same was shown in sport, in particular in football (Musch & Grondin, 2001). In line with recent studies in German (Cobley et al., 2008) and in Spanish football (Jimenez and Pain, 2008), we conducted a follow-up study to compare the birth-date distributions of professional football players in ten European countries between the 2000-01 and 2010-11 competitive seasons. We hypothesized that the RAE would decrease during the last decade based on two arguments. First, various solutions to reduce the RAE were discussed in previous studies. Second, in the 2000-2001 competitive season, the players were exposed to the old cut-off date in their education. Before 1997, the selection period started in August, whereas since 1997, the selection period started in every country in January (Helsen et al., 2005). Players of the 2010-2011 competitive season were exposed to both cut off dates during their player development. Interestingly, the RAE did not decrease over the course of the past ten years, on the contrary. The underlying mechanisms will be discussed as well as potential solutions to reduce the impact of the relative age effect. References Barnsley, R.H., Thompson, A.H., & Legault, P. (1992). *Int. Rev. for the Sociology of Sport*, 27, 78-87. Cobley, SP., Schorer, J., & Baker, J. (2008). *JSS*, 26, 1531-1538. Helsen et al. (2005). *JSS*, 23, 629-636. Jiménez, I.P., & Pain, M.T. (2008). *JSS*, 26, 995-1003. Musch, J., & Grondin, S. (2001). *Dev. Rev.*, 21, 147-167.

#### VALIDATION OF THE LOUGHBOROUGH SOCCER PASSING TEST FOR USE WITH YOUNG SOCCER PLAYERS

ZOUHAL, H., RUÉ, O., BEN ABDERRAHMAN, A., HAMMAMI, M.A., BEN OUNIS, O., LE MOAL, E., ALI, A.

MOVEMENT SPORTS AND HEALTH SCIENCES LABORATORY

**VALIDATION OF THE LOUGHBOROUGH SOCCER PASSING TEST FOR USE WITH YOUNG SOCCER PLAYERS** Zouhal H1; Rué O1; Ben Abderrahman A1,2; Hammami M.A1,2; Ben Ounis O2; Le Moal E1; Ali A3. 1 M2S Laboratory, University of Rennes 2-ENS Cachan. Rennes, France. 2 LPEF, Faculty of Medicine Ibn Eljazzar, Sousse, Tunisia. 3 IFNHH Massey University, Auckland, New Zealand. **Introduction** Ali et al. (2007; 2008) developed the Loughborough Soccer Passing Test (LSPT) to assess the multifaceted aspects of soccer skill including passing, dribbling, control and decision-making. This test has been validated for adult soccer players. However, data concerning young soccer players aged 14-17 are required to recommend this test for talent identification. Consequently, the aim of this study was to validate the LSPT for use with young soccer players. **Method** A total of 87 young soccer players, aged 14-17, participated in the study. Participants were grouped according to playing level: elite (n=44); sub-elite (n=22) and non-elite (n=21). The LSPT requires players to complete 16 passes against colored target areas, whilst maneuvering around a grid of cones, as fast and as accurately as possible. Participants completed 12 attempts to familiarize themselves with the test before undergoing two main trials separated by one week; the mean of the two attempts was recorded as the performance score. All trials were performed inside a sports hall and using an indoor soccer ball. **Results** The results of the global performance (time + penalty time (s)) show significant differences ( $p < 0.01$ ) between the three groups, elite ( $49.3 \pm 11.0$  s), sub-elite ( $58.1 \pm 10.8$  s) and non-elite players ( $66.5 \pm 10.3$  s). Significant relationships were observed between trials for all the players concerning time ( $r = 0.73$ ,  $p < 0.01$ ), penalty time ( $r = 0.67$ ,  $p < 0.01$ ) and global performance ( $r = 0.78$ ,  $p < 0.01$ ). No differences were found for the three test components between the two main trials and for each group, using t-test ( $p < 0.05$ ). The difference percentage between the two main trials was very weak for all the players (-1.9 % for time, -5.7% for penalty time and -2.9% for global performance). The mean ratio multiplied or divided by the agreement ratio indicated greater reliability for the time component as opposed to global performance for all players ( $0.98^* / 1.1$  vs.  $0.97^* / 1.4$ ) and for each group ( $0.98^* / 1.31$  vs.  $0.98^* / 1.24$  in elite players and sub-elite players;  $0.99^* / 1.4$  vs.  $1.00^* / 1.5$  in non-elite players). **Discussion and conclusion** We used the same statistic tests than the studies of Ali et al. (2007; 2008) to explore validity and reliability of the LSPT in young players. Our results confirm that the test is a valid and reliable protocol to assess differences in soccer skill performance and can distinguish players according to their playing level. So, such test could be integrated in a battery of soccer tests in order to evaluate skill aspects of young players. References Ali A, Williams C, Hulse M, (2007). *J Sports Sci*, 25: 1-10 Ali A, Foksett A, Gant N (2008). *Int J Sport Med*, 29: 917-921

#### FACTORS INFLUENCING REFEREES' RATINGS OF PERCEIVED EXERTION DURING COMPETITIVE SOCCER MATCHES

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TEESSIDE UNIVERSITY

**FACTORS INFLUENCING REFEREES' RATINGS OF PERCEIVED EXERTION DURING COMPETITIVE SOCCER MATCHES** Weston, M.1, Castagna, C.2, Batterham, A.M.1 Teesside University, UK, 2University of Roma, Italy **Introduction** Ratings of perceived exertion (RPE) are an accurate means of monitoring exercise intensity (Borg, 1982), and provide a gestalt measure representative of both internal and external load

(Coutts et al., 2007). However, external load in high-level sport is characterised by both technical and physical demand. The aim of this preliminary investigation was to examine the role of these demands on referees' RPE scores following competitive soccer matches. Methods Data were collected from 17 elite referees for 283 Premier and Football League matches over the duration of the 2008/09 English soccer season. The referees recorded their RPE (CR10 scale) 30-min after each match ended to obtain a global intensity rating for the entire match (Foster, 1998). A priori we defined four variables representing the technical and physical match demand: 1) disciplinary points (10 points per yellow card; 25 points per red card); 2) distance from the ball (m); 3) total referee high-speed running (speed >19.8 km•h<sup>-1</sup>); 4) total player high-speed running (speed >19.8 km•h<sup>-1</sup>). The running variables were determined using a computerised, semi-automatic video match-analysis image recognition system (ProZone®). We computed the mean for each variable from the set of repeat matches for each referee (range: 9 to 23 matches). The technical and physical predictor variables were then regressed on the log-transformed RPE outcome in the n=17 cases. The magnitude of the effect of predictors was represented by the partial correlation (the square root of the fraction of variance explained by the predictor after adjustment for all other predictors [Hopkins et al., 2009]). Results Regression diagnostics revealed no degrading collinearity between predictors. The predictor variables combined explained 76% of the variance in match RPE scores (R=0.91, adjusted R-squared=0.76). Partial correlations were -0.88 for distance from the ball, 0.86 for total player high-speed running, 0.75 for match disciplinary points, and -0.55 for total referee high-speed running. These effect sizes are large to very large. For example, after controlling for match physical demand, an increase in disciplinary points equivalent to awarding a yellow card is associated with an increase in RPE of 17%. Discussion The results of this preliminary investigation demonstrate for the first time that elite soccer referees' global match RPE scores are influenced by both the technical and physical match demand. References Borg GA. (1982). *Med Sci Sports Exerc*, 14(5): 377-81. Coutts AJ, Rampinini E, Marcora S, Castagna C, Impellizzeri FM. (2009). *J Sci Med Sport*, 12 (1): 79-84. Foster C. (1998). *Med Sci Sports Exerc*, 30: 1164-8. Hopkins WG, Marshall SW, Batterham AM, Hanin J. (2009). *Med Sci Sports Exerc*, 41: 3-12.

### EFFECTS OF PRELOADING EXERCISE INTENSITY ON PHYSICAL AND COGNITIVE PERFORMANCE IN SOCCER

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Introduction Preloading activities of different intensities and with varied time span prior to competition are usually arranged by coaches to optimize the coordinative, physical and cognitive performance of players during the early stages of a soccer match. To the best of our knowledge there have been no studies, which investigate these expected effects under controlled conditions. In a first approach we compared the short and mid-term effects of different preloading exercises during the morning when kick-off is in the afternoon. Methods 12 male, amateur soccer players participated in the study (24.1±5.5 yrs; 179±9.3 cm; 76.3±9.1 kg). After laboratory testing (VO<sub>2</sub>max 50.6±2.8 ml•kg<sup>-1</sup>•min<sup>-1</sup>, HRmax 192.3±7.6 min<sup>-1</sup>), players completed three experimental Sessions (from 7 am to 4 pm), spaced at least one week apart. In a balanced cross over design players either completed no morning preloading exercise (CON), a moderate preloading (MOD) or a high intensive preloading (INT) at 10 am, each followed by the Bangsbo soccer specific endurance field test (Bangsbo & Lindquist, 1992) at 3 pm. Preloading was either moderate (MOD: 4x2 min in a 10x10 m pitch, 10x10 m sprint, 20 s recovery) or intensive (INT: 4 x 4 min in a 10x20 m pitch, 10 x 20 m sprint, 20 s recovery) and consisted in small side games followed by intermittent sprints. Subjects had a standardized breakfast (7 pm), snack (9 pm) and lunch (1 am), respectively. During MOD (plus 350 kcal) and INT (plus 600 kcal) an adjusted extra caloric cost was administered. In the morning (M), after the preloading (post P) and before endurance testing in the afternoon (pre T) Critical Flicker Fusion Frequency (CFF), reaction time (RT) and the urine concentrations of adrenaline (A) and noradrenaline (NA) were measured. Results Preloading physical demands and endocrine responses were significant higher during INT (HRmax: 87.2±2.9 %, LA: 8.1±5.3 mmol•L<sup>-1</sup>, A: 83.8±58.9 ng ml<sup>-1</sup>) compared to MOD (HRmax: 71.0±6.0 %, LA: 2.7±1.6 mmol•L<sup>-1</sup>, A: 54.3±14.9 ng ml<sup>-1</sup>, p<0.05) and CON (A: 21.7±16.8 ng ml<sup>-1</sup>, p<0.05). RT and CFF improved significantly from M to post P and pre T on all test days while no significant ANOVA interaction between measurements and interventions was calculated. Distances covered during the Bangsbo endurance tests tended to be lower after INT (2068±85 m) and were higher after MOD (2111±142 m) while no significant differences were found. Discussion Morning preloading intensity seems to have no significant impact on cognitive performance and soccer specific endurance during afternoon soccer matches despite significant physiological and endocrine short term effects. We recommend players to develop and to follow their individual routines for match play preparation. This has to be considered by coaches. References Bangsbo J, Lindquist F. (1992). Comparison of various exercise tests with endurance performance during soccer in professional players. *Int J Sports Med* 13, 125-132.

### TRAINING OF PERCEPTUAL-COGNITIVE SKILLS IN OFFSIDE DECISION MAKING

PUT, K.

K.U.LEUVEN

TRAINING OF PERCEPTUAL-COGNITIVE SKILLS IN OFFSIDE DECISION MAKING Put, K.(1); Catteeuw, P.(1); Gilis, B.(1); Jaspers, A.(1); Wagemans, J.(2) & Helsen, W.(1) (1)Department of Biomedical Kinesiology, Perception and Performance Lab, K.U.Leuven (2)Department of Psychology, Laboratory for Experimental Psychology, K.U.Leuven Introduction In association football, the flash-lag effect (FLE) is a viable explanation for erroneous offside decision making (1,2). Recently, it has been demonstrated that off-the-field perceptual-cognitive training programmes are favourable to learn assistant referees (ARs) to better deal with the perceptual consequences of this spatio-temporal illusion (3). The aim of the present study is to investigate the effectiveness of two different off-the-field training formats (video simulations – computer animations) to improve offside decision making. Methods Forty Belgian elite ARs, active in the first division in Belgium voluntarily participated in the present study. In the pre- and post-test, the ARs judged 80 offside situations (2 x 20 video simulations and 2 x 20 computer animations). Based on their pre-test results, two training groups and one control group were created. The video-format training group (n=9) and the computer-format training group (n=9) participated in 4 training sessions of either 30 video simulations or 30 computer animations, respectively, both with extended feedback. The control group (n=22) was only exposed to the pre- and post-test. Response accuracy and type of error (i.e. flag errors or non-flag errors) were analysed in the two test sessions. Results First, response accuracy improved and flag errors decreased for both training groups from pre- to post-test. Second, the video-format training group assessed both the video simulations and computer animations more accurately in the post-test. Similar results were found for the computer-format training group. Thus, training in one format also resulted in a performance improvement in the other format. Discussion The results of the present study clearly show that perceptual-cognitive skill training can overcome the difficulties in offside decision making. Therefore, off-the-field offside training sessions should be considered as part of practice routines of ARs to optimize the perception and decision-making processes in their real matches. References [1] Baldo et al. (2002). *Perception*, 31, 1205-1210. [2] Gilis et al. (2009). *Journal of Sports Sciences*, 27, 551-563. [3] Catteeuw et al. (2010). *Journal of Sport & Exercise Psychology*, 32(6), 828-844.

## PREDICTING CAREER SUCCESS IN AFL FROM DRAFT CAMP RESULTS, DRAFT ORDER, AND PHYSICAL MATCH PARAMETERS: IS THE AFL DRAFT CAMP WORTHWHILE?

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Purpose In Australian Rules Football (AFL) one of the most important perceived predictors of career success is the National Draft Camp. This 4 day event requires Under 18 draftees to complete numerous physical, psychological, medical and skill-based assessments. Prior to this camp, the National Under 18 tournament provides scouts with an opportunity to subjectively assess players in a competitive environment. This project compared 5 year career success in the AFL with physical draft camp tests, final draft selection order and objective analysis of match physical performance using GPS technology. Methods TrakPerformance Software and Global Positioning System (GPS) technology were used to analyse the movement of players, ball speed and game statistics of Under 18 AFL players during competitive matchplay. Physical data was collected over a 2 year period at the National Draft Camp. Both sets of data, along with final draft selection order, were compared to 5 year career success in senior AFL using innovative mathematical modelling. Results Clear, large, positive interactions were observed between various match variables and 5 year career success (percentage of time spent sprinting, distance travelled per minute and distance sprinted per minute). A clear, small positive interaction was observed between draft order and 5 year career success. No clear interactions were observed between any physical draft camp tests and 5 year career success. Conclusions Five year career success in senior AFL is best predicted using physical parameters assessed during match play. The more traditional practice of predicting success using physical draft camp parameters appears flawed

## Oral presentations

### OP-PM07 Nutrition: Carbohydrate

#### CARBOHYDRATE INGESTION DURING ENDURANCE RUNNING ON INFLAMMATION AND HEPcidIN LEVELS

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Introduction Exercise has been shown to increase interleukin-6 (IL-6) levels, resulting in the up-regulation of the iron regulatory hormone, hepcidin (Peeling et al., 2009). Elevated hepcidin levels may decrease iron absorption and recycling (Nemeth et al., 2004), potentially causing athletic induced iron deficiency. However, separate studies have shown that carbohydrate (CHO) consumption during exercise can depress IL-6 levels (Nieman et al., 1998). As such, this study set out to determine the effect of CHO consumption during endurance running on post-exercise IL-6 and hepcidin levels. Method Eleven well-trained male endurance runners completed a graded exercise test, and two experimental trials in a randomized order. The two experimental trials consisted of a 90 min run at 75% of the peak oxygen uptake velocity ( $\dot{V}O_{2peak}$ ), while consuming a solution with either 6% CHO or a placebo (PLA) equivalent at 3 ml.kg<sup>-1</sup> every 20 min. Serum IL-6, free hemoglobin (Hb), haptoglobin (Hp), hepcidin and iron parameters were assessed throughout the post-run recovery period. Results Serum iron and IL-6 were significantly elevated immediately post-run in both CHO and PLA ( $p \leq 0.05$ ), with no significant difference recorded between trials. Serum free Hb increased and Hp decreased significantly immediately post-run in both conditions ( $p \leq 0.05$ ). Serum soluble transferrin receptor levels were significantly below baseline at 3 and 24 h post-run in both conditions ( $p \leq 0.05$ ). Serum hepcidin concentration recorded 3 h post-run in both conditions was significantly elevated ( $p \leq 0.05$ ), and had returned to baseline by 24 h post-run ( $p \leq 0.05$ ). Discussion The use of a 6% CHO solution at 3 ml.kg<sup>-1</sup>.20min<sup>-1</sup> during endurance running did not attenuate the inflammatory response and subsequent increase in serum hepcidin levels during the post-run recovery period. As such, elevated hepcidin levels may reduce the bioavailability of iron, causing a reduction in erythropoiesis up to 24 h post-exercise. References Nemeth E, Tuttle MS, Powelson J, Vaughn MB, Donovan A, Ward DM, Ganz T, Kaplan J. (2004) Science, 306 (5704), 2090-2093. Nieman DC, Nehlsen-Cannarella SL, Fagoaga OR, Henson DA, Utter A, Davis JM, Williams F, Butterworth DE. (1998) Med Sci Sport Ex, 30 (5), 671-678. Peeling P, Dawson B, Goodman C, Landers G, Wiegerinck E, Swinkels D, Trinder D. (2009) Int J Sport Nutr Ex Metab, 19 (6), 583-597.

#### CARBOHYDRATE INGESTION ENHANCES MAXIMAL SPRINT PERFORMANCE IN COMPETITIVE MALE CYCLISTS

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Introduction There is evidence that ingesting carbohydrates (CHO) during exercise or using a CHO mouth rinse can improve 1-h high-intensity exercise performance (Chambers et al., 2009; Rollo et al., 2010), thus suggesting that the ergogenic effect of CHO is mediated by the stimulation of the sweet taste receptors in the oral cavity. In contrast, we recently showed that CHO mouth rinsing has no effect on sprint performance (Chong et al., 2010). Given the presence of sweet taste receptors in the upper intestine (Dyer et al., 2005), the primary aim of this study was to investigate whether the combined stimulation of the taste receptors in the oral cavity and gut can improve the performance of a maximal sprint. Methods Twelve competitive male cyclists ( $\dot{V}O_{2peak}$  57.8 $\pm$ 4.7 mL.kg<sup>-1</sup>.min<sup>-1</sup>; mean  $\pm$  SD) each ingested and rinsed their mouth with 100 mL of one of the following solutions on separate occasions and following a randomised double blind counterbalanced design; (a) 10% glucose solution [Glu], (b) 0.05% aspartame solution [Asp], (c) 9.1% maltodextrin solution [Mal], or (d) water [Wa] as a control, followed by repeatedly mouth rinsing with 11 boluses of 15 mL of the same solution. Then, each participant performed a 30-s maximal sprint effort on a cycle ergometer and performance was assessed. Results The Asp and Mal trials were not significantly different from Wa across all indicators of sprint performance (maximal power output and mean power output,  $p > 0.05$ ). In contrast, the Glu trial improved maximal power output during the sprint effort by 14.7% ( $p < 0.05$ ) compared to Wa and by 9 and 16% ( $p < 0.05$ ) compared to the Asp and Mal trials, respectively. Blood glucose levels increased to a similar extent in response to the Wa and Glu trials. Discussion Our findings suggest that combining the rinsing and ingestion of a glucose solution improves maximal sprint performance. This ergogenic effect is unlikely to be related to sweetness since the Asp trial had no effect on performance despite sweetness matching that of Glu. The benefit of Glu is also unlikely to result from a rise in blood glucose level as Mal resulted in a similar rise but without affecting performance. Given earlier findings from this laboratory that mouth rinsing alone had no effect on maximal sprint performance, we suggest that the ergogenic effect of glucose ingestion on maximal sprint performance is likely to be mediated via the stimulation of the CHO receptors in the upper intestine. References Chambers ES, Bridge MW, Jones DA. (2009). J Physiol, 587(8), 1779-

1794. Rollo I, Cole M, Miller R, Williams C. (2010). *Med Sci Sports Exerc*, 42(4), 798-804. Dyer J, Salmon KSH, Zibrik L, Shirazi-Beechey SP. (2005). *Biochem Soc Trans*, 33, 302-305. Chong E, Guelfi KJ, Fournier PA. (2010). *J Sci Med Sport*, doi:10.101/j.jsams.2010.08.003.

### **EFFECT OF LOW GLYCAEMIC INDEX MEALS ON APPETITE SENSATION AND ENERGY BALANCE OF MALE ADULT ATHLETES**

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**Introduction** A concept of low glycaemic index (LGI) carbohydrate containing foods which provide higher satiating effects than foods with high glycaemic index (HGI) has emerged recently (Bornet et al., 2007). Consumption of LGI meals may be beneficial for athletes to promote satiety so as to achieve optimal body weight. Therefore, the aim of this study was to investigate the short term effect of GI meals on subjective appetite sensation and energy balance in adult male athletes. **Methods** Fourteen recreationally active males (mean  $\pm$  SD; age  $34.5 \pm 8.9$  y, BMI  $22.8 \pm 2.0$  kg /m<sup>2</sup>) participated in a randomised crossover design with LGI and HGI meals. On each trial day, participants consumed a breakfast in the laboratory, then left one hour postprandially with a food bag containing lunch, dinner and snacks. Subjective appetite sensations were recorded regularly using a visual analogue scale during the first postprandial hour in the laboratory and hourly throughout the trial days. Resting energy expenditure (REE) was measured in the fasted state during both trial days and 24 hr later. Energy intake (EI) and expenditure (EE) of the trial days and 24 hr later were assessed by self-report food intake and accelerometry. The overall calculated GI values for the HGI and LGI meals were  $76.0 \pm 2.8$  and  $39.5 \pm 1.0$  respectively. Energy, macronutrients and the fibre contents; and the caloric density were similar between LGI and HGI at each mealtime. **Results** Participants reported a higher appetite score after the consumption of the LGI breakfast than the HGI breakfast throughout the first postprandial hour in the laboratory ( $p=0.03$ ) and throughout the remainder of the trial day ( $p=0.006$ ). The mean appetite score after 20 minutes for all LGI meals was significantly higher than for the HGI meals ( $34.0 \pm 15.6$  vs  $27.5 \pm 12.6$ ,  $p=0.027$ ). No significant differences were found in the REE, EI and the EE between the corresponding trial days and the post-trial days. **Discussion** These results indicate that in the short term frequent consumption of HGI mixed meals can suppress appetite compared to that of LGI mixed meals which is inconsistent with previous findings. As GI may also depend on the exercise level of participants (Mettler et al., 2007), further investigation of the relationship between GI and appetite for the regulation of food intake in trained athletes is required. These results also indicate the importance of matching the protein, fat and fibre contents relative to the GI values for mixed meals. **References** Bornet FR, Jardy-Gennetier AE, Jacquet N, Stowell J. (2007). *Appetite*. Nov;49(3):535-53. Mettler S, Lamprecht-Rusca F, Stoffel-Kurt N, Wenk C, Colombani PC. (2007). *Eur J Clin Nutr*. Jan;61(1):19-24.

### **CARBOHYDRATE SUPPLEMENTATION DURING INTENSE INTERMITTENT TRAINING FOR THREE WEEKS DOES NOT INFLUENCE THE DEVELOPMENT OF THE ENDURANCE CAPACITY AND THE ADAPTATION OF THE FAT METABOLISM.**

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In 1996 Helge et al. showed that the consumption of a diet with  $> 60$  energy % daily during a training period was beneficial for developing the endurance capacity. The results of Hansen et al. (2005) contradict this finding in a way. According to them training in a glycogen depleted state is especially beneficial for the development of the endurance capacity. However, Cluberton et al. (2005) came to the conclusion that not glycogen depletion but reduced glucose availability increases the expression of genes of the fat metabolism. In fact Hanke et al. (2008) showed in muscle cell cultures that the glucose availability was the key factor to shift the metabolic profile to the endurance phenotype. Thus the question emerged: is the customary use of carbohydrates detrimental for the development of the endurance capacity? **Methods:** Each group (Plac and CHO) consisted of 10 males with a mean relative maximal power of  $4.15 \pm 0.7$  W.  $VO_{2peak}$  and endurance capacity was determined in incremental (IC) and constant load tests (EC) before and after the training period. The IC started with a pre-period of 6 min at 100 W. Afterwards power was increased every min by 16.66 W until exhaustion ( $W_{max}$ ). During the IC spirometric data were collected and [Lactate] from a hyperaemized earlobe was determined. The intensity for the EC was 30 % for warming up (6 min) und 80% of  $W_{max}$  (initial IC) to exhaustion. During the constant load tests blood was collected from a cubital vein for determining parameters of the fat metabolism. An additional constant load test was performed at 50%  $W_{max}$  to determine the oxygen on-kinetics. **Intermittent exercise training:** After 10 minutes of warming up with 50% of  $W_{max}$  55 cycles with 100% for 30 s followed by 30 s without breaking force were performed 3 times a week for 3 weeks. **Beverages:** Both groups ingested tap water: in total 26 ml/ kg body weight. In CHO Maltodextrin was added resulting in a concentration of 9.1 weight %. **Results:** The increases in maximum power ( $\pm 2.5$  %) and  $VO_{2peak}$  ( $\pm 1.8$  %) were not significant in both groups. Lactate thresholds did not change significantly. However, the endurance capacity increased by 50% in both groups (each:  $p<0.01$ ). During the low and medium constant intensity tests no change in metabolites, heart rate, ventilation, and RER could be detected. Even at 80% fat metabolites did not change significantly. The time constant of  $VO_2$  (50 %) did not change significantly. **Conclusion:** As the carbohydrate administration and the training had no effect on the aerobic capacity and non the fat metabolites during the EC-tests the increase of the endurance capacity seems to be due to non-metabolic factors.

### **THE EFFECTS OF DIFFERENT DOSES OF CAFFEINE ON ONE HOUR CYCLING PERFORMANCE**

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**Objectives:** This study investigated the effects of two different doses of caffeine on one hour cycle time trial performance in male athletes. **Design:** Randomised, placebo-controlled, double-blind crossover study design. **Methods:** Sixteen well-trained and familiarised male cyclists (Mean  $\pm$  SD: Age =  $32.61 \pm 8.32$  years; Body mass =  $78.53 \pm 6.0$  kg; Height =  $180.91 \pm 5.53$  cm;  $VO_{2peak}$  =  $60.35 \pm 4.06$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) completed three experimental trials, following training and dietary standardisation. Participants ingested either a placebo, 3 or 6 mg·kg<sup>-1</sup> BM of caffeine 90 min prior to completing a set amount work equivalent to 75% of peak sustainable power output for 60 min. **Results:** Exercise performance was significantly ( $p < 0.05$ ) improved with both caffeine treatments as compared to placebo (4.2% with 3 mg·kg<sup>-1</sup> BM and 2.9% with 6 mg·kg<sup>-1</sup> BM). The difference between the two caffeine doses was not statistically significant ( $p > 0.05$ ). Caffeine ingestion at either dose resulted in significantly higher heart rate values than the placebo conditions ( $p < 0.05$ ), but no statistically significant treatment effects in RPE or plasma [K<sup>+</sup>] were observed. **Conclusions:** A caffeine dose of 3 mg·kg<sup>-1</sup> BM appears to improve cycling performance in well-trained and familiarised athletes. Doubling the dose to 6 mg·kg<sup>-1</sup> BM does not confer any additional improvements in performance.

## INFLUENCE OF CARBOHYDRATE SUPPLEMENTATION ON THE ENERGY METABOLISM DURING INTENSE INTERMITTENT TRAINING

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During intermittent exercise of high intensity Type II muscle fibres are activated to a large amount. These fibres are relying on glucose as a substrate to a larger extent than type I fibres. Therefore the question arises: can a carbohydrate supplementation shift the energy supply to a larger carbohydrate combustion during exercise. Methods: 11 male subjects (weight: 82.2 kg; height: 1.82 m, relative power: 4.3 W) performed an intermittent exercise test twice; in one trial tap water (4m /kg/15min) was consumed (Plac). In the other trial the same amount of water was ingested, however, Maltodextrin was added to achieve a 9.1 % carbohydrate solution (CHO). The mean intensity during exercise was 50% of the maximum power reached in an incremental test performed as a pre test. Training schedule: warming up with 50 % for 15 min. Afterwards power changed between 100% of the maximum power minus 10 W and 10 W each for 30 s. The intermittent exercise was performed until subjective exhaustion. Afterwards 10 min at 50% to cool down followed. Spirometric data were collected. From the VO<sub>2</sub> and VCO<sub>2</sub> the RER was calculated. For statistical evaluation of the RER during the intermittent exercise period values over 2 min were averaged. Cubital venous blood was sampled to measure the concentration of HCO<sub>3</sub><sup>-</sup>, Lactate, Glucose, Glycerol, Triglycerides, free Fatty Acids and NH<sub>3</sub>. Results: Performance time was not significantly different between the groups. No difference in heart rate and VO<sub>2</sub> between the trials could be detected. Glucose concentration was significantly higher after Maltodextrin administration ( $p < 0.001$ ). During exercise the lactate concentrations were not different between the trials. The increases in Glycerol and free Fatty Acids were larger under Plac (interaction beverage x time  $p < 0.001$ ). For both quantities the maximal concentrations were found during the cool down. RER during the end of the intermittent exercise period was lower under Plac ( $p < 0.001$ ). Plasma HCO<sub>3</sub><sup>-</sup> concentration and total CO<sub>2</sub> in the blood were constant at the late intermittent exercise period. Thus the RER is a valid indicator for a larger contribution of fat to the energy supply during this part of the experiment. NH<sub>3</sub> increased significantly more under Plac ( $p < 0.001$ ). The highest value was reached with the end of the intermittent exercise period. Discussion: Carbohydrate supplementation reduces the fat combustion during exercise even if a large portion of type II fibres are used. It has to be elucidated whether the larger increase in NH<sub>3</sub> is the result of an increased protein catabolism or of an increased AMP-combustion activity.

## Oral presentations

### OP-PM09 Cardiac Physiology

## DIURNAL VARIATION IN THE MECHANICAL AND NEURAL COMPONENTS OF THE BAROREFLEX

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Introduction Exercise-related measurements of blood pressure (BP) variability and baroreflex sensitivity are prognostic indicators of cardio and cerebro-vascular events. Intriguingly, these events are up to 3.5 times more likely within the first 3 h after waking. Diurnal variation in BP responses to exercise is evident (Jones et al., 2008), yet the importance of baroreflex sensitivity is unclear in this context. We aimed to determine the contribution of the mechanical and neural components of the cardiac baroreflex to diurnal variation in BP control. Given that carotid arterial distensibility shows diurnal variation (Kool et al., 1991), we hypothesised that diurnal variation in baroreflex gain is explained by variability in the mechanical component. Methods In 12 participants (7 male, mean $\pm$ SD age 24.7  $\pm$ 4.0yrs) we measured continuous BP, R-R intervals and carotid artery (CA) diameter during intravenous bolus injections of sodium nitroprusside (SNP) followed by phenylephrine (PE) (modified Oxford method) at 0700 and 1600h. This technique quantifies baroreflex gain for falling BP via SNP (G-down) and rising BP via PE (G-up). Integrated gain was determined by plotting beat-to-beat R-R intervals against systolic BP. The mechanical component was diameter plotted against systolic BP, and the neural component was R-R intervals plotted against CA diameter. A novel analysis method based on linear mixed models (Atkinson et al., 2010) was employed to compare the integrated, mechanical and neural gains between 0700 and 1600h. Results An attenuated ( $P < 0.05$ ) baroreflex gain was found in the morning (G-up= 13.0 $\pm$ 0.6; G-down= 6.3 $\pm$ 0.4 ms/mm Hg) compared with the afternoon (G-up= 15.1 $\pm$ 0.6; G-down= 12.6 $\pm$ 0.4 ms/mm Hg). For rising pressures, the reduced integrated gain in the morning was explained by a smaller ( $P = 0.004$ ) mechanical gain (0.015  $\pm$  0.001mm/mmHg) compared with the afternoon (0.018  $\pm$  0.001mm/mm Hg). However, the reduced falling pressure was explained by a diminished ( $P < 0.0005$ ) neural gain in the morning (256.0  $\pm$  30.6 ms/mm) compared with the afternoon (494.9  $\pm$  48.8 ms/mm). Discussion Our findings explicate the underlying mechanisms of diurnal variation in BP control. We suggest that the high prevalence of cardiovascular events in the morning is due to diminished mechanical transduction of pressure into arterial distension at this time. Interventions (e.g. exercise) targeting enhancement of vascular properties may improve baroreflex function, thus reducing the risk that follows waking and the onset of physical activity. References Jones et al. (2008). Eur J Appl Physiol, 104, 481-489 Kool et al. (1991). J Hypertens Suppl, 9, 108-109 Atkinson et al. (2010). Clin Physiol Funct Imaging, 31, 80-82

## DOES EXERCISE TRAINING INDUCE CARDIAC REMODELING IN HUMANS? A COMPARISON OF RESISTANCE AND ENDURANCE EXERCISE USING MRI TECHNOLOGY.

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Introduction An accepted dogma in exercise science is that, due to divergent haemodynamic overloads, endurance training induces eccentric cardiac hypertrophy whereas resistance exercise results in a concentric form of cardiac remodeling. However, this tenet relies solely upon cross-sectional comparisons of athlete groups, often using inappropriate scaling and echocardiographic approaches, which are variable. This is the first prospective, longitudinal, randomised study to evaluate the impact of different exercise training modes on cardiac morphology using gold-standard MRI in healthy humans. Methods Participants were randomly assigned to endurance (ENDUR n=10) or resistance (RESIST n=13) training groups and underwent a supervised, intensive training program followed by a detraining period. Measures included aerobic fitness, muscular strength, cardiac morphology assessed using MRI, and body composition using DEXA. Measures were taken at baseline, 6 mo post-training and 6 wk post-detraining. Results Aerobic fitness increased significantly in ENDUR (45.8 to 49.3 mL.kg.min<sup>-1</sup>,  $P < 0.05$ ) but was unchanged in RESIST. Muscular strength significantly improved in both groups, but to a greater

extent in RESIST ( $27.3 \pm 4.6$  vs  $37.5 \pm 4.9\%$ ,  $P < 0.001$ ). Although total fat mass did not significantly change, total lean mass increased in both groups (RESIST:  $59.7 \pm 2.35$  to  $62.0 \pm 2.2$  kg,  $P < 0.001$ , ENDUR:  $56.9 \pm 2.9$  and  $58.3 \pm 3$  kg  $P < 0.05$ ). Left ventricular mass (LVM) increased significantly following ENDUR ( $112.8 \pm 7.4$  to  $122.7 \pm 6.6$  g,  $P < 0.01$ ) but not in RESIST ( $126.8 \pm 7.7$  to  $130.8 \pm 6.5$  g NS). Similarly, end diastolic volume (EDV) increased 3-fold more in ENDUR ( $134.1 \pm 7.9$  to  $143.1 \pm 7.8$  mL) compared to RESIST ( $147.1 \pm 7$  to  $150.2 \pm 7.1$  mL), although neither change achieved statistical significance. Following detraining, ENDUR aerobic fitness returned to baseline, whereas both LVM and EDV remained somewhat elevated. Discussion This is the first study to incorporate highly accurate MRI technology to assess cardiac adaptation using closely supervised intensive longitudinal exercise interventions. In contrast with accepted wisdom, we observed no evidence in these healthy, young and relatively inactive subjects to support the notion that resistance training induces concentric cardiac hypertrophy. Our data are generally consistent, however, with previous echocardiographic evidence that endurance exercise is associated with increased LVM and EDV. These adaptations were maintained for 6 weeks following exercise cessation. In conclusion, endurance exercise induces cardiac morphological adaptations whereas resistance exercise does not, despite the presence of physiological adaptations in strength and body composition.

### COUPLING OF LEFT VENTRICULAR TWIST MECHANICS AND ARTERIAL HAEMODYNAMICS DURING EXERCISE

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**Introduction** During exercise, left ventricular (LV) twist increases and arterial augmentation index (Alx), a measure of arterial wave reflection, is reduced. The reduction in Alx may directly facilitate the enhanced twist, however the interaction between LV twist and Alx has not been examined. To gain insight into the potential coupling of LV twist and wave reflection, the purpose of this study was to examine whether the magnitude of change and also the timings in peak LV twist velocity and Alx from rest to exercise are related. **Methods** We examined 11 healthy males (age:  $22 \pm 2$  yrs; height:  $181 \pm 8$  cm; body mass:  $81.6 \pm 12$  kg) with varied aerobic fitness ( $\text{VO}_{2\text{max}}$  range:  $43.7$ – $62.5$  mL·kg<sup>-1</sup>·min<sup>-1</sup>) both at rest and during supine cycling exercise (~40% peak power). Heart rate, stroke volume and maximal twist velocity were assessed using echocardiography and Alx was assessed using radial applanation tonometry. Alx was calculated as the difference between the second (P2) and first (P1) peak arterial pressure (mmHg) divided by the pulse pressure (mmHg). Data were analysed for the magnitude of change in twist velocity and Alx between rest and exercise. The temporal relationship between peak twist velocity and peak arterial pressure within the systolic period was also examined. Statistical differences were assessed with paired samples t-tests, relationships were determined using Pearson's product moment correlation. **Results** From rest to exercise, heart rate and LV stroke volume increased significantly from  $60 \pm 15$  to  $131 \pm 16$  bpm and  $95 \pm 11$  to  $121 \pm 18$  mL, respectively ( $P < 0.001$ ). Concomitantly, peak twist velocity increased ( $79 \pm 22$  to  $139 \pm 35$  deg.sec<sup>-1</sup>,  $P < 0.0001$ ) while Alx decreased ( $11.1 \pm 0.9$  to  $9.1 \pm 0.5\%$ ,  $P < 0.0001$ ) and the change in both parameters correlated significantly ( $r^2 = .55$ ,  $P < 0.01$ ). Peak systolic pressure shifted from P2 at rest to P1 during exercise, which was paralleled by a temporal shift in peak systolic twist velocity from P2 at rest to P1 during exercise, suggesting a coupling of cardiac mechanics with arterial haemodynamics. Neither the increase in LV twist velocity nor the reduction in Alx was related to  $\text{VO}_{2\text{max}}$  ( $r^2 < .02$ ,  $P > 0.69$ ). **Discussion** This is the first study to show that the increase in LV twist velocity from rest to exercise is related to a reduction in Alx, moreover a temporal relationship between the timing of peak systolic twist velocity and peak systolic pressure was also apparent. These findings provide novel insight into ventricular-arterial coupling suggesting that LV twist mechanics and arterial Alx may work in concert to enhance LV output during exercise.

### DIVERSE PATTERNS OF MYOCARDIAL FIBROSIS IN LIFELONG, VETERAN ENDURANCE ATHLETES

WILSON, M., O'HANLON, R., PRASAD, S., DEIGHAN, A., MACMILLAN, P., OXBOROUGH, D., GODFREY, R., SMITH, G., MA-CEIRA, A., SHARMA, S., GEORGE, K., WHYTE, G.

ASPETAR - QATAR ORTHOPAEDIC AND SPORTS MEDICINE HOSPITAL

**Introduction** – Several case studies have speculated that in the absence of any other cause, life-long repetitive bouts of arduous endurance exercise may result in fibrous replacement of the myocardium, resulting in a pathological substrate for the development of arrhythmias. Despite such speculation only limited evidence exists for exercise-induced myocardial fibrosis in endurance veteran athletes. Consequently, the impact of life-long episodes of intense prolonged exercise, as experienced by veteran endurance athletes is not fully understood. **Aim** – To examine the cardiac structure and function of a unique cohort of documented life-long, competitive endurance veteran athletes (> 50 years). **Methods** – Twelve life-long veteran male endurance athletes (mean  $\pm$  SD [range] age:  $56 \pm 6$  yr [50–67]), 20 age-matched veteran controls ( $60 \pm 5$  y; [52 – 69]) and 17 younger male endurance athletes ( $31 \pm 5$  years [26–40]) without significant comorbidities underwent cardiac magnetic resonance (CMR) imaging with late gadolinium enhancement (LGE) to assess cardiac morphology and function, and to assess myocardial fibrosis. **Results** – Life-long veteran athletes had significantly larger absolute and indexed LV and RV end-diastolic and systolic volumes, wall thicknesses, and LV and RV stroke volumes ( $p < 0.05$ ), together with reduced LV and RV ejection fractions ( $p < 0.05$ ) compared to veteran controls. In 6 (50%) of the veteran athletes, LGE of CMR indicated the presence of myocardial fibrosis (4 veteran athletes with LGE of non-specific cause, 1 probable previous myocarditis and 1 probable previous silent myocardial infarction). There was no LGE in the age-matched veteran controls or young athletes. The prevalence of LGE in veteran athletes was not associated with age, height, weight or BSA ( $p > 0.05$ ), but was significantly associated with the number of years spent training ( $p < 0.001$ ), number of competitive marathons ( $p < 0.001$ ) and ultra-endurance (>50 miles) marathons ( $p < 0.007$ ) completed. **Conclusion** – An unexpectedly high prevalence of myocardial fibrosis (50%) was observed in healthy, asymptomatic life-long veteran male athletes, compared to zero cases in age-matched veteran controls and younger athletes, supporting the role of life-long endurance exercise for the incidence of LGE.

### ALTERED MYOCARDIAL FUNCTION AND CARDIAC BIOMARKERS FOLLOWING MARATHON RUNNING

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**Introduction** Cardiac changes are not often recognized as a health risk after exercise. However, previous research using echocardiography has shown that marathon running alters cardiac performance (i.e. cardiac cycle timing and contractility), but later returns to normal suggesting a transient myocardial dysfunction (George et al 2005, George et al 2008). Furthermore, it has been shown that an interaction between intensity and duration play a critical role in this response (Dawson et al 2003). The primary dysfunction identified is a reduction in

diastolic filling and performance. This study explored changes in cardiac performance before and after a marathon using seismocardiography (SCG), and assessing cardiac biomarkers (Shave et al 2007). Methods Recreational runners with no known cardiovascular disease completed a full marathon (FM; N=19; age=46.3±5.2yr; time=3:49±24 min) or half-marathon (HM; N=6; age=39.7±7.9yr; time=1:52±12 min). A tri-axial SCG device was placed on the sternum of the chest and used to monitor resting cardiac cycle amplitude events, electrocardiography (ECG), and serum samples for cardiac troponin-I (cTn-I; Immunoassay). Resting data was collected before (Pre-M), immediately after (Post-M), and on day 1 (D1), 2 (D2), 3 (D3), and 7 (D7) post-marathon. A 30-sec SCG and ECG was recorded and stored for later analysis (15-22 beats). Computer software was designed to analyse SCG timing events and waveform amplitude (mG) for mitral valve open (MVOamp). Repeated measures ANOVA was used for statistical analysis (p<0.05). Results MVOamp (mG) was significantly reduced Post-M in both FM (33%) and HM (46%). This reduction in MVOamp mirrored increases in cTn-I (291% and 42%, respectively). MVOamp remained significantly reduced in FM runners immediately post (30%), on D1 (29%) and returned to Pre-M values on D2; while HM runners MVOamp return to Pre-M values on D1, but declined on D3 (18%) and D7 (24.8%). cTn-I remained elevated in FM on D1 (169%), D2 (106%), and D3 (50%). cTn-I in FM peaked at D1 (92.5%) and was still 17% higher on D3. Marathon distance (FM vs HM) showed significant main effects for MVOamp and cTn-I, from Pre-M to D7. Discussion There was a significant reduction in diastolic function, as measured by MVOamp, immediately following the marathon and this lasted until at least D2 depending on whether a HM or FM was run. These functional changes also corresponded to changes in cTn-I biomarker. Differences between FM and HM persisted up to D7, suggesting that both exercise duration and intensity contribute to these differences. Our findings suggest the impaired diastole is a transient change in myocardial function lasting up to D7 post-marathon. Finally, waveform amplitude (i.e., contractility) can be monitored with SCG before and after exercise. Dawson et al. Sports Med. 2003; 33:365–80 George et al. J Physiol. 2005; 569:305–13 Shave et al. Med Sci Sports Exerc. 2007; 39:2099–2106 George et al. Med Sci Sports Exerc 2008; 40:1390-1392

## SIX WEEKS RESISTANCE TRAINING HAS NO EFFECT ON LEFT VENTRICULAR STRUCTURE

RICHARDS, J., KERR, C., BISWELL, K., OXBOROUGH, D., GEORGE, K., SCULTHORPE, N.

UNIVERSITY OF BEDFORDSHIRE

SIX WEEKS RESISTANCE TRAINING HAS NO EFFECT ON LEFT VENTRICULAR STRUCTURE Richards, J.I, Kerr, C.I, Biswell, K.I, Oxborough, D.3, George, K.2 and Sculthorpe, N.1 1: UoB (Bedford, UK), 2 : LJMU (Liverpool, UK), 3: UoL (Leeds, UK) Introduction The 'Morganroth Hypothesis' suggests that strength training causes significant increases in left ventricular (LV) wall thickness and thus LV mass due to the high afterload associated with that type of exercise (Morganroth et al., 1975). However it has recently been criticised partially due to a lack of training studies and the fact that heart size may be more closely associated with fat free mass (FFM; Naylor et al., 2008). The initial stages of strength training where afterload on the LV is elevated normally induces strength changes due to neural adaptation with little change in FFM (Moritani and DeVries, 1979). This study aimed to use this as a model to determine if afterload without concomitant changes in FFM would affect cardiac morphology. Methods Eight inactive males (aged 18-20 years; height 179.7 ± 8.4 cm; body mass 79.39 ± 18.84 kg) followed a progressive 6-week resistance training programme designed to increase strength but not FFM. Interventricular septal wall (IVS), LV internal dimension (LVD) and LV posterior wall (PW) measurements were assessed from M-mode echocardiograms (Vivid 7, GE Healthcare) at baseline and after training. FFM was estimated via air displacement plethysmography (BodPod, Life Measurement Inc.). Resting HR and blood pressure were assessed via standard techniques (MI-5, Omron) strength was assessed weekly by 1 repetition maximum (RM) prediction (Brzycki, 1993) of bench press and squat. VO2max was assessed at baseline and after training to ensure any cardiac adaptation was not due to improvements in aerobic capacity. Results Training did not increase FFM or VO2max. Bench press 1RM increased by 9 kg (P=0.005) and squat 1RM increased by 19 kg (P=0.001) post-training. There was no change in IVS (1.13 ± 0.08 to 1.10 ± 0.16cm; P>0.05), LVD (5.08 ± 0.4 to 5.16 ± 0.48cm; P>0.05) and PW (1.07 ± 0.1 to 1.08 ± 0.12 cm; P>0.05). Discussion As anticipated, 6-weeks of resistance training increased strength but not FFM and is thought to be due to neuromuscular adaptation (Moritani and DeVries, 1979). The afterload induced by the resistance exercise however, did not bring about measurable changes in cardiac dimensions. This is in contrast to Morganroth et al (1975) and suggests that increased afterload may not be a potent stimulus for cardiac adaptation. References Brzycki M. (1993). The J of Phys Ed, Rec & Dance, 64. Morganroth J, Maron BJ, Henry WL, and Epstein SE. (1975). Ann Intern Med 82, 521-524. Moritani T, DeVries H. (1979). Am J Phys Med, 58, 115-130. Naylor LH, George K, O'Driscoll G, and Green DJ. (2008) Sports Med 38: 69-90

**18:00 - 19:30**

## Oral presentations

### OP-BN04 Balance and Stability 1

#### POSTURAL BALANCE AND RIFLE STABILITY IN HIGH AND LOW LEVEL BIATHLETES

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UNIVERSITY OF SALZBURG

Introduction Biathlon shooting, as well as the athletes' strategies, motor and mental shooting skills, developed remarkably during the last two decades (personal communication). A few studies demonstrated that the quality of 1) postural balance (Sattlecker et al. 2007; Era et al. 1996), 2) rifle/gun stability and vertical movement of the aiming point (Mononen et al. 2003; Zatsiorsky & Aktov 1990) and 3) triggering and shooting score (Sattlecker et al. 2007) differentiate shooters of various skill levels. The aim of the current study was to focus on biathlon specific stability as the main factor of shooting performance. It was hypothesized that biathletes with high shooting scores show lower postural and rifle sway in all directions. Methods Twenty two biathletes of various levels were tested in an indoor measure station. During 40 shots (individual rhythm, without physical load), the postural balance (FITRO SWAY CHECK, 100 Hz) and the rifle stability (8 cam VICON system, 100 Hz) were measured. Rifle and postural (COP) stability were defined by medio-lateral [x], anterior-posterior [y], vertical [z] and total 1) path length (PL), 2) mean velocity (MV), 3) excursion (EX) and 4) standard deviation (SD) within 0.6/0.3 seconds before firing. A discriminant analysis was used to distinguish between high and low score performers (P<0.05, Pooled correlations - discriminating variables canonical discriminant functions, r = coefficient). Results Postural balance: For all variables except Ply\_0.3s and MVy\_0.3s, the two groups showed significant differences with lower values (P<0.05) for high scorers. Stepwise discriminant analysis indicated SDy\_0.6

/ 0.3s ( $r = 0.58$  and  $0.51$ ) and  $EXy_{0.6s}$  ( $r = 0.50$ ) as the most distinguishing variables. Rifle stability: Medio-lateral ( $x$ ; 0.3 & 0.6 s) PL, MV, EX, as well as SD were lower in high scorers ( $P < 0.05$ ) along with lower values for seven other variables (anterior-posterior [ $y$ ], vertical [ $z$ ], total).  $PLx_{0.6}$  / 0.3s ( $r = 0.24$  and  $0.28$ ) and  $EXx_{0.6s}$  ( $r = 0.23$ ) were found to differentiate most clearly between the groups. Discussion & Conclusion High score performers are characterized by lower and slower 1) body sway (all directions) and 2) rifle sway in medio-lateral direction. The most discriminating factors were 1) SD and EX of COP in shooting direction and 2) rifle PL and EX across the shooting direction. The results of this study recommend focussing on the previously mentioned factors in biathlon shooting training. However, they also bring to mind topics that require further studies such as 1) the intercorrelation between rifle and body sway, 2) the influence of foot/ski position and 3) the status of stabilizing musculature on sway, among others. References For references see Mononen et al. (2003). Scand J Med Sci Sports: 13: 200-207

## THE SEVERITY OF EXPERIMENTALLY INDUCED PAIN INFLUENCES MUSCULAR PERFORMANCE DURING MAXIMAL VOLUNTARY ISOMETRIC KNEE EXTENSOR CONTRACTIONS

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1: UON (NORTHAMPTON, UK), 2: UOD (DERBY, UK)

Introduction Experimental pain has been shown to decrease maximal muscular performance (Ervilha et al., 2004) with evidence to suggest that motor unit firing rate is inversely correlated to perceived pain intensity when pain is induced via invasive hypertonic saline injections (Farina et al., 2004). The aims of the present study were to examine the influence of the severity of pain induced by a non-invasive gross pressure device (GPD) on muscular performance in the lower limb. Methods Thirty-one healthy male participants (mean  $\pm$  SD; age =  $32.7 \pm 12.3$ yr, height =  $1.8 \pm 0.1$ m, mass =  $85.3 \pm 12.1$ kg) volunteered for the study after giving written, informed consent, with ethical approval granted by the University of Northampton's ethics committee. Isometric knee extensor joint moment and electromyographic (EMG) activity of the vastus lateralis (VL) and semitendinosus (ST) muscles were measured during maximum voluntary isometric contractions (MVC) within control and three experimental conditions (100%, 200% and 300% of pain perception threshold). A repeated measures ANOVA determined significance between conditions; post-hoc analysis with Bonferroni correction determined the location of any significant differences. Statistical significance was accepted at  $p < 0.05$  for all tests. Results Mean isometric knee extensor moment significantly declined ( $p < 0.05$ ) in all conditions compared with control and 100% pain perception threshold conditions, with greater mean reductions apparent as the severity of pain increased. However, no significant difference existed between 200-300% conditions ( $p > 0.05$ ). Similar significant reductions ( $p < 0.05$ ) were evident within EMG VL and ST data, reflective of the changes in force. Discussion Increasing levels of pain resulted in greater mean decreases in force and EMG data, however when pain perception threshold increased above 200%, no further significant reductions occurred. Unlike previous invasive methods using saline injections into the target muscle (Farina et al., 2004), the present study used a GPD to induce pain remote from the muscles responsible for force production and therefore, could not influence muscle mechanics or physiology. The present VL EMG data reveal a concomitant reduction in neuromuscular activity reflective of the changes in force. This data in conjunction with the methods employed, are suggestive of neurological impairment as the likely cause of reductions in force; however, the location (spinal or supra-spinal) remains unknown and should be investigated further. References Farina D, Arendt-Nielsen L, Graven-Nielsen T. (2005). Clin Neurophysiol, 116, 1558-1565. Ervilha UF, Farina D, Arendt-Nielsen L, Duarte M, Graven-Nielsen T. (2004). Exp Brain Res, 156, 174-182.

## THE INFLUENCE OF VARYING ACCELERATION ON KINETICS, KINEMATICS AND ELECTROMYOGRAPHIC ACTIVITY DURING REACTIVE JUMPS

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THE INFLUENCE OF VARYING ACCELERATION ON KINETICS, KINEMATICS AND ELECTROMYOGRAPHIC ACTIVITY DURING REACTIVE JUMPS Kramer, A.1, Ritzmann, R.1, Gruber, M.2, Gollhofer, A.1 1: University of Freiburg (Germany); 2: University of Konstanz (Germany) Introduction: It has been shown that the stretch shortening cycle (SSC) is essential for many types of human movement. Several studies have analyzed the influence of parameters like ground contact time, muscle preactivation or additional weight on the SSC, in order to define a range where the SSC's energy-storage potential - and therefore the efficiency of the movement - is maximized. One important factor that determines how much energy can be stored and then released during the SSC is the load on the tendomuscular system: if it is too high, the contact and coupling time is too long for a storage of energy (Gollhofer & Kyröläinen 1991). This load is mainly determined by the velocity of the jumper and his mass, but also by the acceleration, which does not only affect the load, but potentially also the motor program (via its effect on the vestibular system). The aim of the present study was to assess the influence of the acceleration on the ground reaction force, the rate of force development, the ground contact time, the joint angle progression, the leg stiffness and the muscle activity during reactive jumps. Methods: Ground reaction forces, kinematic and electromyographic (EMG) data of 20 healthy subjects were recorded during reactive hopping in a sledge jump system for seven different acceleration levels: three acceleration levels lower than normal gravity (0.7g, 0.8g, 0.9g), one with gravitational acceleration (1g) and three with higher acceleration (1.1g, 1.2g, 1.3g). Results: Increasing the acceleration from 0.7g to 1.3g resulted in increased peak forces (+15% when comparing the value at 1.3g to the one at 0.7g), longer contact times (+10%), increased muscular activity (+7% to +87%, depending on the muscle), an increased momentum (+28%), unchanged leg stiffness and increased joint excursions in the ankle and knee joints (+3°). Discussion: For the first time, the present study allowed the assessment of the influence of the acceleration on the jump pattern under almost natural movement conditions. The main finding was that the neuromuscular system tried to maintain a high leg stiffness by adjusting the other parameters, such as the movement amplitudes in the joints or the activation of the leg muscles. Furthermore, with this jump system, reactive jumps with short ground contact times were possible in a wide acceleration range. This might be meaningful both for rehabilitation purposes where reduced accelerations could be used to retrain natural movement patterns under reduced load conditions, and for training regimens where higher accelerations would increase the load while still allowing the correct execution of the intended movement. References: Gollhofer A, Kyröläinen H. (1991). Int J Sports Med. 12(1), 34-40.



## TRAINING THE CORE IN CHILDREN WITH CEREBRAL PALSY USING COMPUTER GAMES: A SENSITIVITY ANALYSIS OF ITS IMPACT ON WALKING

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Reduced selectivity of the core (trunk & pelvis) can lead to difficulties in walking in children with Cerebral Palsy (CP), impacting upon activities of daily living. The Gait Deviation Index (GDI) (Schwartz & Rozumalski, 2008) and Movement Deviation Profile (MDP) (Barton et al., 2010) express the deviation of gait from normality as a single discrete value. In addition, the MDP enables a sensitivity analysis of the entire gait cycle, with the potential to indicate which joints contribute most to the deviations. We aimed to explore whether a virtual reality (VR) game designed to train selectivity of the core can improve walking, comparing the GDI and MDP as outcome measures of walking. One child with CP diplegia (10yrs) was trained on the VR game 'The Goblin Post Office' twice a week for 6 weeks. Game speed increased as a function of performance, controlled by a psychophysical algorithm (PEST) (Macmillan & Creelman, 2005), used to determine changes in selectivity of the core during the VR game. Nine gait curves of the pelvis, hip, knee and ankle were measured using a motion capture system to calculate GDI and MDP values before and after intervention. To conduct the sensitivity analysis pelvic, hip and knee/ankle variables (3 groups) were systematically eliminated from the MDP calculation to assess the influence each group had on the outcome. There was a significant increase in game speed in response to training ( $t_{10} = -9.836$ ,  $p < 0.0005$ ), with a mean increase of  $32.6 \pm 11.0$  m/s. There was minimal change in GDI or MDP mean as a result of intervention (GDI: before=75.8; after=75.4, MDP: before=20.8°; after=23.2°). Sensitivity analysis revealed minimal deviation from normality when considering pelvic and knee/ankle angles combined (normal = 6.9°, before = 9.8°, after = 11.3°). Hip and pelvic (normal=5.9°, before=14.4°, after=16.4°) or hip and knee/ankle angles (normal=9.0°, before=19.5°, after=21.0°) combined produced greater deviations from normality for both before and after MDP values. Improvements in game speed suggest VR game play improves selective control of the trunk and pelvis. No change in GDI and MDP implies that improvement in selectivity does not transfer to global changes in walking. Sensitivity analysis revealed hip angles had the greatest effect on deviations from normality using the MDP, suggesting the MDP is sensitive enough to identify problematic areas in a patient's walking. Evaluating activities of daily living (stepping, sit-to-stand, reaching) could be considered as future methods for assessing changes in response to VR training. Schwartz & Rozumalski, 2008: Gait Posture, 28, 351-357. Barton et al., 2010: Hum Movement Sci, In press. Macmillan & Creelman, 2005: Detection Theory, Lawrence Erlbaum, NJ.

## COGNITIVE DEMAND OF REACTIVE AND PREDICTIVE RESPONSES TO GAIT PERTURBATIONS IN YOUNG AND ELDERLY ADULTS

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Introduction A growing body of evidence strongly suggests the involvement of high-level processing in the modulation of reactive and predictive balance adjustments. However, the effect of a concurrent cognitive task on postural responses to unexpected gait perturbations and predictive adjustments during repeated exposure has not been investigated thus far. Methods Thirty-two young (mean age 27 yrs) and 27 elderly (mean age 69 yrs) male subjects participated in the present study and were randomly assigned to either control or dual task group. The subjects performed 18 gait trials on a gangway with alternating surface and surface-information conditions. After baseline assessment (Base) the surface was changed from hard to soft without knowledge of the subjects, inducing an unexpected perturbation (s1). Before (H1), between (H2) and after (H3) the adaptation phases (early, late) performed aware of the soft surface, unexpected hard surface trials represented after effects (i.e. predictive adjustments). Throughout the gait protocol the dual task groups performed a concurrent cognitive task, adjusted in the level of difficulty. The subjects executed respective mathematical operations according to the type of auditory cue and verbalized the result. Whole body kinematic data was recorded to quantify dynamic stability based on the 'extrapolated center of mass' concept proposed by Hof et al. (2005). Main findings and conclusions Irrespective of age or cognitive load, the margin of stability (MoS) decreased significantly ( $p < 0.001$ ) at touchdown of the recovery leg following the unexpected perturbation compared with baseline (Base: -4.63cm; s1: -13.32cm). Recovery performance improved in the early and late adaptation phase. Correspondingly the MoS at touchdown of the disturbed leg increased significantly ( $p < 0.001$ ) in the trials representing predictive adjustments (Base: -4.2cm; H1: -1.3cm; H2: -0.6cm; H3: -1.1cm). The cognitive task performed by the dual task groups neither affected reactive balance recovery, nor subsequent fast predictive adjustments. However, the unexpected perturbation (s1) induced a deterioration of cognitive task performance in the dual task groups. The number of faults (Base: 0.13; s1: 0.48;  $p = 0.02$ ) increased significantly in both groups, response times only in the young group (Base: 1.36s; s1: 1.91s;  $p = 0.007$ ). This indicates an involvement of cortical areas in the modulation of the postural response. Predictive gait adjustments, on the other hand, did not interfere with the concurrent cognitive task, suggesting that age-related cognitive impairments do not affect locomotor adaptational responses during disturbed walking, even when additional cognitive load is applied. References Hof AL, Gazendam MG, Sinke WE. (2005). J Biomech, 38(1), 1-8.

## DOES A HIGHER MUSCLE FORCE OUTPUT REQUIRE MORE PRIMARY MOTOR RESOURCES? -AN EEG STUDY

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Introduction: Recently, a new method to investigate changes in brain cortical activity during whole-body exercise up to maximal effort has been developed. Using electroencephalography (EEG) in combination with low resolution brain electromagnetic tomography (LORETA) we were able to display elevated primary motor cortex activity with increasing exercise intensity during a dynamic incremental bicycle exercise test until subjective exhaustion (Brümmer et al. 2011). A second study intended to proof whether this is also true for increasing efforts during an isometric strength task. Based on the prior study it was expected to observe increasing primary motor cortex activity with increasing exercise intensity. Methods: Twelve subjects were asked to perform isometric leg extensions randomly at 20%, 40%, 60% and 80% (calculated on the basis of 3 individual maximal voluntary contractions) for 20 sec. A target line indicated the particular force level which participants were asked to hold as accurate as possible. EEG was recorded during the 20 sec of the four different practice trials as well as for 20 sec prior to the test under resting conditions (rest). Current density of EEG was analyzed and localized using LORETA in several regions of interest related to motor, sensory and behavioral processes. Results: Compared to the rest condition current density was found to be higher during the isometric force task in brain areas related to motor and sensorimotor processes such as the primary motor and sensory cortex, the somatosensory association and the premotor cortex. With increasing efforts activity of motor and sensory brain areas, but also frontal brain regions known to be involved in emotional and behavioral processes were found to be elevated.

Discussion: These findings confirm that several motor and sensory cortexes are active during the execution of an isometric strength task and that not only primary motor cortex activity is elevated with increasing exercise intensity. Additionally, brain regions related to emotional and behavioral processes showed enhanced activity at higher strength levels, which might be a sign of a more complex brain network at higher efforts.

## Oral presentations

### OP-PM15 Training and Testing: High Intensity Training

#### INDICES OF METABOLIC HEALTH ARE SIMILAR FOLLOWING INTENSE-INTERVAL OR ENDURANCE CYCLING TRAINING

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Introduction Recent research has shown the effectiveness of repeated high intensity exercise (RHIE) for increasing muscle carbohydrate stores and fat utilisation during endurance exercise (Burgomaster et al., 2008), and RHIE may be a time-efficient strategy for health promotion (Gibala, 2007). Recently, 12-wk high-intensity interval running training was shown to be less effective than endurance running for cholesterol levels, but as effective for glucose tolerance (Nybo et al., 2010). The purposes of this study were to examine whether 8-wk RHIE training, relative to endurance training, improves energetics of aerobic exercise and blood markers of metabolic health. Methods Twelve healthy, untrained adults (5 males, 7 females; age  $23 \pm 4$  y;  $\text{VO}_{2\text{max}}$   $38 \pm 5$  mL/min/kg) completed two 8-wk training blocks of RHIE or endurance (END) cycle ergometer training in a randomised cross-over design with 7-wk washout between blocks. RHIE training progressed from four to six 30-s intervals 3 d/wk, while END training progressed from 40 to 60 min at 65%HRmax 5 d/wk, as previously reported (Burgomaster et al., 2008). Participants' metabolic function was assessed at rest (blood samples) and during cycling tests ( $\text{VO}_2$  and Respiratory Exchange Ratio (RER)) before and after each training block. The tests were an incremental  $\text{VO}_{2\text{max}}$  test and, ~3 h following a standardised breakfast on a separate day, 50-min cycling at 65% pretraining  $\text{VO}_{2\text{max}}$ . Results  $\text{VO}_2$  max increased to a similar extent following END and RHIE ( $11 \pm 6\%$ ,  $16 \pm 10\%$  resp.; 95%CI:  $5 \pm 8\%$ ). RER during submaximal exercise fell similarly across blocks: by  $0.03 \pm 0.04$  (END) and  $0.05 \pm 0.04$  (RHIE); CI:  $0.01 \pm 0.03$ . Fasting blood glucose tended to increase after RHIE training ( $0.31 \pm 0.59$  mmol/L), and decrease after END training ( $-0.08 \pm 0.33$  mmol/L; CI:  $0.38 \pm 0.43$ ). Triacylglycerol (TAG) concentration decreased across RHIE ( $-0.16 \pm 0.37$  mmol/L) and increased across END ( $0.20 \pm 0.43$  mmol/L), such that training type had a differential effect (CI:  $0.36 \pm 0.35$ ). However, 8-wk of either training did not alter fasting cholesterol or insulin concentrations. Discussion Low volume, high-intensity training was as effective as traditional endurance training in improving fuel utilisation during endurance exercise. Resting blood glucose and TAG concentrations responded differently to the two training types, but these effects were small and not matched by cholesterol or insulin changes. References Burgomaster KA, Howarth KR, Phillips SM, Rakobowchuk M, MacDonald MJ, McGee SL et al (2008). J Physiol, 586(1), 151-160. Gibala MJ (2007). Curr Sports Med Rep, 6(4), 211-213. Nybo L, Sundstrup E, Jakobsen MD, Mohr M, Hornstrup T, Simonsen L et al (2010). Med Sci Sports Exerc, 42(10), 1951-1958.

#### COMPARISON OF SHORT-TERM SPRINT INTERVAL TRAINING AND TRADITIONAL EXERCISE RECOMMENDATIONS IN SEDENTARY OVERWEIGHT/OBESE MEN

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COMPARISON OF SHORT-TERM SPRINT INTERVAL TRAINING AND TRADITIONAL EXERCISE RECOMMENDATIONS IN SEDENTARY OVERWEIGHT/OBESE MEN Skleryk JR1, Karagounis L2, Hawley JA2, Sharman MJ1, Watson G1 and Laursen PB1, 3, 4 1Edith Cowan University (AUSTRALIA), 2RMIT University (AUSTRALIA), 3New Zealand Academy of Sport (NEW ZEALAND), 4AUT University (NEW ZEALAND) Introduction While exercise is essential to reduce chronic disease risk, many individuals do not adhere to exercise recommendations, with the primary reason being 'lack of time.' In recreationally trained individuals, short-term sprint interval training (SIT) has been shown to induce metabolic and performance adaptations that parallel those of traditional exercise recommendations (TER), and require considerably less time commitment (1, 2). However, little is known about the effectiveness of short-term SIT in sedentary overweight individuals. This study compared the effects of 2-weeks of SIT and TER on metabolic and health-related markers in sedentary, overweight/obese men. Methods Sixteen men ( $37.8 \pm 5.8$  y; BMI  $32.8 \pm 4.7$  kg•m<sup>-2</sup>) were evenly assigned to either a SIT or TER group. Over a 2-week period, 6 sessions of 8-12 x 10 s supramaximal cycle sprints (3 sessions per week) were performed in SIT, while TER consisted of 10 sessions of cycling for 30 min at 65%  $\text{VO}_{2\text{peak}}$  (5 sessions per week). Fasting plasma glucose, insulin, nonesterified fatty acids (NEFA), homeostasis model assessment of insulin resistance (HOMA-IR), body composition and peak oxygen consumption ( $\text{VO}_{2\text{peak}}$ ) were assessed at baseline and 72 h after the final training bout. Muscle biopsy samples were taken from the vastus lateralis at the same time points, and analysed for proteins related to glucose uptake and mitochondrial function. Paired t-tests were used to compare the pre and post-training measurements within each group, and independent t-tests were used to compare changes from pre to post-training between groups. Results No significant changes in BMI, body composition,  $\text{VO}_{2\text{peak}}$ , fasting plasma glucose, insulin and HOMA-IR were observed from pre to post training, either within groups, or between groups. A decrease ( $p < 0.05$ ) in fasting plasma NEFA was found only in the TER group post training. Muscle biopsy analysis revealed that protein expression of specific markers (AS160, COX II, COX IV, GLUT-4, Nur77 and SIRT1) did not change in either training group. Discussion It appears that the response of sedentary overweight/obese men to training may be different to that of young active men reported in previous studies (1,2). It should be noted that considerably greater work and time were spent completing the TER compared to SIT, but neither group elicited notable improvements. Further research is necessary to extend the training period to see if TER and SIT produce beneficial effects in sedentary, overweight/obese men. References 1) Gibala MJ et al. (2006) J Physiol, 575, 901-11 2) Gibala MJ, McGee SL. (2008) Exerc Sport Sci Rev, 36, 58-63

#### EFFECT OF HIGH- VERSUS MODERATE-INTENSITY INTERVAL TRAINING ON AEROBIC FITNESS IN SOCCER PLAYERS

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EFFECT OF HIGH- VERSUS MODERATE-INTENSITY INTERVAL TRAINING ON AEROBIC FITNESS IN SOCCER PLAYERS Impellizzeri FM1, Castagna C2, Coutts AJ3, Schena F1, Santos TM4 1: CeRISM, University of Verona (Rovereto, Italy), 2: University of Tor Vergata (Rome, Italy), 3: UTS

(Sydney, Australia); 4: Universidade Gama Filho (Rio de Janeiro, Brasil) Introduction Interval training performed at intensities from 90 to 95% of maximal heart rate (HRmax) has been shown to improve maximal aerobic power (VO2max) and soccer-specific endurance [1]. No studies have examined whether interval training performed at lower intensity induces similar effects. The aim of the study was to compare the effects of moderate and high-intensity interval training on aerobic fitness in junior soccer players. Additional aims were to examine whether an increase of interval training intensity from moderate to high-intensity determined additional improvements, and whether one session a week of high-intensity training is enough for maintaining the aerobic fitness. Methods Twenty-eight male players from two teams were randomized during the competitive season into two groups: high-intensity (HIGH, 90-95% of HRmax; final n=11) and moderate-intensity (MOD, 80-85% of HRmax; final n=10) interval training. Twenty-one players completed the study: age 17 (SD 1) years old, height 176 (5) cm, and weight 71 (8) kg. We used two interrupted-time series (ITS) designs nested in a randomized parallel-group trial (RPT). Training lasted 6 weeks for the RPT and additional 6 weeks for each arm (MOD and HIGH) for the ITS. In the RPT both groups trained 6 weeks twice a week. After this period MOD increased the intensity to 90-95% of HRmax for 6 weeks, while HIGH decreased the training frequency to one session a week. Before (pre), after the RPT (mid) and after the ITS (post) players performed the Yo-Yo Intermittent Recovery Test and VO2max test. Results No effect of group was found for VO2max ( $P=0.519$ ). The group  $\times$  time interaction was significant for the YYIRT ( $P=0.002$ ). The MOD group increased the YYIRT by 4.1% (90%CI -1.5 to 10%) from pre to mid, and 8.5% (5.7 to 11.6%) from mid to post (compare to pre: 13%, 6.2 to 20.3%). The HIGH group increased the YYIRT by 15.5% (8.5 to 22.8%) from pre to mid, and -0.6% (-3.3 to 2.3%) from mid to post (compare to pre: 14.8%, 8.0 to 22.1%). No changes were found for VO2max. Discussion This study showed that during the competitive season high-intensity interval training induced greater improvements in YYIRT than the same exercise modality completed at moderate intensity. The increase of exercise intensity to about 90% of HRmax induced in the MOD group improvements comparable to HIGH. Furthermore, training once a week using high-intensity interval training seems to be sufficient to maintain the specific-endurance level. References 1) Iaia FM, Rampinini E, Bangsbo J. (2009). *Int J Sports Physiol Perform*, 4, 291-306. 2) Bangsbo J, Iaia FM, Krstrup P. (2008), *Sports Med*, 38, 37-51.

### ACUTE PHASE RESPONSE TO MODERATE AND HIGH INTENSITY AEROBIC EXERCISE IN SEDENTARY YOUNG MALES

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Introduction Exercise induced local inflammatory response is accompanied by a systemic response known as the acute phase response (APR) (1). Inflammatory response is essential and promotes tissue healing. However, improper regulation of inflammation can lead to excess tissue damage. IL-6 is the main cytokine involved in the induction of APR, which includes synthesis of certain proteins in the liver such as c-reactive proteins (CRP). To date a few studies compared the acute exercise-induced IL-6 and CRP responses to moderate and high intensity aerobic exercise. Therefore, the aim of this study was to compare APR to one bout of aerobic exercise of moderate and high intensities in sedentary young males. Furthermore, we aimed to evaluate the impact of IL-6 released during exercise on CRP generation. Methods Eighteen young sedentary volunteers (age range 20-26 years, BMI: <25) were assigned to either moderate (ME, n: 8, 60% VO2max) or high (HE, n: 10, 75% VO2max) intensity exercise groups. Each group ran on the treadmill for 30 minutes at the respective exercise intensities. Blood samples were collected before, immediately after and 2 h after the exercise session to determine IL-6 and CRP levels. IL-6 and CRP were measured by nephelometry and ELISA, respectively. The data analyzed by paired t-test and ANOVA with repeated measures (General Linear Model). Results A single bout of both moderate and high intensity exercise induced significant increases in serum CRP and IL-6 levels ( $p<0.05$ ), however, no significant difference was observed between experimental groups (time  $\times$  group effects) ( $p>0.05$ ). There was no significant correlation between serum levels of IL-6 and CRP either at immediately or 2 h after exercise ( $p>0.05$ ). Discussion Findings of this study demonstrated that a single bout of both moderate and high intensity aerobic exercise increased serum IL-6 and CRP concentrations in untrained males. Exercise intensity didn't seem to affect the magnitude of the increase in either IL-6 or CRP within the limits of this study. Moreover, there was no association between IL-6 and CRP at any observation consistently with the literature (2). Therefore, it seems that there are other factors stimulating CRP synthesis in response to acute exercise other than IL-6. References 1. Gruys E, Toussaint MJM, Niewold TA, Koopmans SJ. (2005) *J Zhejiang Univ Sci*, 6B(11):1045-1056. 2. Czarkowska-Paczek B, Bartłomiejczyk I, Gabrys T, et al. (2005) *Immunol Lett*, 15;99(1):136-40.

### CHANGES IN PHOSPHOCREATINE CONCENTRATION OF SKELETAL MUSCLE DURING INTENSIVE INTERMITTENT EXERCISE IN CHILDREN AND ADULTS

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Introduction It was shown that children possess a higher resistance to fatigue and a quicker recovery during high-intensive intermittent exercise compared to adults, which is mainly explained by lower blood lactate concentrations and a more stable blood pH (Falk & Dotan, 2006; Ratel et al., 2006). The aim of the present study was to investigate if this can also be explained by the amount and speed of phosphocreatine (PCr) breakdown and resynthesis during and after intensive short-term anaerobic interval work. Methods 16 untrained children (C; 8 girls, 8 boys:  $9.2\pm0.3$  yrs;  $139\pm6$  cm;  $35.8\pm7.7$  kg body mass;  $16.6\pm2.8$  kg muscle mass) and 16 untrained adults (A; 8 women, 8 men:  $26.1\pm0.3$  yrs,  $175\pm8$  cm,  $69.1\pm9.4$  kg body mass,  $40.1\pm8.2$  kg muscle mass) participated in the study. All subjects completed an intermittent protocol of dynamic plantar flexion followed by 10 min of passive recovery. The protocol consisted of 10 bouts of 30s exercise (24 concentric and eccentric movements) intermitted by 20s recovery. The individual load corresponded to the 28 repetition maximum. We recorded the absolute and relative changes of PCr during exercise and during post exercise recovery by means of non invasive <sup>31</sup>P-magnetic resonance spectroscopy as well as the mean force production. Results The results (mean $\pm$ SD) were calculated using a multi factor ANOVA (main factors were age, sex and measurement time). No significant differences between the age groups were found for the initial PCr concentrations. Average relative PCr break down during each exercise period was significantly lower ( $p<0.05$ ) in C ( $-71.4\pm5.4\%$ ) compared to A ( $-85.8\pm4.9\%$ ). Time constant to reach 63% of initial PCr during post exercise recovery was significantly shorter in children (C:  $47\pm31$ s, A:  $74\pm33$ s,  $p<0.05$ ). Force production relative to maximum values did not differ significantly between C and A. Discussion The results give further explanations for the intermittent exercise performance of children. Our data suggest that children require more aerobic and less anaerobic pathways for ATP production than adults. The lower PCr-breakdown during exercise and the accelerated PCr-resynthesis during recovery point to a better oxygen transport or utilization in the working muscles. This can possibly be attributed to an improved muscle flow after maximum contraction and a greater oxidative mitochondria capacity related to skeletal muscle mass. Coaches should be encouraged to include more short term intensive intermittent work in children's work out. References Falk B, Dotan R. (2006). *Exerc Sport Sci Rev*, 34, 107-12. Ratel S, Duché P, Williams CA. (2006). *Sports Med*, 36, 1031-1065.

## THE ADDITION OF STRENGTH TRAINING TO HIGH-INTENSITY INTERVAL EXERCISE TRAINING IN CHRONIC HEART FAILURE PATIENTS

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**INTRODUCTION:** Aerobic exercise training is an important means of cardiopulmonary rehabilitation in chronic heart failure (CHF) patients. The effects of strength training inclusion in an aerobic regime, especially a high-intensity one, have not been thoroughly studied. The aim of this study was to investigate the effects of two different regimes (high-intensity interval vs. combined) on exercise capacity in CHF. **METHOD:** Forty four CHF patients, 36 males / 8 females [(M±S) age: 53.6±11.5 yrs, VO<sub>2</sub>peak: 15.9±4.8 ml/kg/min] participated in an exercise training program for 12 weeks, 3 times/week. Participants were randomly assigned to either aerobic (AER, n=20) or combined regime (COM, n=24), which included aerobic and strength training. Aerobic exercise was performed in interval type (30 sec exercise – 60 sec rest) on cycle ergometers at intensity >100% VO<sub>2</sub>peak. Strength training involved exercises for various muscle groups, including the quadriceps. Both regimes were of the same duration. At the beginning and the end of the program, participants performed a maximum symptom-limited test to exhaustion to assess oxygen uptake at the peak (VO<sub>2</sub>peak) and the anaerobic threshold (VO<sub>2</sub>AT), the corresponding power outputs (Wpeak and WAT), the linear VO<sub>2</sub> slope at the first minute of the recovery phase (VO<sub>2</sub>/t slope), and a 2-resistance maximum test (2-RM) for each leg to assess quadriceps strength. **RESULTS:** The whole cohort improved (p<0.05) VO<sub>2</sub>peak (from 15.9±4.8 to 18.3±5.5 ml/kg/min), VO<sub>2</sub>AT (from 10.3±2.8 to 11.4±2.9 ml/kg/min), Wpeak (from 101±38 to 119±42 watt), WAT (from 58±23 to 70±25 watt), the VO<sub>2</sub>/t slope (from -0.48±0.25 to -0.60±0.28 ml/kg/min<sup>2</sup>) and the 2-RM sum of the two legs (from 35.6±13.1 to 44.0±17.5 kg). In relation to between-group comparison, COM improved more than AER (p<0.05) in VO<sub>2</sub>peak (AER: from 16.4±4.2 to 17.8±4.7 ml/kg/min, COM: from 15.5±5.3 to 18.7±6.1 ml/kg/min), the VO<sub>2</sub>/t slope (AER: from -0.49±0.25 to -0.56±0.25 ml/kg/min<sup>2</sup>, COM: from -0.46±0.25 to -0.64±0.31 ml/kg/min<sup>2</sup>), and 2-RM sum (AER: from 35.9±12.6 to 39.2±13.2 kg, COM: from 35.3±13.9 to 48.0±19.7 kg). No between-group differences were found (p>0.05) on VO<sub>2</sub>AT (AER: from 10.4±2.5 to 11.2±2.8 ml/kg/min, COM: from 10.2±3.1 to 11.5±3.0 ml/kg/min), WAT (AER: from 60±18 to 69±19 watt, COM: from 56±28 to 71±30 watt) and Wpeak (AER: from 104±29 to 118±30 watt, COM: from 99±44 to 120±51 watt). **DISCUSSION:** A combined rehabilitation program of high-intensity aerobic interval and strength training, in comparison to an aerobic interval regime, induced at least similar improvements on aerobic parameters of functional and predictive value and greater enhancement of the maximum strength in CHF patients. Strength training is safe, well-tolerated, and can amplify the benefits of the CHF exercise training rehabilitation programs.

## Oral presentations

### OP-PM28 Stress Damage Inflammation 1

## THE INFLUENCE OF BODY TEMPERATURE ON THE OXIDATIVE STATUS OF THE PLASMA IN LONG DISTANCE RUNNERS AND UNTRAINED MEN

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**Introduction** Prooxidant-antioxidant status of the organism depends on different factors such as physical effort or elevation of body temperature. The aim of this study was to evaluate changes in plasma oxidative status under exogenic heat in sauna and combined exogenic and endogenic heat during prolonged exercise in elevated environment temperature in untrained and trained men. **Methods** Ten untrained non-smoking, healthy men (20-22 yrs; 44.46±8.98 ml kg<sup>-1</sup>min<sup>-1</sup>) - UT group and ten long distance runners (20-23 yrs old; VO<sub>2</sub>max 60.53±13.5ml kg<sup>-1</sup>min<sup>-1</sup>) - T group participated in this study. They had not been accustomed to sauna before. There were 2 tests during the experiment. In the 1st one the subjects had been pedaling on a cycloergometer with intensity of 53±2%VO<sub>2</sub>max in the climatic chamber (temp. 33±1°C; RH 70%) until the rectal temperature (Tre) increased by 1.2°C. The 2nd test consisted of passive heating in a Finnish sauna (96±2°C at face-level; RH 5-16%). The subjects stayed in the sauna for 15 min and were subsequently cooled down for 2 minutes under the shower (temp. 20°C). Warming and cooling were repeated until Tre increased by 1.2°C. Body mass (BM), heart rate (HR) and Tre were measured. Venous blood was taken before and 3 min after sauna exposure. Hematocrit and hemoglobin concentration were measured in full blood. Total protein concentration, lactate concentration (La), lipid peroxidation concentration (PerOx) and antioxidant plasma concentration (AntiOx) were measured in the plasma samples. **Results** The resting AntiOx was higher by 10-25% (p<0.05) in T compare to UT subjects, whereas PerOx was higher by 40-53% (p<0.05) in UT subjects before both tests. After exercise test AntiOx decreased by 24% and PerOx increased by 62% in UT subjects (p<0.05), whereas 21% decrease in AntiOx and 90% increase in PerOx were observed in T subjects (p<0.05). After sauna exposure 65% decrease in AntiOx and 37% increase in PerOx were observed in UT subjects (p<0.05), whereas AntiOx decreased by 21% and PerOx increased by 56% in T subjects (p<0.05). The differences in changes between T and UT were statistically significant in both tests. **Discussion** Physical training leads to improvement in prooxidant-antioxidant status of the organism. Changes in the level of the indicators of oxidative stress observed after exercise test were greater among athletes comparing to untrained subjects, which may be explained by longer work periods and a faster pace of glycolysis, as is indicated by higher concentrations of lactate observed following the exertion. Physical exercise in the elevated temperature of the environment caused greater changes of the indicators of oxidative stress (PerOx) than heating in sauna.

## LOW-INTENSITY ECCENTRIC CONTRACTIONS ATTENUATE MUSCLE DAMAGE INDUCED BY MAXIMAL ECCENTRIC CONTRACTIONS FOR 2 WEEKS

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**Introduction** It has been reported that eccentric exercise with a light dumbbell that does not change any muscle damage markers provides some protection against a subsequent bout of a higher intensity eccentric exercise with a heavier dumbbell performed 2 days later (1). It appears that the duration of the protection remains is dependent on the magnitude of the initial muscle damage; however, it is unknown how long the protective effect lasts when the initial eccentric exercise bout induces little or no muscle damage. This study investigated how long the protective effect induced by a low-intensity eccentric exercise against maximal eccentric exercise would last.

**Methods** Sixty-five untrained men ( $21.3 \pm 1.6$  y) were assigned ( $n=13$  per group) to four repeated bout groups and one control group. The four repeated bout groups performed 5 sets of 6 submaximal eccentric contractions of the elbow flexors using a dumbbell set at 10% of maximal isometric strength at  $90^\circ$  (10%-ECC) for the first bout followed 2 (2d), 7 (1w), 14 (2w) or 21 days (3w) by 5 sets of 6 isokinetic ( $30^\circ.s^{-1}$ ) maximal eccentric contractions (Max-ECC) using non-dominant arm. The control group performed Max-ECC only. The dependent variables included maximal voluntary isometric and isokinetic ( $30^\circ.s^{-1}$ ) concentric strength, range of motion, upper arm circumference, muscle soreness, plasma creatine kinase activity and myoglobin concentration, and echo-intensity of the B-mode ultrasound images. Changes in the variables following 10%-ECC were analysed by a one-way repeated measures ANOVA, and the changes following Max-ECC were compared among the groups by a two-way repeated measures ANOVA. Results The 10%-ECC did not change any of the dependent variables. The changes in all dependent variables following Max-ECC were significantly ( $P<0.05$ ) smaller for the 2d, 1w and 2w groups compared with control groups, without significant differences between the 2d and 1w groups. The 2w group showed significantly ( $P<0.05$ ) greater changes in all variables compared with the 2d and 1w groups. Changes in the variables were similar between the 3w and control groups, except for muscle soreness that showed significantly ( $P<0.05$ ) smaller changes for the 3w than the control group. Discussion These results confirmed that non-damaging eccentric exercise conferred protective effect against maximal eccentric exercise, supporting the previous study finding (1) and showed that the protective effect lasted for 2 weeks, but the protective effect was attenuated between 1 and 2 weeks. A light eccentric exercise should be performed within 2 weeks prior to a higher intensity eccentric exercise to attenuate muscle damage. References 1) Lavender AP, Nosaka K. (2008). J Sci Med Sport, 11, 291–98.

### **ASSOCIATION OF INFLAMMATORY FACTORS , OXIDATIVE STRESS AND CELL INJURY INDICES AFTER STRENUOUS TRAINING PERIODS AND VITAMIN-MINERAL SUPPLEMENTATION**

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This study is aimed to investigate the association of inflammatory factors (IL6, TNF $\alpha$ ), oxidative stress (MDA) and cell injury indices after strenuous training periods and Vitamin-mineral supplementation in female elite swimmers. Materials and Methods: Twenty-four elite female swimmers volunteered to participate in this study and were randomly divided into two groups, the experimental (Vitamin-mineral supplemented) and the control (Placebo). Both groups were in a monthly swimming programs, 3 times a week, for a total of 4 weeks and swimming, almost 3.5 to 4 km/d. Blood sampling was done before and after the training period to assess inflammatory cytokines such as IL-6 and TNF- $\alpha$ , and also MDA and muscle injury indices, such as aspartat aminotransferase (AST), creatine kinase (CK), lactate dehydrogenase, and myoglobin. 100 m crawl records were measured at the beginning and the end of the training period. Results: Results showed that inflammatory cytokines decreased significantly in the vitamin-mineral supplemented group, and MDA decreased, though not significantly, in this group. There was no significant change between the groups. No significant change was observed in swimming performance in either groups. Some of the muscle injury indices, namely, CK and AST, decreased significantly in the vitamin-mineral-supplemented group ( $p=0.011$  and  $0.04$ , respectively). Inter-group comparisons showed a difference only with regard to CK ( $p=0.021$ ). Conclusion: In conclusion, ROS was found to affect exercise-induced cytokine production, in which Vitamin-mineral supplementation was found to play an effective role

### **MULTI-ANALYTICAL MEASUREMENT OF HORMONES AND CYTOKINES WITH EVIDENCE BIOCHIP ARRAYS**

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RANDEX LABORATORIES LTD

**MULTI-ANALYTICAL MEASUREMENT OF HORMONES AND CYTOKINES WITH EVIDENCE BIOCHIP ARRAYS** Huxley, A., Kelly, F.M., Rodriguez, M.L., McConnell, R.I., Fitzgerald, S.P. Randox Laboratories Ltd., 55 Diamond Road, Crumlin, Co Antrim BT29 4QY, Northern Ireland, UK. Introduction Using miniaturized assay procedures, Evidence biochip array technology enables the simultaneous determination of multiple analytes from a single sample with the reduction of sample/reagent consumption and better cost-effectiveness of the tests. Variations in the levels of hormones such as cortisol, dehydroepiandrosterone-sulphate (DHEAs),  $17\alpha$ -hydroxyprogesterone ( $17\alpha$ -OHprog) and leptin in response to physical exercise have been reported. The intensity and duration of the exercise is also related to the plasma levels of cytokines that influence leukocyte functions. The multi-analytical measurement of these molecules generates a quantitative profile, providing more information than single-analyte determinations, which is relevant in studies of complex interactive networks. We report the application of biochip arrays to the multiplex measurement of hormones and cytokines. Methods Simultaneous chemiluminescent immunoassays are employed for analyte detection and the microarrays of capture ligands define the discrete test areas for each of the analytes in the biochip (9mm x 9mm). The semi-automated analyser Evidence Investigator was used. The system automatically processes, reports and archives the generated data. Results The endocrine biochip array allows simultaneous quantitative determination of cortisol, DHEAs,  $17\alpha$ -OHprog and leptin with the following sensitivity values: 5.88ng/ml (cortisol, calibration range 0-800ng/ml), 0.003 $\mu$ g/ml (DHEAs, calibration range 0-10 $\mu$ g/ml), 0.1ng/ml ( $17\alpha$ -OHprog, calibration range 0-20ng/ml) and 0.64ng/ml (leptin, calibration range 0-100ng/ml). Twenty-two soluble cytokines and five cytokine related markers are determined using different biochip arrays with sensitivity values ranging from 0.74pg/ml (IL-15) to 3.03ng/ml (MMP-9). For all the assays the intra-assay and inter-assay precision, expressed as %CV, were typically <15%. Conclusion The data indicate applicability of biochip array technology to the multiplex determination of a broad range of biomarkers. This technology enables the generation of quantitative patient profiles and represents a useful tool for application in clinical research settings.

## **Oral presentations**

### **OP-PM36 Sports Medicine and Rehabilitation 1**

#### **VISUALISATION OF KINEMATIC PARAMETERS IN GAIT TRAINING: USING THE EXAMPLE OF TOTAL HIP REPLACEMENT**

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Introduction Augmented Reality (AR) is mainly used in industrial scenarios. However, the efficiency of AR-based interventions to optimize established rehabilitation processes still remains unknown. Hence, the purpose of the present study is the evaluation of AR vs. conven-

tional therapeutic instructions during gait training in patients with total hip replacement (THR). Methods A total of 21 patients (female,  $58 \pm 4.3$  years) with THR have been randomly assigned either to an intervention group (IG,  $n = 11$ ) or a control group (CG,  $n = 10$ ). Additional to the post-hospital curative treatment all patients passed a standardized gait training (20 min / day). Corrections of gait patterns were given by either verbal therapeutic instructions (CG) or with help of an AR-based real-time visualisation (IG). In order to identify differences between the intervention strategies, a pre-test, follow up test and post-test were performed. Based on clinical gait analysis the assessment of kinematic values (Moven, Xsens) and neuro-physiological parameters (surface electromyography, SEMG, 16-channel Noraxon) is conducted. A reference group (RG) of 26 subjects without any motor and functional impairments (female,  $59 \pm 11$  years) was utilized to capture kinematic reference values (Moven). These data served as reference values for visualization (IG) and in comparison with the IG and CG. Results Initial results show no differences in SEMG data of the IG vs. CG. In comparison of CG vs. RG significant differences in gait velocity ( $p = .001$ ) were analysed in the post test. In contrast, for IG vs. RG we could not find any differences. Furthermore, significant differences were detected in CG post-test vs. RG post-test in the average inclination ( $p = .027$ ) and range of motion ( $p = .000$ ) of the pelvis in the frontal plane. Discussion If the AR-based intervention treatment is used, equivalent results seem to be achievable compared to conventional therapeutic instructions. Particularly due to further reduction of the technical complexity and temporal outlay of this technology, the presented approach appears to be a promising and effective tool to optimize rehabilitation processes, such as in rehabilitation of individuals with total hip replacement.

## EFFICACY OF RICE THERAPY IN TREATING ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE

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Introduction RICE therapy (rest, ice, compression, elevation) is a universally accepted clinical practice for immediate treatment of any soft tissue injury including sprains, strains and contusions. Whilst individual components of the RICE principle have been tested and proven to be effective, no single trial has been conducted to prove the efficacy of this treatment modality in its entirety. In addition it is not known if participants receiving RICE therapy would demonstrate the typical adaptation following muscle damage i.e. the repeated bout effect. Methods Nineteen healthy, active but untrained males were recruited for the study. The participants performed 12 sets of elbow extensions (eccentrically-biased) at a pre-determined repetition maximum (bout 1). They were then randomly assigned to the RICE treatment or control group (CG). Indirect markers of muscle damage were recorded at 3, 6, 9, 12, 24, 48, 72, 96 and 120h post exercise. The same procedure was followed 4 weeks later (bout 2). Results For creatine kinase there was a significant group effect ( $p = 0.002$ ). Values for RICE for both bouts of exercise combined ( $2119 \pm 514$  IU/L) were 53% lower than for both bouts of eccentrics performed by the CG ( $4019 \pm 639$  IU/L). Isometric strength (expressed as % of baseline) in the CG between bout 1 ( $76 \pm 4\%$ ) and bout 2 ( $93 \pm 3\%$ ) was significantly different, while surprisingly, there was no significant difference for RICE between bout 1 ( $81 \pm 3\%$ ) and bout 2 ( $85 \pm 3\%$ ). For the first 12h post exercise the RICE group experienced greater ( $p = 0.002$ ) DOMS however during the subsequent 12h periods (up until 120h post) the CG experienced greater DOMS ( $p = 0.009$ ). Neutrophils and monocytes were 3-15% higher ( $p < 0.05$ ) in the CG following the exercise bouts. Significant bout effects were observed for all markers indicating the manifestation of the repeated bout effect. Discussion The primary objective of this study was to determine if RICE therapy is effective in reducing indirect markers of muscle damage following a bout of strenuous unaccustomed eccentric exercise. A second aim of the study was to determine if the repeated bout phenomenon would manifest in participants that had received RICE therapy, in other words would RICE therapy 'interfere' with normal adaptive healing processes. RICE therapy improved recovery from a bout of strenuous eccentric exercise and failed to negatively impact on a subsequent bout performed 4 weeks later. The latter finding may only be of practical significance for recreational athletes or those training sporadically. The results may give support to the application of RICE therapy following normal 'uneventful' strenuous training that is likely to induce DOMS. References Bleakley C, McDonough S, MacAuley D. Am J Sports Med. 2004;32 (1):251-261. Jarvinen TAH, Jarvinen TLN, Kaariainen M, Kalimo H, Jarvinen M. Am J Sports Med. 2005;33 (5):745-764.

## THE EFFECTIVENESS OF AN INJURY PREVENTION PROGRAMME ON PHYSICAL ACTIVITY INJURY INCIDENCE IN PRIMARY SCHOOL CHILDREN

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Collard D. 1, Chinapaw M. 2, Verhagen E. 2, van Mechelen W. 2 1: Mulier institute ('s-Hertogenbosch, The Netherlands), 2: EMGO Institute for Health and Care Research, VU University Medical Center (Amsterdam, The Netherlands). Introduction The health benefits of regular sport activities in children are widely known. Participation in sport activities, however, also increases the risk of adverse effects, such as injuries. Although most physical activity injuries in children are not life-threatening, they may coincide disability, school absence, and loss of enthusiasm for participating in sports. Given these consequences of injuries, prevention of injuries in children is an important public health issue. Methods The Injury Prevention Lessons Affecting Youth (iPlay) intervention programme was developed according to the intervention mapping protocol. The 8-month intervention programme focused on both children and parents and included newsletters, posters displayed in the classroom and an exercise programme to improve physical fitness of children. The iPlay-study was designed as a cluster randomised controlled trial. Forty schools (about 2200 children) were willing to participate in the study. Before baseline measurements a randomisation was performed. The intervention group received the iPlay-programme during 1 school year, whereas the control group followed the regular curriculum. To evaluate the effect of the iPlay-intervention on the number of injuries per 1000 hours of sports participation all children completed a questionnaire that collected information on demographic variables and frequency and duration of sports club and leisure time activities (exposure time). In addition, all injuries as a result of physical activities were registered throughout the schoolyear. Results The analyses showed a positive intervention effect on total, sport club and leisure time injuries, although these effects were not significant due to lack of statistical power. Remarkably, the data showed that children who were less physically active had more benefit from the iPlay-programme. In this group the iPlay-programme reduced the total and leisure time injury incidence density with approximately 50%. Sport club injury incidence density in this group was significantly reduced. Furthermore, children in the intervention group reported less often sporting time loss as a result of an injury than those in the control group. Discussion In this study, individual randomisation was no option due to the school-based nature of the iPlay-programme. When calculating the sample size for a cluster randomised controlled trial it is essential to address clustering. Often studies do not adequately account for clustering effects in design and analysis. Our results showed that cluster effect in this study was much larger than expected, thereby decreasing statistical power.

**A PROSPECTIVE COHORT STUDY ON MINOR BICYCLE ACCIDENTS IN COMMUTER CYCLISTS IN BELGIUM**

DE GEUS, B.

VRIJE UNIVERSITEIT BRUSSEL

**A PROSPECTIVE COHORT STUDY ON MINOR BICYCLE ACCIDENTS IN COMMUTER CYCLISTS IN BELGIUM** Bas DE GEUS<sup>1</sup>, Grégory VANDEN-BULCKE<sup>2</sup>, Bart DEGRAEUWE<sup>3</sup>, Luc INT PANIS<sup>3,4</sup>, Elke CUMPS<sup>1</sup>, Joris AERTSENS<sup>3</sup>, Isabelle THOMAS<sup>2</sup>, Rudi TORFS<sup>3</sup>, Romain MEEUSEN<sup>1</sup> 1 Vrije Universiteit Brussel; 2 Université catholique de Louvain; 3 Flemish Institute for Technological Research; 4 University of Hasselt INTRODUCTION Bicycle injury statistics from police, hospital and insurance statistics are well described, but predominantly include major or fatal injuries. In Belgium, it is estimated that 15 to 30% of the cycling accidents are officially reported. Studies showed large differences in bicycle use and incidence (major accidents) between the three institutional regions which reflects similar situations in other countries. To get insight in minor bicycle accidents and to overcome underreporting, the SHAPES project conducted a prospective cohort study on bicycle accidents using an online registration system. Bicycle accident and exposure data were prospectively collected in order to calculate injury incidence density (ID) of minor bicycle accidents. METHODS Participants who are included in the data analysis live in Belgium, are 18-65 years and cycled to work >2 times/wk. Inclusion criteria for accident registration were: bicycle accident occurred during cycling for transport; acute injury; accident resulting in corporal damage. Week books were prospectively filled out every week for 1 year, including travel frequency, distance and time spent cycling. If an accident occurred, a detailed questionnaire was filled out. RESULTS One thousand eighty-seven adult cyclists were included. Over the 1 year follow-up period, 20107 weeks were covered. 62 participants were involved in 70 minor (ICISS ≤0.941) bicycle accidents, resulting in an overall ID of 0.287 (95% CI 0.216-0.358) per 1000 trips, 0.794 (95% CI 0.596-0.991) per 1000 hours and 0.042 (95% CI 0.032-0.052) per 1000 kilometres of exposure. The incidence of accidents differed between the regions and between gender, but when exposure is taken into account these differences were not significant. Injuries were mainly caused by 'slipping' (35.7%) and 'direct contact with a car' (18.6%). Accidents caused abrasions (41.6%) and bruises (27.0%) on the lower (45.3%) and upper extremity (41.3%). In 7.1%, 10.0% and 30% of the cases the police, hospital emergency department or insurance company was involved respectively. 44.3% of the participants indicated that they could have avoided the accident. DISCUSSION & CONCLUSION Keeping cycling surfaces clean, avoid direct contact with cars and cyclists paying attention are measures to decrease the injury incidence. Underreporting of minor bicycle accidents in Belgium has been confirmed. Incidence differs between regions and gender, but when exposure is taken into account (ID) these differences are not significant anymore. If exposure is not taken into account, no statement can be made about whether or not safety measures are effective.

**NINE MONTHS OF PILATES TRAINING ARE EFFECTIVE IN ENHANCING THE FITNESS LEVEL OF ADULT WOMEN**

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**NINE MONTHS OF PILATES TRAINING ARE EFFECTIVE IN ENHANCING THE FITNESS LEVEL OF ADULT WOMEN** Cortis C.1,2, Capranica L.1, Santobuono E.3, Di Cristofaro C.3, Piacentini M.F.1 1: Department of Human Movement and Sport Science, University of Foro Italico (Rome, Italy), 2: Department of Sport Science and Health, University of Cassino, (Cassino, Italy), 3: University of Molise (Campobasso, Italy) Introduction Pilates training focused on the improvement of flexibility, strength, and posture (Caldwell et al., 2009; Kloubec, 2010). Although this activity is very popular among women, there is a lack of longitudinal studies. Thus, the aim of this study was to evaluate the effects of a 9-month Pilates program on selected fitness components in adult women. Methods Twenty-six women (36.8 ± 9.6 years) participated in a Pilates program (2 sessions weekly). Before (pre) and after (post) the 9-month training period trunk flexibility (sit and reach-SR), muscular endurance (knee push up-KPU and curl up-CU) and cardio respiratory fitness-CRF (Rockport walking test) according to the ACSM's guidelines for exercise testing (ACSM, 2006) were assessed. To verify whether age acts as a confounding factor, participants were divided into 3 age categories (≤30 yrs, n=9; 31-40 yrs, n=8; >40 yrs, n=9). A 3 (age categories) x 2 (experimental sessions) ANOVA for repeated measures was applied to verify differences (p<0.05) before and after the training period. Results Independently from age, at the end of the program participants significantly (p<0.001) improved SR (10.3 ± 6.7 cm), CU (29.9 ± 13.1) and CRF (13.6 ± 2.1 min) performances with respect to basal values (SR: 5.9 ± 7.9 cm; CU: 21.6 ± 11.2; CRF: 17.4 ± 2.1 min). KPU showed significantly (p<0.001) higher pre values in the 31-40 yrs group (15.6 ± 8.5) compared to the ≤30 yrs (9.3 ± 2.5) and the >40 yrs (8.6 ± 5.8). The post values were different only between 31-40 yrs (17.4 ± 7.6) and >40 yrs (11.8 ± 3.5) group. Discussion Although CRF improvements from pre to post evaluations were similar (21%) among age categories, a different trend emerged for SR (range: 103-209%), CU (range: 44-58%) and KPU (range: 31-86%), with the >40 yrs category always showing the highest improvements, probably due to the pre higher overall fitness of the other age categories. However, the present results show that a 9-month Pilates program enhances flexibility, muscular endurance and also if in a lower extent, cardio respiratory fitness performances regardless of age. References ACSM's Guidelines for exercise testing and prescription. (2006). Lippincott Williams and Wilkins, Baltimore, USA. Caldwell K., Harrison M., Adams M., Triplett N.T. (2009). J Bodyw Mov Ther, 13: 155-163. Kloubec J.A. (2010). J Strength Cond Res, 24: 661-667.

**STANDARD PHYSIOTHERAPY AFTER ELECTIVE TOTAL HIP REPLACEMENT IN THE UK: AN OBSERVATIONAL STUDY OF PRACTICE.**

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**BACKGROUND** Total hip replacement (THR) has revolutionised the care of patients with end stage joint disease, leading to pain relief, and substantial improvement in quality of life (1). However there is a persistence of impaired function, even in the absence of pain (2). This may be due to the lack of a standardised approach to rehabilitation (3) and/or the failure to incorporate progressive resistance training (PRT), an exercise modality proven to improve muscle strength and function following THR (3). This study aimed to investigate 'standard' rehabilitation care in the UK after THR. **METHODOLOGY** After Local Research Ethics approval, the development of questionnaire items about physiotherapy practice was guided by a focus group interview with a small number of physiotherapists (n = 4; minimum 5 years post-qualification) who regularly treated patients undergoing THR. 25 items were developed to reflect the exercises prescribed in the pre-operative and post-operative phases. These questions were then sent via email to physiotherapists identified from hospitals on the National Joint Registry and the Chartered Society of Physiotherapists website. **RESULTS** On analysis of 67 responses, the most important muscle group to target in the pre and postoperative phase were reported to be the hip abductors (57%), followed by the quadriceps (19%), and other muscles (24%). No consensus existed as to which form of exercise was most important in these phases; with weight bearing (42%) and functional (41%) exercises being the most favoured and bed-based/bridging/postural exercises together accounting

for 17% of responses. Despite 76.2% of respondents knowing what PRT entailed, only 34.9% routinely built it into the exercises prescribed. A majority (68.2%) did not refer their patients on for further physiotherapy post-operatively. In the outpatient setting, the prescribed regimens consist of functional exercises (60%), weight bearing exercises (20%) and bed-based/hydrotherapy exercises (20%). CONCLUSIONS Despite the evidence base supporting PRT use in THR rehabilitation, only approximately one-third of physiotherapists surveyed include it in their prescribed programs. Education to facilitate standardisation of post-operative care and increase awareness is needed to help address deficits in function that persist following THR surgery. REFERENCES 1. S. Patil, D. S. Garbuz, N. V. Greidanus, B. A. Masri and C. P. Duncan, J. Arthroplasty, 2008, 23, 550-553 2. C. H. Shih, Y. K. Du, Y. H. Lin and C. C. Wu, Clin. Orthop. Relat. Res., 1994, (302), 115-120. 3. M. Di Monaco, F. Vallerio, R. Tappero and A. Cavanna, Eur. J. Phys. Rehabil. Med., 2009, 45, 303-317.

## Oral presentations

### OP-PM40 Sports Anthropometry

#### MATURITY-RELATED DIFFERENCES BY PLAYING POSITION IN U14 YOUTH TEAM HANDBALL PLAYERS

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**Introduction** Research on anthropometric and physical performance measures in expert adult handball players reveals specific positional demands. During puberty, a shift towards a higher degree of specialized training in youth sports is apparent. However, the shares of diversification and multilateral development versus specialization in this stage are equally large and therefore a complete focus on specialized training during puberty is ill-advised. The purpose of this study was to examine differences in anthropometry and physical performance, accounted for maturation, between field positions in U14 team handball players. **Methods** The sample included 155 male handball players, 13.0 to 13.9 years of age, and mainly playing on one specific position: keeper (n=20), wing (n=68), back (n=49) or pivot (n=18). Morphological and physical performance measures were taken covering most of the physical performance-related characteristics. MANCOVA was used to investigate the positional differences, with age at peak height velocity (APHV as a measure of biological maturation) accounted for. Post hoc tests were executed in case of a significant main effect. All analyses were performed using SPSS 15.0 with the minimal level of significance set at  $p < 0.05$ . **Results** Chronological age was not different between playing positions, whereas APHV revealed a strong significant difference between the positions ( $p < 0.001$ ). The back-positions have a significant earlier maturity offset compared to the wing-position. APHV was a significant covariate ( $p < 0.05$ ) for all anthropometric variables, and in some performance characteristics. Position specific differences were found for height ( $p < 0.05$ ), weight and body fat (both  $p < 0.05$ ). Backs and keepers were in general taller. The lowest weight was observed in wing-players. Back players jumped higher ( $p < 0.05$ ) and further ( $p < 0.01$ ) compared to the other positions, and significant differences were also observed for speed ( $p < 0.05$ ) and agility ( $p < 0.05$ ) in favour of the back players. **Discussion** The result of a maturation-based selection for certain playing positions results in a field position specific specialization as soon as the age of 13. Ideally at this age, players should be encouraged to play a wide variety of field positions instead of just specializing in one. Coaches and training professionals in youth team handball should be aware of the maturity-based selection of young handball players for different playing positions. These differences between players are likely to change throughout puberty and maturity-based selection is therefore not recommended in youth handball.

#### PHYSICAL AND ANTHROPOMETRIC CHARACTERISTICS OF MIDDLE EASTERN YOUNG SOCCER PLAYERS IN COMPARISON TO INTERNATIONAL COUNTERPARTS

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ASPIRE

**PHYSICAL AND ANTHROPOMETRIC CHARACTERISTICS OF MIDDLE EASTERN YOUNG SOCCER PLAYERS IN COMPARISON TO INTERNATIONAL COUNTERPARTS** Simpson, B.M., Buchheit, M., and Mendez-Villanueva, A. ASPIRE (Doha, Qatar) **Introduction** The aim of the present study was to compare physical and anthropometric data in highly-trained young soccer players from the Middle East to their international counterparts of Western African and South American origin. **Methods** Seven Middle Eastern soccer players (bone age:  $14.0 \pm 0.0$  y) were compared with five South American matched for bone age ( $14.2 \pm 0.4$  y), playing position and playing standard. Similarly nine other Middle Eastern players ( $17.1 \pm 0.2$  y) were compared with thirteen West African ( $17.2 \pm 0.3$  y) players. All players performed a counter movement jump (CMJ), a 40-m sprint with 10-m splits to estimate maximal sprinting speed (MSS, km/h) and an incremental running test to estimate maximal aerobic speed (MAS). Anaerobic speed reserve (ASR) was calculated as  $MSS - MAS$ . **Results** Compared with South American, Middle Eastern players presented lower neuromuscular abilities (CMJ:  $32.6 \pm 3.1$  vs  $37.6 \pm 2.5$  cm,  $P = 0.01$ ; 10-m sprint:  $1.84 \pm 0.05$  vs  $1.69 \pm 0.04$  s,  $P < 0.01$ ; MSS:  $27.9 \pm 1.3$  vs  $30.4 \pm 1.0$  km/h,  $P < 0.01$ ; ASR:  $11.0 \pm 1.8$  vs  $14.0 \pm 1$  km/h,  $P < 0.01$ ), while MAS was similar ( $16.9 \pm 0.9$  vs  $16.4 \pm 0.7$  km/h,  $P = 0.30$ ). All anthropometric variables were similar (Height:  $165.0 \pm 4.4$  vs  $166.8 \pm 4.2$  cm,  $P = 0.49$ ; Weight:  $48.9 \pm 4.8$  vs  $54.7 \pm 4.7$  kg,  $P = 0.06$ ; sum of six skinfolds:  $44.2 \pm 9.5$  vs  $42.5 \pm 6.6$  mm,  $P = 0.74$ ). When comparing Middle Eastern to Western Africa players, differences were observed in ASR ( $15.3 \pm 1.3$  vs  $13.7 \pm 1.6$ ,  $P = 0.02$ ) and a tendency towards a lower MAS ( $16.2 \pm 1.0$  vs  $17.0 \pm 0.8$  km/h,  $P = 0.06$ , effect size = 0.92). No differences were observed in the remaining physical performances ( $42.2 \pm 5.0$  vs  $39.7 \pm 3$  cm,  $P = 0.16$ ;  $1.71 \pm 0.05$  vs  $1.72 \pm 0.07$  s,  $P = 0.84$ ; MSS:  $31.4 \pm 1.0$  vs  $30.7 \pm 1.1$ ,  $P = 0.12$ ) nor anthropometric variables ( $169.7 \pm 6.8$  vs  $173.0 \pm 6.6$  cm,  $P = 0.27$ ;  $59.0 \pm 4.8$  vs  $61.7 \pm 4.2$  kg,  $P = 0.16$ ;  $47.7 \pm 8.0$  vs  $41.5 \pm 11.4$  mm,  $P = 0.16$ ). **Discussion** Highly-trained Middle Eastern young soccer players had inferior neuromuscular-related performance compared with bone age-matched South American players and inferior MAS compared with Western Africa players, despite similar anthropometric profiles. While these differences could be related to specific genetic profiles, the possible impact of training experience and background on physical qualities could not be controlled for in this study. Further study controlling for training content and background in higher sample sizes are warranted to generalize these findings.



## LONG-TERM SOCCER-SPECIFIC TRAINING ENHANCES THE RATE OF PHYSICAL DEVELOPMENT OF ELITE JUNIOR SOCCER PLAYERS INDEPENDENT OF MATURATION

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**Introduction** Elite junior soccer players demonstrate increased physical performance compared to age matched sub-elite players (Vaeyens et al., 2006). However, the degree to which these observations reflect differences in genetic predisposition and growth and maturation relative to training has yet to be fully evaluated. The present study therefore compared changes in physical performance in aged matched elite (E) and sub-elite (SE) junior soccer players across three domestic seasons to determine the relative influence of changes in maturation and training. **Methods** Changes in the physical performance of twenty seven E (U12 (n=9), U14 (n=9), U 16 (n= 9)) and eighteen SE (U12 (n=6), U14 (n=6), U16 (n=6)) soccer players were monitored across three seasons. All E players were part of a Premier League Academy development programme. SE players regularly participated in competitive soccer. Performance tests included countermovement jump, 10m and 20m sprint, repeated sprint (7x30m), agility (505) and intermittent endurance. Changes in maturation status of all players across the three years were estimated using change in the maturity offset (Mirwald et al., 2002). Data were analysed with an age-group x competitive level general linear model with covariates of initial performance and maturation changes. Results Baseline performance across all tests was generally greater in E compared to SE across all age groups ( $P<0.01$ ). A significantly greater improvement in 20m sprint (E,  $0.28\pm0.03$ s; SE,  $0.14\pm0.04$ s;  $P=0.02$ ), agility (E,  $0.18\pm0.02$ s; SE,  $0.06\pm0.02$ s;  $P<0.01$ ), and intermittent endurance (E,  $1031\pm95$ m; SE,  $290\pm110$ m;  $P<0.01$ ) performance was observed in E relative to SE across all ages. This was so even when baseline performance and changes in maturity status were covariate-controlled. Improvements in 10m sprint (E,  $0.14\pm0.02$ s; SE,  $0.09\pm0.02$ s;  $P=0.07$ ) and 30m repeated sprint performance (E,  $0.56\pm0.06$ s; SE,  $0.38\pm0.06$ s;  $P=0.09$ ) also showed a tendency to be greater in E. **Discussion** Data indicate that elite junior soccer players undergo greater changes in physical performance across a three year period relative to sub-elite players. This was not due to differences in initial performance nor maturity status. These findings confirm the importance of elite physical development programmes for accelerating the physical development of elite junior soccer players. **References** Mirwald, R.L., et al., (2002). An assessment of maturity from anthropometric measurements. *Med Sci Sports and Exerc*, 34, 689-694. Vaeyens, R. et al., (2006). A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project. *Br J Sports Med*, 40, 928-934.

## RELATIONSHIP BETWEEN GOLF PERFORMANCE, ANTHROPOMETRY AND MUSCLE STRENGTH IN YOUNG ELITE GOLFERS

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**Introduction** Despite its increasing popularity, very few studies (Keogh et al., 2009; Wells et al., 2009) have tried to examine competitive golf in relation to physical characteristics. This study aimed to analyze the relationship between golf performance (determined through assessments of different parts of the game), muscle strength, anthropometrics and handicap (HCP) in young elite golfers. **Methods** Forty-four male golfers from the Golf Spanish Federation volunteered to take part in this study (age:  $18.0 \pm 7.7$  yr; HCP: -2.7 to 5.1). Subjects undertook specific golf performance assessments in a practice course: Peak Drive Ball Speed (DBS) (8 golf swings with their own driver), approach accuracy (30 shots to 100m target), putt accuracy (30 shots at 1.5m, 3m and 5m to hole). Anthropometric (sitting height, body mass, arm length and span, biacromial width) and strength measurements: 1kg and 2kg swing medicine ball throws (MB), vertical jump (CMJ), bench press (BP) and squat (SQ) progressive loading tests were performed. Peak ball speeds were determined using a Stalker ATS radar gun (Applied Concepts, Inc., USA). A linear velocity transducer (T-Force System, Ergotech, Spain) was used for isoinertial strength tests. Correlation analyses were performed using Pearson's correlation coefficient. **Results** No relationship was found between HCP, approach accuracy, putt accuracy or anthropometrics. Significant correlations ( $p<0.001$ ) were observed between HCP and best ( $r=-0.58$ ) and average ( $r=-0.61$ ) DBS, as well as between DBS and all strength variables, the most significant being: 1RM in SQ ( $r=0.64$ ) and BP ( $r=0.61$ ), mean propulsive power (Sánchez-Medina et al., 2010) with the load that elicits a 1m/s mean velocity in SQ ( $r=0.70$ ) and BP ( $r=0.68$ ). **Discussion** Our results suggest that among young amateur elite golfers (15-26 yr), DBS is more determinant to performance (HCP) than approach or putt accuracy. Hence, an increase in DBS should be considered a priority training goal. This does not mean that approach or putt training is unnecessary, but rather that an increase in these two skills alone is probably not enough to increase overall golf performance. The high correlations found between DBS and upper- and lower-body dynamic strength suggest that performing some kind of traditional resistance training, as well as developing trunk strength by means of MB throws simulating the swing movement (Keogh et al., 2009), may be beneficial to performance (DBS and HCP). However, muscle strength does not seem to be a factor for approach or putt accuracy in golf. **References** Keogh J, Marnewick MC, Maulder PS, Nortje JP, Hume PA, Bradshaw EJ (2009). *J Strength Cond Res*, 23(6), 1841-850. Sánchez-Medina L, Perez CE, González-Badillo JJ (2010). *Int J Sports Med*, 31(2), 123-129. Wells GD, Elmi M, Thomas S (2009). *J Strength Cond Res* 23(3), 741-750.

## BODY MASS LOSS DURING TRAINING AND COMPETITION IN ELITE FUTSAL SPANISH PLAYERS

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**Introduction** It has been proposed that the level of dehydration and noot impair the exercise performance; rather, it is altered to limit the extent to which the osmolality of the brain increases (Sawka and Noakes, 2007), and the level of dehydration over -2% body mass might not impair exercise performance (Sharwood et al., 2004). The aim of this study was to determine the level of body mass loss during training and during competition of elite Futsal players. **Methods** Eleven elite Futsal players (age:  $30.1 \pm 2.8$  yrs, experience:  $11.1 \pm 3.0$  yrs, BMI:  $23.6 \pm 1.5$  yrs) of an elite Spanish soccer team drank water ad libitum in 10 consecutive training sessions (INT) and in a competition (INC). Body mass was measured before (BMBT) and after (BMAT) training and before (BMBC) and after (BMAC) competition. Body mass lost during training (BMLT) and competition (BMLC) was calculated. Comparisons between variables were made by means of a Student's t test for paired data. Statistical significance was set at  $p<0.05$ . **Results** In spite of no significant differences were shown between INT respects to INC ( $584 \pm 232$  vs.  $760 \pm 471$  mL water;  $7.6 \pm 3.0$  vs.  $9.8 \pm 6.0$  mL water·kg<sup>-1</sup>·BM<sup>-1</sup>, respectively), it was shown a decrease for both BMBT respects to BMAT ( $77.2 \pm 6.8$  vs.  $76.8 \pm 6.8$  kg,  $p<0.001$ , respectively) and BMBC respects to BMAC ( $77.9 \pm 8.2$  vs.  $76.1 \pm 7.9$  kg,  $p<0.001$ , respectively). BMLC was higher than BMLT ( $-2.3 \pm 0.8$  vs.  $-0.7 \pm 0.4$  kg,  $p<0.001$ , respectively). **Discussion** There are not studies in literature about BML of Futsal players. In this study, BML was little in training, in competition was over -2%. Edwards et al. (2007) have reported lower BML (0.7 %) associated with lower drink intake (5 mL mL·kg<sup>-1</sup>·BM<sup>-1</sup>) in active soccer players. While some authors have

reported a decrease of performance in elite soccer players associated to a small BML (2%) (Mohr et al., 2010), other authors have suggested that the level of dehydration even up to -11% BM might not impair exercise performance in the fastest endurance finishers that are often among the most dehydrated (Sharwood et al., 2004). Thus, it exists evidence that genetic factors regulating the thirst response might explain this highly individualistic response (Saunders et al., 2006). In conclusion, drinking ad libitum elite Futsal players prevents the BML during training sessions. BML during competition was moderate and may be had a little effect on increase in plasma osmolality and on exercise performance. References Edwards AM, Mann ME, Marfell-Jones MJ, Rankin DM, Noakes TD, Shillington DP. (2007). *Br J Sports Med*, 41(6), 385-391. Saunders CJ, De Milander L, Hew-Butler T, Xenophontos SL, Cariolou MA, Anastas-Siades LC, Noakes TD, Collins M. (2006). *Hum Mol Genet*, 15(20), 2980-2987. Mohr M, Mujika I, Santisteban J, Randers MB, Bischoff R, Solano R, Hewitt A, Zubillaga A, Peltola E, Krstrup P. (2010). *Scand J Med Sci Sports*. 20 (Suppl. 3), 125-132. Sharwood KA, Collins M, Goedecke JH, Wilson G, Noakes TD. (2004). *Br J Sports Med*, 38(6), 718-724.

## PHYSICAL CHARACTERISTICS OF EXPERIENCED AND JUNIOR OPEN WHEEL RACE CAR DRIVERS

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**Introduction** Open-wheel car racing is one of the most exciting sports. The multidimensional activity with great emphasis on physical fitness is comparable to other high performance athletes (Jacobs et al., 2002). Published scientific studies which have investigated the fitness of open-wheel race car drivers (Backman et al., 2005) or long distance car racers (Baur et al., 2006) are rare. To our knowledge, the only available fitness data from Formula One drivers is wrist strength results (Masmejean et al., 1999). The aim of this project was to analyse and compare selected fitness parameters of experienced and junior open-wheel race car drivers. **Methods** 18 open-wheel car drivers were divided into two groups. Experienced drivers (ED) consisted of 5 Formula One, 2 GP2 and 2 Formula 3 athletes whereas the juniors (JD) drove in the Formula Master, Koenig, BMW and Renault racing series. The selected performance tests included hand/foot reaction (HFR) anticipation (HFA), postural stability (PS), cyclic foot speed (CFS), isometric trunk/upper body strength (ITUS), isometric leg strength (ILS), isometric grip strength (IGS) and counter movement jump (CMJ). Group differences were analysed with a Mann Whitney U-test. The alpha level was Bonferroni adjusted to  $p=0.007$ . Results ED were older than JD and higher in CMJ and ILS ( $p=0.007$ ). Tendencies were that ED performed better in IGS ( $p=0.013$ ) and faster in CFS ( $p=0.07$ ). No differences were detected in HFR, HFA, PS, ITUS ( $p=0.1$ ). **Discussion** Motor sport teams now focus more on driver fitness. This could reduce impact injuries in crashes. Our results may indicate that ED drivers have minimally adapted over their racing careers or that JD concentrate more on physical fitness. Baur et al. (2006) reported similar fitness profiles between endurance race car drivers and physically active controls. Backman et al. (2005) showed that open-wheel car drivers differ in neuromuscular performance compared to rally drivers. Neck strength should be tested, but drivers were not prepared to give 100% effort with available isometric tests. This will be a future project. Due to the absence of race specific fitness data open-wheel car drivers would benefit from further research in this field. References Backman J, Häkkinen K, Ylinen J, Häkkinen A, Kyrölainen H. (2005). *J Strength Cond Res*, 19(4), 777-784. Baur H, Mueller S, Hirschi Mueller A, Huber G, Mayer F. (2006). *Br J Sports Med*, 40, 906-911. Jackobs PL, Olvey SE, Johnson BM, Cohn KA. (2002). *Med Sci Sports Excer*, 34(12), 2085-2090. Masmejean EH, Chavane H, Chantegret A, Issermann JJ, Alnot JY. (1999). *Br J Sports Med*, 33, 270-273.

## Oral presentations

### OP-PM49 Physiology: Environmental and Circadian

#### INFLUENCE OF REHYDRATION ON HOMOCYSTEINE LEVELS PLASMA AFTER EXERCISE

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**ImFINE** research group. Department of Health and Human Performance. Universidad Politécnica de Madrid (Spain). **Introduction** Homocysteine (Hcy) has been identified as a cardiovascular risk factor, whenever it reaches high levels in plasma (Boushey CJ, 1995). Some research suggests that exercise increases the levels of Hcy (Gelecek N, 2007). The aim of this study is to check the behavior of Hcy concentrations after submaximal constant exercise in heat environment, with a rehydration protocol after exercise. **Methods** We studied 10 male physically active subjects ( $23.51 \pm 1.84$  years) who performed two stable submaximal tests with a 65%  $\dot{V}O_2$  max intensity on a treadmill with a duration of 40 minutes. During the two tests temperature (30°C) and humidity (60%) were controlled. After the tests the subjects were rehydrated during two hours with water in one test (SA) and Powerade® in the other (SP). The amount of fluid intake was related to weight loss for each of the subjects. Blood samples were taken before (A), immediately after (B), one hour (C) and two hours (D) after completion of each test. We analyzed Hcy, folate and creatine Kinase (CK) levels. A minimum period of two days between both tests was established. Results Plasma Hcy concentrations increased significantly immediately after both SA and SP tests (both  $p < 0.05$ ). We also observed a statistically significant increase in plasma Hcy between A and D points in SA and SP (both  $p < 0.05$ ). During the rehydration process (B, C and D points) no significant differences ( $p > 0.05$ ) in plasma Hcy levels were found. Folate levels were statistically significant from the start of the test (A) up to two hours after completion (D) in the SA ( $p < 0.001$ ) and in the SP ( $p < 0.001$ ). A negative correlation between Hcy levels and folate in all phases of testing was found. We obtained statistically significant differences in baseline levels of CK two hours after completing the effort in the SA ( $p < 0.05$ ), while no statistically significant differences for these values in the SP were found ( $p > 0.05$ ). **Discussion** Although no significant differences were found during rehydration, the plasma Hcy level decreased slightly during this period in both tests. In the case of the sport drink (SP), a tendency of better recovery of plasma Hcy levels after exercise were found, but it did not reach the baseline levels in any case. Rehydration with a sports drink after 2 hours was more effective than hydration with water in order to restore the basal levels of CK after exercise; by contrast, water recovery process was transient. References Boushey, C. J., Beresford, S. A., Omenn, G. S., & Motulsky, A. G. (1995). A quantitative assessment of plasma homocysteine as a risk factor for cardiovascular disease. *JAMA*, 274, 1049-1057. Gelecek, N., Teoman, N., Ozdirenc, M., Pinar, L., Akan, P., Bediz, C., et al. (2007). Influences of acute and chronic aerobic exercise on the plasma homocysteine level. *Ann Nutr Metab*, 51(1), 53-58.

**EXERCISE AS A COUNTERMEASURE TO SLEEPINESS DURING THE NIGHT**

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**Introduction** Higher risk of accident is related to nocturnal activity when circadian clocks and sleep pressure increase sleepiness and decrease neurobehavioral performances. Performances assessed by simple reaction times remain stable for about 16 hr of wakefulness, and decrease thereafter to reach a dramatic impairment about 2-4 hr after the peak of melatonin (Cajochen 1999). At that time the drowsiness that occurs has been identified as the reason behind fatal many individual and industrial accidents (Mitler 1988). Studies have demonstrated the efficiency of some countermeasures such as sleeping (or napping) and the use of alertness-increasing agents (i.e. caffeine) on driving. If alertness is improved immediately following exercise (Tomprowski 2003), during the day, this potential countermeasure has never been study during the night. Furthermore, Matsumoto et al. (Matsumoto 2002) suggested that exercise during an extended period of wakefulness results in an increased risk in human error. **Methods** In this study, standardized bouts of 20 minutes of exercise at 50% of the maximal aerobic capacity of the participant has been compared with those of rest on 4 hours night-time simulator driving performance in 12 young male sedentary healthy volunteers. Exercise was performed at 0:00 and 2:35 and participants had to drive just after each of these exercise, 2 hours from 0:30 to 2:30 and 2 hours from 2:55 to 4:55. Performance criteria on driving simulator were number of inappropriate line crossing (ILC) and standard deviation of the position of the car. Self-rated sleepiness and self-rated fatigue were also recorded before and after driving. **Results** The results show that there are no statistical differences between the 2 conditions either in the number of ILC or in the standard deviation of the position of the car were compared by a one-way analysis of variance for repeated measurements (time\*treatment). An small improvement seems to occur only during the 15 min following the physical activity. **Conclusion** There is no significant improvement of nocturnal driving ability with exercise as a countermeasure to nocturnal sleepiness in young healthy volunteers. Exercise during the night might be less effective than during the day. It is also possible that the intensity of the exercise was too small to produce the expected effect. **References** Cajochen C, Khalsa SB, Wyatt JK, Czeisler CA, Dijk DJ. (1999) *Am J Physiol.* 277, R640-9. Matsumoto Y, Mishima, Satoh K, Shimizu T, Hishikawa Y, (2002) *Neurosci Lett.* 28, 133-6. Mitler MM Carskadon MA, Czeisler CA, Dement WC, Dinges DF, Graeber RC. (1988) *Sleep.* 11, 100-9. Tomporowski, PD (2003) *Acta Psychologica*, 112, 297-324.

**THE EFFECT OF EXERCISE INDUCED DEHYDRATION ON NEUROMUSCULAR PERFORMANCE INDEPENDENT OF CORE TEMPERATURE.**

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Dehydration may decrease neuromuscular performance (NMP) and contribute to a reduction in exercise performance outcomes. While many studies have examined the combined effect of temperature and dehydration on NMP, no studies have examined the effect of dehydration alone, independent of thermal strain. The aim of this study was to determine whether dehydration directly altered neuromuscular drive, independent of hyperthermia. Seven male participants were recruited for the study (mean  $\pm$  SD age  $23 \pm 4$  years, peak power output  $371 \pm 57$  W). Using a counterbalanced design, participants completed two performance trials one week apart. Initial testing involved neuromuscular assessments for maximum voluntary torque (MVT), voluntary activation (VA), EMG and evoked contractile properties. Participants then engaged in a dehydration exercise protocol that reduced body mass by  $\sim 4\%$ . Following this, participants rested for 2 h during which time they either replaced the volume of fluid lost or remained dehydrated. Pre-exercise values for core temperature and heart rate were re-established by the end of the rest period and NMP reassessed. The active dehydration protocol reduced body mass by  $3.8 \pm 0.5\%$ . Body mass was re-established to within  $0.2 \pm 0.6\%$  of pre-exercise values in the rehydration trial. Plasma osmolality following the recovery period was  $297.7 \pm 4.9$  and  $282.1 \pm 3.4$  Osm/l for the dehydration and rehydration trials, respectively ( $P < 0.05$ ). MVT remained unchanged throughout the dehydration and rehydration trials ( $\sim 314.5$  Nm). The VA before exercise was  $\sim 90.7\%$  for both trials and remained relatively unchanged for the dehydration ( $88.7 \pm 6.4\%$ ) and rehydration ( $90.6 \pm 6.2\%$ ) trials. Evoked peak twitch torque (Pt) increased by  $14\%$  ( $P < 0.05$ ) and  $11\%$  ( $P < 0.01$ ) following the recovery period in the dehydration trial. However, the rate of Pt increased by  $19\%$  ( $P < 0.05$ ) following the recovery in the dehydration trial compared with only  $3\%$  in the rehydration trial. These findings demonstrate the resilience of the neuromuscular system to the internal imbalances in homeostasis associated with significant active dehydration.

**PHYSIOLOGICAL RESPONSES TO CONSECUTIVE DAY TREADMILL RUNNING IN TEAM SPORT ATHLETES FOLLOWING ONE NIGHT OF SLEEP DEPRIVATION.**

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(1) School of Sport and Exercise, Massey University, New Zealand (2) School of Human Movement Studies, Charles Sturt University University, Australia (3) Department of Sport and Exercise, University of Auckland, New Zealand **Introduction** We have previously demonstrated that one night of sleep deprivation separating consecutive day bouts of simulated team sport exercise reduced intermittent-sprint performance, muscle glycogen content, recruitment of active muscle and increased perceptual strain when compared to a control night of habitual sleep (Skein et al., in press). The aim of the present study was to describe the physiological responses to graded, constant velocity, treadmill running performed on consecutive days separated by habitual or deprived sleep. **Methods** At  $19 \pm 1$  °C and  $54 \pm 9\%$  relative humidity, ten male team sport athletes (mean values  $\pm$  SD; Age =  $21 \pm 3$  yrs;  $\text{VO}_{2\text{max}} = 57 \pm 5$  ml/kg/min) completed 10-minute stages on a treadmill corresponding to  $60\%$  ( $9.4 \pm 0.5$  km/h),  $70\%$  ( $11.0 \pm 0.6$  km/h) and  $80\%$  ( $12.6 \pm 0.7$  km/h) velocity at  $\text{VO}_{2\text{max}}$  on consecutive days before (Day1) and after (Day2) their habitual ( $8.5 \pm 1.5$  h) or without any sleep (0 h). Measures of heart rate, expired gases, lactate and glucose were taken at the end of each stage and concentrations of bicarbonate, growth hormone, cortisol, C-reactive protein and IL-6 determined before and after the treadmill exercise. **Results** During the graded treadmill stages heart rate, minute ventilation, RER and  $\% \text{VO}_{2\text{max}}$  increased significantly with running velocity (all  $p < 0.001$ ) but values were depressed on Day2 compared to Day1 (all  $p < 0.05$ ) whilst  $\% \text{VO}_{2\text{max}}$  tended to be greater on Day2 ( $p = 0.07$ ); however, no effect of sleep deprivation was observed (all  $p > 0.43$ ). Lactate and glucose increased significantly with running velocity (both  $p < 0.01$ ) but no effects of day or sleep deprivation were observed (all  $p > 0.27$ ). Concentrations of growth hormone (increase) and bicarbonate (decrease) were different following exercise (both  $p < 0.001$ ) and C-reactive protein was higher post-exercise and on Day2 (both  $p < 0.05$ ); however, no effect of sleep deprivation was observed (all  $p > 0.22$ ). No effects of exercise, day or sleep deprivation were observed for cortisol or IL-6 (all  $p > 0.20$ ). **Conclusion** When running at constant velocities between  $\sim 9$  and  $13$  km/h ( $60\% - 80\%$  velocity at  $\text{VO}_{2\text{max}}$ ) it appears that team sport athletes can withstand the stress of one night sleep deprivation without physiological compromise, although the effects of consecutive day running are more pronounced.

References Skein M, Duffield R, Edge J, Short MJ, Mündel T. (in press). Med Sci Sports Exerc DOI: 10.1249/MSS.0b013e31820abc5a Acknowledgements The authors gratefully acknowledge funding received from Sport and Recreation New Zealand and Massey University Research Fund.

### INFLUENCE OF SHIFT-WORK AND LEISURE-TIME PHYSICAL ACTIVITY ON BODY MASS INDEX, APPETITE-RELATED HORMONES AND SLEEP QUALITY

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**Introduction** Shift-work is associated with an increased risk of obesity, yet it is unclear whether this is due to disruption of circadian rhythms or a poor lifestyle of shift-workers (Atkinson et al., 2008). In an effort to tease out the influence of these two factors, we examined the body mass index, appetite-related hormones and sleep characteristics of shift-workers who, uniquely, were higher in terms of leisure-time physical activity (LTPA) than their day-working peers. **Methods** A cross-sectional study was undertaken on 57 male lorry drivers (age: 39.8yrs, SD=6.6), of whom 31 worked irregular shifts and 26 worked the day shift. Participants completed the International Physical Activity Questionnaire (IPAQ long-version) and were assessed for body mass index (BMI). Participants also provided a fasting blood sample for analysis of appetite-related hormones and wore an actigraphy device for seven consecutive days. **Results** Although LTPA was generally low (<150 min/week) in both groups, the irregular shift-workers were more physically active than day-workers (98.5±166.2 min/week vs 23.1±76.0 min/week,  $P=0.0027$ ). Nevertheless, the mean BMI of shift-workers was still 2 kg/m<sup>2</sup> greater than that of day-workers (28.4±3.8 kg/m<sup>2</sup> vs 26.4±3.6 kg/m<sup>2</sup>,  $P=0.0441$ ). Leptin concentration was also higher in shift-workers (5205±4181 pg/ml vs 3179±2413 pg/ml,  $P=0.0443$ ), but this was explained by the differences in BMI, more obese workers having increased leptin concentration ( $P=0.001$ ) along with decreased ghrelin concentration ( $P=0.036$ ) and shorter sleep duration ( $P=0.011$ ). This latter variable was unaffected by LTPA. Nevertheless, higher levels of LTPA were found to be generally associated with shorter sleep latency ( $P=0.042$ ). **Conclusions** Even though the shift workers in our study were more physically active in leisure time, they still had a higher BMI than day-workers. The relationships between BMI and appetite-related hormones indicate that dietary habits are more important than physical activity in moderating the health of this population of shift workers, although the established usefulness of LTPA in improving sleep onset latency is also apparent amongst shift-workers. **Reference** Atkinson G, Fullick S, Grindley C, Maclaren D. (2008). Sports Med, 38(8), 671-685. **Support:** CNPq - 474199/2008-8 and CNPq - 200388/2010-0

### DIURNAL VARIATION IN MELATONIN RESPONSES TO EXERCISE: A SLEEP-CONTROLLED STUDY

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**Introduction** Previously, we have identified several important relationships between the pineal hormone, melatonin (MEL) and exercise (Atkinson et al., 2003). It is emerging that exercise is a synchroniser of human circadian rhythms, possibly via the exercise-related effects on MEL and/or thermoregulation. In support of this hypothesis, we have found that increases in salivary MEL and core body temperature (Tcore), are greater following exercise in the morning compared with the afternoon (Marrin et al., 2011). Nevertheless, prior sleep, which is itself a synchroniser of human circadian rhythms, was not controlled in this previous study. Therefore, we aimed to examine diurnal variation in the MEL and thermoregulatory responses to exercise, whilst controlling the duration of sleep prior to each test. **Methods** Two trials were conducted in a counterbalanced order at 06:30h or 16:30h with sleep duration controlled at 4 h prior to each trial. Nine men (mean±SD age: 27±9y) completed 3 bouts of 10 min cycling at 60% peak power output, interspersed with 10 min rest. Salivary MEL was measured at baseline in bed, after standing, pre exercise and immediately following each 10 min bout of exercise. Tcore and skin (Tskin) temperatures were also measured. Data were analysed using factorial within-subjects general linear models. Within-subjects correlation coefficients between changes in MEL and body temperatures were also calculated (Bland and Altman, 1995). Data are described as mean±SE. **Results** On waking, MEL was 33.5±4.4 pg/ml in morning compared with 4.8±1.2 pg/ml in afternoon (mean difference = 28.7±3.6pg/ml,  $P<0.0005$ ). This diurnal difference decreased to 21-22pg/ml after standing, but there was no further change in MEL during exercise. Baseline Tcore was 37.27±0.11°C at 16:30h compared with 36.82±0.09°C at 06:30h ( $P<0.0005$ ). Exercise increased Tcore and Tskin by similar magnitudes at both times of day. The slope of the Tcore – MEL relationship was similar (3.1-3.6 pg/ml/°C) at both times of day. **Discussion** Our data indicate that the diurnal variation in MEL is robust even when prior sleep is controlled, indicating that control of this pineal hormone is largely endogenously-mediated by the human body clock. We found little change in MEL during an exercise period nor any difference in the MEL-body temperature relationship between morning and afternoon, when prior sleep is controlled, suggesting that the masking effects of sleep and exercise on MEL are interactive. **References** Atkinson G, et al. (2003) Sports Med, 33, 809-831 Bland, J.M., Altman D.J. (1995) BMJ, 310, 446 Marrin K, et al. (2011) Eur J Appl Physiol, In Press.

## Invited symposia

### IS-SH05 A National Initiative to Fund Prevention Research

#### PHYSICAL ACTIVITY IN OLDER ADULTS IN THE UK: SUMMARY OF OUTCOMES FROM PROJECT OPAL

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**Background** Project OPAL (Older People and Active Living) was funded through Phase 1 of the National Prevention Research Initiative. Its primary aim was to describe the physical activity levels and patterns of adults aged 70 and over using accelerometry. Associations with deprivation of area of residence, perceptions of neighbourhood walkability, convenience and attractiveness, objectively assessed physical function, body mass index, pain and mental well-being were also addressed. **Methods** Twelve primary care practices in Bristol were selected by low, medium and high deprivation, and low or high access to amenities as a sampling frame. A total of 240 adults aged 70 to 96 were recruited who were representative of the practice and national distributions of age-related BMI and level of deprivation of area of residence. Measures included 7-day accelerometry (ActigraphGT1M), the Short Physical Performance Battery, a 7-day purposes and mode of journeys log, and a range of questionnaires including the Neighbourhood Quality of Life Survey for Seniors. **Results** The final sample was 125 males (mean age 77.5 yrs) and 115 females (mean age 78.6 yrs). Physical activity levels were very low with males engag-

ing in more steps per day and moderate to vigorous (MVPA) activity than females (Davis et al., in press). Although 47% totalled over 150 minutes of MVPA per week, only 3 participants met UK recommendations because sustained bouts of at least 10 minutes rarely occurred. Lower levels of physical activity were found in areas of higher deprivation, but this was explained by differences in residents' physical function, body mass index, and frequency of journeys away from the home (Fox et al., 2011). Regardless of where people lived or their level of function, those people who managed to get and about more frequently were more active. This effect was strongest for those whose main mode of transport was walking but also for those who relied mainly on their car. Additionally, physical activity was higher in those who reported that they live close to shops and other amenities. Conclusions and implications These low levels of physical activity and associations with physical function suggest that interventions are needed to promote physical activity in order to prevent decline in function and maintain independence. AvoNet, which is a Lifelong Health and Well Being funded collaborative network arose from OPAL work and has been addressing the challenge of intervening and several proposals for programmes of delivery are currently in review. References Davis M et al. (in press). Objectively measured physical activity in a diverse sample of older urban-living UK adults. *Medicine and Science in Sport and Exercise*. Doi: 10.1249/MSS.0b013e3181f36196. Fox KR et al. (2011). Neighbourhood deprivation and physical activity in UK older adults. *Health and Place*. Doi:10.1016/j.healthplace.2011.01.002.

## TRANSLATING ACUTE AND CHRONIC EVIDENCE INTO PRACTICE IN DESIGNING PHYSICAL ACTIVITY INTERVENTIONS FOR SMOKING CESSATION

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Treatments for nicotine addiction have notoriously low success rates, and exercise may increase smoking cessation (Ussher et al, 2008). Interventions have involved both structured exercise and physical activity (PA) counseling with varying reach, acceptability and effectiveness. Surveys have shown that c.22% of smokers use PA as a cessation aid (Everson et al, 2010), and 56% of NHS Stop Smoking Advisors promote PA as an aid (Everson-Hock et al, 2010a), but how best to concurrently promote physical activity and smoking cessation remains a challenge (Everson-Hock et al, 2010b). Counseling approaches can target explicit and implicit processes by which physical activity may help as an aid. Explicitly, PA has been shown, during temporary abstinence, to reduce cravings and withdrawal symptoms, ad lib smoking, and attentional bias to smoking related cues, and neuropsychological processes (Taylor et al, 2007; Janse van Rensburg et al, 2009a; 2009b). Implicitly, PA can minimise the considerable weight gain (ie, c. 5kg after 12 months) during cessation, reduce depression and anxiety and facilitate a shift from a smoker to exerciser identity (all known to be associated with relapse). Examples of recent interventions designed to aid quit attempts, or help reduce smoking, alongside existing treatments, will be presented, within the context of developing complex interventions. As an aid for quitting, an intervention (Walk-2-Quit) will be described and justified that aimed to increase the time that NHS Stop Smoking Service advisors spent on promoting physical activity, during six weekly group discussions, with a self-help guide and pedometers (Taylor et al, 2010). Building on this work, an on-going trial (Exercise Assisted Reduction then Stop) will be briefly described, targeted at 'hard to reach' smokers wishing to cut down, but not quit in the next month. The intervention, involving Health Trainers, will be described and justified, in light of what we have learned from both acute and chronic research, and also developmental applied work funded by an NPRI award. References Everson ES, Taylor AH, Ussher M. (2010). Patient Ed & Counselling, 78, 53–56. Everson-Hock ES, Taylor AH, Ussher M. (2010a). Patient Ed & Counselling, 79, 156–9. Everson-Hock ES, Taylor AH, Ussher M. Faulkner G. (2010b). J of Smoking Cessation, 5, 7–14 Janse van Rensburg K, Taylor AH, Hodgson T, Benattayallah A (2009a). Psychopharmacology, 203, 589–98. Janse van Rensburg, K, Taylor AH, Hodgson T (2009b). Addiction, 104, 1910–1917 Taylor AH, Everson-Hock ES, Ussher M. (2010). BMC Health Service Research, 10: 317. Taylor AH, Ussher M., & Faulkner G. (2007). Addiction, 102, 534–543. Ussher MH, Taylor AH, Faulkner G. (2008). Cochrane Systematic Reviews, (4):CD002295.

## THE ENVIRONMENT AND CHILDREN'S PHYSICAL ACTIVITY: THE PEACH PROJECT

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Introduction: The PEACH project (Personal and Environmental Associations with Children's Health: [www.bris.ac.uk/enhs/peach](http://www.bris.ac.uk/enhs/peach)) is a longitudinal study investigating the environmental and personal determinants of physical activity and eating behaviours in children across the transition from primary to secondary school. A cohort of 1307 final year primary school children was initially recruited from 23 UK primary schools (Year 6: aged 11.0 ± 0.4yrs) and 953 of these were followed up one year later in their first year of secondary school (Year 7: aged 12.0 ± 0.4yrs). Methods: Weekly physical activity was measured by accelerometry (Actigraph GT1M) and children wore a GPS receiver (Garmin Foretrex 201) after school to objectively record activity in different locations. Accelerometer and GPS data were recorded at 10 second epochs and were date and time matched to describe patterns of physical activity when both a GPS and accelerometer record were present (outdoors) and when there was accelerometer data only (indoors). Height (m) was measured with a stadiometer and weight (kg) was measured using digital scales (SECA), with children wearing indoor clothing, and shoes removed. Self-reported determinants of physical activity including perceptions of the environment were measured via a computerised questionnaire. Results: Compared to primary school, levels of active commuting, the proportion of young people consuming 5 portions of fruit and vegetables and the numbers eating breakfast everyday were lower at secondary school. Results of combined GPS and accelerometer data indicate that children gain more activity on their journey to school than in the school playground when they arrive and overall children recorded 41.7 ± 46.1 minutes outdoors between 3.30 pm and 8.30 pm. Children were up to 2.5 times more active outdoors than indoors (1345.8 ± 907.3 vs 508.9 ± 282.9 counts per minute). Children were also 5 times more active outside in green space compared to time spent indoors, but only 2% of monitored time was spent in green space, the majority of their time outside was not spent in green space. There was no gender difference in time spent outdoors. The most consistent determinant of physical activity was 'independent mobility', the reported frequency children were allowed to go to different destinations unsupervised by adults. Combined physical activity and sedentary data also indicated that watching TV or playing computer games for more than 2 hours a day was related to greater psychological difficulties irrespective of how active the children were. Discussion: PEACH is the largest data set to include both objectively measured location and physical activity. It is already providing important evidence that along with the social environment, both the built environment and green space matter for children's physical activity. The transition from primary to secondary school is a pivotal for the decline in activity and diet related health behaviours. The PEACH Project is funded by the National Prevention Research Initiative and the World Cancer Research Fund.

## Invited symposia

### IS-PM07 Clinical Sports Nutrition

#### A CENTRAL ROLE FOR CARNITINE AVAILABILITY IN REGULATING MUSCLE FAT AND CARBOHYDRATE OXIDATION

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UNIVERSITY OF NOTTINGHAM

The body's carnitine pool is confined principally to skeletal muscle, where it regulates mitochondrial fatty acid translocation and ensures maintenance of a viable pool of free co-enzyme A (CoASH) during intense contraction. Oral L-carnitine feeding has been advocated as an ergogenic aid, however L-carnitine feeding per se has no impact on muscle carnitine content, fuel metabolism or exercise performance. We have demonstrated that intra-venous L-carnitine infusion (steady-state plasma [550-600]  $\mu\text{mol.l}^{-1}$ ) under insulin clamp conditions acutely increases muscle total carnitine (TC, by ~15%) in healthy male volunteers when serum insulin concentration is increased above 50 mU.l<sup>-1</sup>. More recently, we have shown this increase in muscle TC content can be achieved by combined carbohydrate and L-carnitine feeding over a 6 month period. Moreover, this increase in TC content reduced pyruvate dehydrogenase complex activation and muscle glycogen utilisation during prolonged low intensity exercise (Wall et al. 2011). Conversely, we have very recently found that muscle TC content can be markedly depleted by blocking renal carnitine retention using mildronate, which had the effect of reducing whole body fat oxidation and increasing muscle glycogen utilisation in a rodent model of obesity (Porter et al. unpublished observation). Collectively these findings point to a central role for carnitine in the regulation of muscle fuel selection at rest and during exercise, which will be discussed in the context of muscle insulin resistance and obesity. References Wall et al. J Physiol. (2011) 589:963-973.

#### DIETARY PROTEIN TO AUGMENT MUSCLE HYPERTROPHY

VAN LOON, L.

MAASTRICHT UNIVERSITY MEDICAL CENTRE

Aging is accompanied by a progressive loss of skeletal muscle mass and strength, leading to the loss of functional capacity and an increased risk of developing chronic metabolic disease. The age-related loss of skeletal muscle mass is attributed to a disruption in the regulation of skeletal muscle protein turnover, resulting in an imbalance between muscle protein synthesis and degradation. As basal (fasting) muscle protein synthesis rates do not seem to differ substantially between the young and elderly, many research groups have started to focus on the muscle protein synthetic response to the main anabolic stimuli, i.e. food intake and physical activity. Recent studies suggest that the muscle protein synthetic response to food intake is blunted in the elderly. The latter is now believed to represent a key factor responsible for the age-related decline in skeletal muscle mass. Physical activity and/or exercise stimulate post-exercise muscle protein accretion in both the young and elderly. However, the latter largely depends on the timed administration of amino acids and/or protein. Prolonged resistance type exercise training represents an effective therapeutic strategy to augment skeletal muscle mass and improve functional performance in the elderly. The latter shows that the ability of the muscle protein synthetic machinery to respond to anabolic stimuli is preserved up to very old age. Though there has been much research on the impact of dietary co-intervention to maximize the impact of exercise training in young athletes, much less work has been performed in the elderly population. Research is warranted to elucidate the interaction between nutrition, exercise, and the skeletal muscle adaptive response at a more advanced age. The latter is needed to define effective strategies that will maximize the impact of exercise intervention to attenuate and/or reverse the loss of muscle mass and function with aging and, as such, support healthy aging.

#### INTERACTION OF DIET AND TRAINING ON EXERCISE RESPONSES: IMPLICATIONS FOR HEALTH AND PERFORMANCE

HAWLEY, J.

RMIT UNIVERSITY

Changes in macronutrient intake rapidly alter the concentration of blood-borne substrates and hormones, causing marked perturbations in the storage profile of skeletal muscle and other insulin-sensitive tissues. In turn, muscle energy status exerts profound effects on resting fuel metabolism and patterns of fuel utilisation during exercise as well as acute regulatory processes underlying gene expression and cell signaling. As such, these nutrient-exercise interactions have the potential to activate or inhibit many biochemical pathways with putative roles in training adaptation. Given that the greatest stimulus to any exercise-induced skeletal muscle adaptation is repeated training bouts, diet alterations for both health- and performance-driven outcomes must be tolerable and robust enough to ultimately cause an augmented adaptation that serves some functional purpose. This talk will provide state-of-the-art information from the results of contemporary human studies that have manipulated substrate availability in the face of endurance- and resistance-based training regimens, and examine the effects on both health and performance outcomes.

## Invited symposia

### IS-BN04 Real Time Monitoring of Sports Performance

#### UBIQUITOUS COMPUTING IN ATHLETICS - MONITORING SPRINT RUNNING

KERWIN, D.1, CHENG, L.2, KUNTZE, G.1, IRWIN, G.1, BEZODIS, I.1, HAILES, S.3, TAN, H.3, WILSON, A.2, KALRA, D.3

1: CARDIFF SCHOOL OF SPORT, UNIVERSITY OF WALES INSTITUTE, CARDIFF (WALES, UK), 2: THE ROYAL VETERINARY COLLEGE (LONDON, UK), 3: UNIVERSITY COLLEGE LONDON (LONDON, UK)

Introduction Performance development in sprint running relies on small groups of athletes working closely with experienced coaches. Direct observation of technique is usually followed by verbal feedback. Video recordings are used sometimes to supplement feedback, and intermittent performance measures, from competitions, and from training data (e.g. 'flying 30s'), are used to monitor progress. Most enhancements arising from technology are provided in one-off sessions, or in the presence of third party specialists. The purpose of this paper is to outline the development and deployment of a self-contained computerised system to support athletics coaching and per-

formance, in which athletes and coaches have become part of a ubiquitous computing network. Methods The primary component of the system is a novel light gate system (Pisa Light Gates, or PLG, Cheng et al, 2010a), used to provide split times and split velocities for multiple athletes running at the same time. PLG comprises banks of photocell beams integrated into an athletics-training arena and operated by coaches from a web enabled hand-held wireless device (i.e. iPod touch). PLG logs split times automatically via an integrated gumstix computer, enabling immediate display to the coach via the hand-held device, and if required, on a large trackside screen. PLG provides a high level of flexibility for data retrieval: the coaches can view the data immediately or interrogate it confidentially via an SQL database using a password protected web interface to review their athletes, or in consultation with an individual sprinter (Cheng et al, 2010b). System evaluation has comprised validity checking of the novel timing beam configuration; and coach and athlete feedback on the operation and use of the data. Results Beam break times were evaluated against criterion 3D kinematic data (CODA) and found to agree to <10 ms. Interview responses from coaches and athletes have been overwhelmingly positive with the flexibility offered by the controller receiving universal acclaim. Discussion The lack of setup time, the ease of use and the ability to time multiple athletes simultaneously have made PLG ideal for its purposes. Importantly the system has been found not to interfere with the coaching process, but rather to enhance it; not to interfere with the athlete's performance but to enrich it; and finally to be easy to control via familiar every day mobile wireless technology. References Cheng L, Tan H, Kuntze G, Bezodis IN, Hailes S, Kerwin DG, Wilson A (2010a). JSET, 224, 167-179. Cheng L, Kuntze G, Tan H, Nguyen D, Roskilly K, Lowe J, Bezodis IN, Austin T, Hailes S, Kerwin DG, Wilson A, Kalra D, (2010). IEEE-SECON. 1-9.

## BETTER TIMES: MONITORING PERFORMANCE IN SWIMMING

SANDERS, R., MCCABE, C., MACHTSIRAS, G., THOW, J., EINARSSON, I.  
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BETTER TIMES: MONITORING PERFORMANCE IN SWIMMING Sanders, R.1, McCabe, C.2, Machtsiras, G.1, Thow, J.1, Einarsson, I. 3 1: CARE, The University of Edinburgh (Edinburgh, Scotland), 2: University of Abertay (Dundee, Scotland), 3: University of Iceland (Reykjavik, Iceland) Introduction The extent to which feedback is valued by swimming coaches is related to how quickly the feedback is available. At the Centre for Aquatics Research and Education (CARE) methods have been developed with the aid of recent technology to return information to swimmers and coaches with quick turnaround times. The purpose of this paper is to describe the methods currently used at CARE to provide information to coaches and swimmers aimed at improving the performance of the swimmer. Methods The following protocols have been developed for providing feedback to swimming coaches and swimmers: 1. Video recording of mid-pool, starts, and turns, using above and below water cameras. The recordings are replayed on a plasma screen on poolside in normal, slow, and stopped motion. Advice of coaches and biomechanists can then be tried immediately by the swimmer and changes observed again in the same session. 2. Simple quantitative analysis is performed using the video data obtained from several camera views. Dartfish software is used to enhance the effectiveness and attractiveness of the reports. In addition to the typical 'race analysis' variables, two-dimensional angles and body positions are quantified enabling assessment of posture and technique. Discussion of the results with coaches, physiotherapists, strength and conditioning specialists, and the CARE biomechanists leads to informed interventions to improve performance. 3. A new method of quantifying glide performance in starts and turns (Naemi, and Sanders, 2008) has been further developed to yield coach friendly software that enables fast feedback (Naemi et al., under review). The efficacy of the system to improve start performance has been established by (Thow et al., under review). 4. Feedback regarding muscle activity could be instructive with respect to teaching a swimmer to relax muscles when they are not required to generate force. However, EMG is rarely used to provide feedback to coaches and swimmers. This is due to the difficulty of collecting EMG from swimmers while swimming. Waterproofing is normally problematic and the time required to prepare the swimmers is excessive. Additionally there is a problem in moving the recording system and the EMG electrode leads with the moving swimmer. However, recent technological advances have enabled the development of a wireless system that is easily waterproofed and quick to set up. References Thow J, Machtsiras G, Sanders RH. Journal of Sports Sciences. Under review. Naemi R, Goodwill S, Aratan S, Haake S, Machtsiras G, Sanders RH. Sports Technology. Under review. Naemi R, Sanders R. (2008). Journal of Biomechanical Engineering, 130(6), 9-16.

## MONITORING SPORTS PERFORMANCE IN VARIOUS SETTINGS – THE MOBILE MOTION ADVISOR

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Introduction The intention of mobile motion assistance is to support athletes (leisure time and elite sport) in their training. A mobile device gathers performance parameter values on the spot and sends them to a server component for further analyses. The classification of the data and generation of (immediate) feedback is based on expert knowledge. Methods A prototype system for monitoring, transmitting and processing sports performance data for the purpose of providing feedback has been developed (cf. Baca et al., 2010). During training, athletes are equipped with a mobile device and wireless sensors communicating via the ANT protocol in order to acquire biomechanical, physiological and other sports specific performance parameters. The measured data is buffered locally and forwarded via Internet to a server. The server provides experts with remote data access, analysis and (partly automated) feedback routines. In this way, experts are able to analyse the athlete's performance and return individual feedback messages from remote locations. Results and Discussion Three use cases comprising application fields of the MMA have already been realised (Preuschl et al., 2010). Our first implementations concern running and mountain biking, two endurance sports. Furthermore, selected weight training machines have been equipped with sensor and communication technology for giving feedback during resistance exercises. The prototype installations of the MMA have been set up for use during physical education activities. Interactive communication technology is thus provided to teachers and students. Characteristic parameters of the performances of a whole class can be supervised continuously. In this way the teachers are able to monitor performance and activity data of a large number of students and may give the students individual feedback. References Baca A, Kornfeind P, Preuschl E, Bichler S, Tampier M, Novatchkov H. (2010) Sensors, 10, 10640-10662. Preuschl E, Baca A, Novatchkov H, Kornfeind P, Bichler S, Boeckskoer M. (2010) Procedia Engineering, 2, 2741-2747.

## Oral presentations

### OP-PM51 Physiology: Methods

#### ANAEROBIC THRESHOLD DETERMINATION IN HEALTHY MALES: CAN NIRS HELP?

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**PURPOSE:** Muscle O<sub>2</sub> extraction (i.e. deoxyHb), as measured non-invasively by near-infrared spectroscopy (NIRS), increases linearly during an incremental cycling exercise, showing a modified slope (deflection point) at 50-70% of VO<sub>2</sub>max. A possible coincidence of this deflection point with anaerobic threshold (AT) has been suggested, yet not univocally demonstrated, by previous studies using different NIRS systems/parameters and AT indexes. We tested the hypothesis that AT can be accurately determined based on quantitative measures of deoxyHb. We compared the NIRS-derived AT (NIRSAT, determined by double linear function fitting) to the first ventilatory threshold (VT1) defined by Wasserman method. **METHODS:** 77 healthy men (age 55±17 yrs - range 20-80; VO<sub>2</sub>max 35.0±9.6 mL•Kg<sup>-1</sup>•min<sup>-1</sup> - range 17-60) performed an incremental test to exhaustion on a cycle ergometer (Sport Excalibur, Lode, The Netherlands). Cardiorespiratory variables were measured BbB using a metabolic cart (Quark b2, Cosmed, Italy). DeoxyHb was monitored non-invasively on the right vastus lateralis with a quantitative, continuous-wave, single-distance NIRS (OxiplexTS, ISS, USA). The possible coincidence of VO<sub>2</sub> and HR values at NIRSAT and at VT1 was tested by: i) paired Student's t-test; ii) Pearson product moment correlation and iii) Bland Altman analysis. **RESULTS:** VO<sub>2</sub> and HR at VT1 were 1917±484 mL•min<sup>-1</sup> (70±8 % VO<sub>2</sub>max) and 124±16 bpm (77±7 % HRmax) respectively. Muscle O<sub>2</sub> extraction increased as a function of exercise intensity up to a deflection point, NIRSAT, at which VO<sub>2</sub> was 1991±533 mL•min<sup>-1</sup> (73±11 %VO<sub>2</sub>max) and HR was 128±19 bpm (80±9 % HRmax). For both VO<sub>2</sub> and HR, the difference from VT1 values was statistically significant (p<0.05), yet practically very small (<4%, i.e. below the minimum detectable difference). VO<sub>2</sub> and HR data at NIRSAT were highly correlated with values at VT1 (0.9 and 0.8 respectively). The Bland Altman analysis confirmed a significant yet very small bias for VO<sub>2</sub> and HR (3.8 mL•Kg<sup>-1</sup>•min<sup>-1</sup> and 4 bpm, respectively) and a small imprecision (0.4 mL•Kg<sup>-1</sup>•min<sup>-1</sup> and 11 bpm respectively). **CONCLUSIONS:** In a large and heterogeneous group of healthy males, a change in muscle O<sub>2</sub> extraction was consistently demonstrated at a VO<sub>2</sub> and HR that are highly correlated and substantially coincident with the values measured at VT1, during an incremental cycling exercise. Therefore, our data confirm the hypothesis that the anaerobic threshold can be accurately determined with a NIRS. Along with the non-invasiveness, NIRS offers the advantage of the independence from irregularity of breathing pattern that can heavily affect ventilatory-based techniques.

#### ULTRASOUND MEASUREMENTS OF MUSCLE STRUCTURAL CHANGES RELATED TO ASYMMETRY IN POWER PRODUCTION DURING GAIT IN CHILDREN WITH CEREBRAL PALSY

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**Introduction** The muscle is a highly adaptive tissue; it responds rapidly to mechanical stress, hormonal activity and changes in the amount and magnitude of activity. The potential for adaptation in muscle derives from the rapid turnover of proteins in the muscle cell [1]. It has been shown in hemiplegic patients that muscle volume was significantly reduced at the involved leg and biarticular muscles were predominantly affected [2]. However it is not known whether structural changes in the muscle tendon unit are directly related to pathological function during gait. Therefore the aim of this study was to measure asymmetry in muscle structure in children with cerebral palsy and to relate those to asymmetries in power production during gait. **Methods** Sixteen children with cerebral palsy GMFCS I and II with asymmetric as well as symmetric involvement of the legs were gait analyzed using an eight camera Vicon system. Muscle structures (tendon, aponeuroses and fiber lengths, as well as angle of pennation) of m. gastrocnemius were determined using ultrasonography (Siemens Andara, 7.5 MHz probe). During the sonography the patients were seated on a chair and the ankle joint was passively moved by the examiner from maximal plantar to maximal dorsiflexion, while the joint angle and position of the ultrasound probe was monitored with the Vicon camera system. Concentric ankle joint energy at push-off was correlated with the muscle structure at average ankle joint angle during stance phase of gait. **Results** Significant correlations with mechanical joint energy at push off were shown for asymmetry in tendon and aponeurosis length (R=-0.56, p=0.003) and the asymmetry in fiber length (R=-0.50, p=0.04). The tendon-aponeurosis and the fiber lengths were on average 4% and 6% shorter at the involved leg. **Discussion** Asymmetries in muscle fiber and tendon-aponeurosis lengths show clinically significant correlation to power production during gait. Consequently impairment during gait can be directly related to structural changes in the muscle tendon unit. For that reason sport therapy might therefore be focused on the structures responsible for asymmetries in power production during gait. **Literature** [1] Ponten et al. 2008, J. Neurol Sci 266:52-56 [2] Lampe et al. 2008, Brain Dev 28:500-506

#### THE EFFECT OF USING A PORTABLE GAS ANALYSIS SYSTEM ON ENERGY EXPENDITURE DURING SUBMAXIMAL EXERCISE

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**Introduction:** The use of portable gas analysis has become widespread in physiological research and training over the last decade. The versatility of such systems allows them to be used in a wide variety of settings, and during a multitude of exercise modes. Despite their extensive use, few studies have investigated the possible additional effects of their carriage on the very physiological responses they are designed to measure (Sparks and Orme 2009). No studies have evaluated the effects of carrying a portable gas analyser during long duration submaximal exercise. The aim of this study was to evaluate the effects of gas analyser carriage over a prolonged period at a variety of submaximal speeds during treadmill exercise. **Method:** Ten male participants of mean (±SD) age 30.8(5.1) y, body mass 79.6(6.9) kg, and height 1.81(0.1) m, completed six randomly ordered laboratory treadmill tests at three different speeds (4, 8 and 12 km/h) for 40 minutes under two conditions. The experimental trials required participants to complete the exercise bout whilst either wearing a portable (P) respiratory gas analysis system (Metamax 3B, Cortex, Germany) in a harness on the chest, or a control trial (L) where the weight of the gas analyser was supported by a harness adjacent to the treadmill. Throughout each exercise trial, respiratory gases, heart rate (HR) and rating of perceived exertion (RPE) were measured. Respiratory gases were used to calculate energy expenditure (EE) via



indirect calorimetry (Frayn 1983). All data were analysed using a General Linear Model ANOVA with Repeated Measures, significance was accepted at  $p < 0.05$ . Results: Total EE was elevated with increased speed ( $p < 0.001$ ). Significantly higher EE occurred during the P trial than during the L trial ( $p = 0.01$ ) only at 12 km/h ( $855.3 \pm 104.3$  and  $801.5 \pm 82.2$  kcal respectively), but not at either of the other speeds ( $220.1 \pm 31.7$ ,  $207.8 \pm 25.8$  and  $569.9 \pm 91.8$ ,  $568.7 \pm 58.6$  kcal for the 4 and 8 km/h speeds in the L and P trials respectively). VO<sub>2</sub> ( $p = 0.03$ ), and breathing rate ( $p = 0.006$ ) were also only elevated in the P trial at 12 km/h. Conclusion: Running at speeds of 12 km/h whilst carrying a portable gas analysis system elevate the energy demands of the activity. Additional EE is caused by an increased oxygen demand and this is met by an increase in breathing rate. The use of portable gas analysis systems may have an adverse impact on the performance of prolonged running due to the increased EE demands. References: Frayn, K. N., (1983), J. Appl. Phys., 55: 628-634. Sparks, S.A., and Orme, D., (2009). Proceedings of the 14th Annual Congress of the ECSS, Oslo, Norway, (24th-27th June 2009, PP-PH08, 354).

## A COMPARISON OF METHODS FOR QUANTIFYING TRAINING LOAD: RELATIONSHIPS BETWEEN MODELLED AND ACTUAL TRAINING RESPONSES

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Introduction Training load (TL) can be described as either the external (i.e. the training completed by the athlete) or internal (i.e. the athlete's response to external TL) stimulus applied to athletes. At present, it is not known which of the TL measures relate best to the training outcomes (i.e. performance, fitness and fatigue). To assess the validity of each of these TL measures, we compared the relationships between predicted and actual performance, fitness and fatigue with both internal and external TL using a mathematical model. Methods A modeling post facto longitudinal research design was used to compare the performance, fitness and fatigue responses in 7 trained runners (age:  $35.8 \pm 9.1$  yr, VO<sub>2</sub>max:  $52.8 \pm 4.1$  ml/kg/min) during a 15 wk period. Each runner completed between 5-10 sessions per week, which were measured via a Polar RS800 heart rate (HR) monitor with foot pod and also perception of effort. The dose for each training session was then calculated using the session-RPE method, Banisters TRIMP and the Training Stress Score (TSS). Weekly running performance (1500-m time trial), fitness (submaximal HR tests) and fatigue (Profile of Mood States) were measured. Busso's [1] model was applied to the training data from each runner using each of the three TL input measures to predict performance, fitness and fatigue. Pearson's correlation assessed the relationships between modelled and the actual weekly performance, fitness and fatigue measures within each runner. Significance was  $p < 0.05$ . Results The 15 wks of training improved 1500-m performance by  $5.4 \pm 2.6\%$ . Modelled performance significantly correlated with actual performance in each subject, with average relationships ( $r$  values) being  $0.74 \pm 0.16$ ,  $0.53 \pm 0.24$  and  $0.18 \pm 0.22$  for the TSS, session-RPE and TRIMP input methods, respectively. Similarly, there were moderate correlations between modelled and actual fitness measures (%HRmax) for the TSS ( $-0.54 \pm 0.28$ ), session-RPE ( $-0.48 \pm 0.26$ ) and TRIMP ( $-0.48 \pm 0.31$ ) methods. Actual and predicted fatigue were not correlated with any input method ( $P < 0.05$ ). Discussion These findings show that the TSS and session-RPE methods are appropriate for quantifying TL when using a systems model to examine training responses in endurance runners. In contrast, care should be taken in using the HR-based to quantify TL. Our findings also show that submaximal HR may be a valid simple fitness test for assessing fitness changes in endurance runners. However, the lack of relationship between the actual and predicted fatigue suggests that the fatigue component of the POMS is insensitive to small changes in trained athletes. References Busso, T. (2003). Med Sci Sports Exercise, 2003. 35: 1188-95

## VALIDITY OF THE BIOHARNESS MONITORING SYSTEM

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1: UNIVERSITY OF HERTFORDSHIRE 2: BRITISH OLYMPIC ASSOCIATION

Introduction: The Bioharness monitoring system may provide physiological information on sporting performance by recording multiple data streams simultaneously during activity. There is limited information on the precision of the Bioharness against established criterion measures. Therefore, this study assessed the validity of the Bioharness monitoring system. Methods: 23 healthy males (age  $21.5 \pm 2.8$  yrs, body mass  $71.4 \pm 7.9$  kg, height  $1.79 \pm 0.07$  m) participated. Heart rate (HR), Breathing Frequency (BF) and Accelerometry (ACC) precision were assessed during a discontinuous incremental (0-12 km.h<sup>-1</sup>) treadmill protocol ( $n = 13$ ). Infra-red skin temperature (ST) was assessed during a 45 minute sub-maximal cycle ergometer test ( $n = 10$ ) on two separate occasions with environmental temperature controlled at  $\sim 20^\circ\text{C}$  and  $\sim 30^\circ\text{C}$ . Posture (P) was assessed by securing devices to a tilt table which were moved through 160° at 10° intervals. Reference precision of measurement devices were; HR: Polar T31 (Polar Electro), BF: Spirometer (Cortex Metalyser), ACC: Oxygen expenditure (Cortex Metalyser), ST: Skin thermistors and data logger (Grant Instruments), P: Goniometer (Leighton Flexometer). Results: There was a strong relationship between predicted and criterion measure for HR ( $r = 0.99$ ,  $p < 0.01$ ), BF ( $r = 0.94$ ,  $p < 0.01$ ), ACC ( $r = 0.97$ ,  $p < 0.01$ ) and P ( $r = 0.99$ ,  $p < 0.01$ ). Limits of Agreement (LOA) identified absolute differences in HR (mean difference  $\pm 95\%$  LOA;  $-0.63 \pm 9.88$  b.min<sup>-1</sup>), BF ( $-0.84 \pm 7.56$  b.min<sup>-1</sup>), P ( $0.06 \pm 2.62^\circ$ ). Less precision was observed with increasing treadmill velocity. LOA increasing at 12 km.h<sup>-1</sup> for HR ( $-1.64 \pm 11.07$  b.min<sup>-1</sup>;  $r = 0.96$ ,  $p < 0.01$ ) and BF ( $1.27 \pm 8.26$  b.min<sup>-1</sup>;  $r = 0.77$ ,  $p < 0.01$ ) respectively. ST established a moderate relationship between the predicted and criterion measure ( $-0.22 \pm 1.98^\circ\text{C}$ ;  $r = 0.76$ ,  $p < 0.01$ ) which was not enhanced when data was analysed specific to the thermal environment (Thermo-neutral  $0.03 \pm 2.93^\circ\text{C}$ ;  $r = 0.43$ ,  $p < 0.01$ ; Hot  $-0.49 \pm 1.44^\circ\text{C}$ ;  $r = 0.75$ ,  $p < 0.01$ ). Discussion: Data suggest that the Bioharness is a valid multivariable monitoring device within ambulatory laboratory testing. Weaker precision of ST data could be linked to the positioning of infra red device relative to the skin surface. High treadmill velocity resulted in increasing errors for HR and BF which could be attributed to EMG and movement artefacts. Comparatively consistent performance of ACC and P may be due to these variables being related to well developed piezoelectric technology, the data from which is not reliant on contact with the skin. Bioharness devices provided by Zephyr Technology

## EFFECT OF ADIPOSE TISSUE THICKNESS ON NIRS-DERIVED PARAMETERS DURING INCREMENTAL EXERCISE

MARWOOD, S.

LIVERPOOL HOPE UNIVERSITY

Marwood, S.1, Roche, D.1, Garrard, M.1,2, Unnithan, V.B.1,3. 1: Sport & Exercise Science Research Team, Liverpool Hope University 2: Physical Activity, Sport & Exercise Science, Leeds Metropolitan University 3: Sport & Exercise Science, Staffordshire University Introduction Adipose tissue thickness (ATT) has the capacity to blunt the signal derived from near-infrared spectroscopy (NIRS) at the site of interrogation. However this has not previously been examined during large muscle mass exercise and a wide range of exercise intensities. Methods 14 healthy male adolescents undertook 2 incremental cycle-exercise tests to the limit of tolerance, starting at 40W with 40W incre-

ments. At rest and during the final 30s of each completed 4min stage, concentrations of tissue total haemoglobin (THb), oxyhaemoglobin (HbO<sub>2</sub>) and deoxyhaemoglobin (HHb) were measured via NIRS (Oxiplex TS) at the vastus lateralis, and pulmonary oxygen uptake (VO<sub>2</sub>) was determined breath-by-breath. Prior to exercise, ATT was determined at the site of interrogation via ultrasound (Bodymetrix BX2000). Individual mean responses of NIRS data during the two trials were correlated with ATT using a bivariate (Pearson) correlation. Results Absolute values of [THb], [HbO<sub>2</sub>] and [Hb] were strongly, inversely correlated ( $P < 0.01$ ) with ATT at rest ( $r = -0.91, -0.88, -0.84$ , respectively). As exercise intensity increased from 40W to 240W, these strong correlations remained for [THb] and [Hb] (range of  $r$ : [THb]  $r = -0.85$  to  $-0.90$ ; [HHb]  $-0.87$  to  $-0.92$ ), but weakened progressively for [HbO<sub>2</sub>] (though remaining significant; range of  $r$ :  $-0.85$  to  $-0.59$ ,  $P < 0.05$ ). When the NIRS data were expressed as the change from rest (deltaNIRS) there were no significant relationships between ATT and [THb], [HbO<sub>2</sub>] and [Hb] at 40W ( $r = -0.46, -0.16, -0.34$ ). As exercise intensity increased however, there was a progressive increase in the strength of the relationship for [HbO<sub>2</sub>] and [Hb] but not for [THb], ( $r = 0.71, -0.90, -0.39$ , respectively at 240W). This pattern of relationship between NIRS / deltaNIRS data and ATT remained when the NIRS data were corrected for VO<sub>2</sub> / deltaVO<sub>2</sub>. Discussion The strong relationship between absolute NIRS-derived data and ATT indicates a reduction in the interrogative depth of NIR light as ATT increases. Comparisons of absolute NIRS-derived data between separate groups should therefore be treated with caution, particularly if differences exist in the ATT. Recalculating the [HbO<sub>2</sub>] and [HHb] data as the change from rest reduced the impact of ATT at low, but not high, exercise intensities, indicating a blunting of the maximal detectable oxy- and deoxygenation with increasing ATT. If source-detector distance is fixed (and relatively small), it may be prudent to consider only those subjects with the lowest ATT as participants in a study.

# Friday, July 8th, 2011

## 08:30 - 10:00

### Invited symposia

#### IS-PM08 JSPFSM Exchange Symposium:

#### Health benefits of physical activity - Brain and metabolic perspectives

#### AEROBIC FITNESS AND BRAIN HEALTH IN PREADOLESCENT CHILDREN

KAMIJO, K.1.2, PONTIFEX, M.B.2, O'LEARY, K.C.2, SCUDDER, M.R.2, WU, C.2, CASTELLI, D.M.3, HILLMAN, C.H.2

1: JSPS (TOKYO, JAPAN), 2: UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN (USA), 3: UNIVERSITY OF TEXAS AT AUSTIN (USA)

**Introduction** Today, children in industrialized nations have become more sedentary and less fit, which is related to increases in the prevalence of obesity and several chronic diseases such as cardiovascular diseases and type-2 diabetes. Recent neuroelectric studies using event-related brain potentials (ERPs) in our laboratory have suggested that aerobic fitness is associated with not only chronic diseases prevention, but also brain health and cognition in preadolescent children (Hillman et al., 2005, 2009; Pontifex et al., in press). However, these ERP studies have mainly employed cross-sectional designs. This study aimed to better establish a causal link between aerobic fitness and changes in brain health and cognition in preadolescent children using a randomized control design. **Methods** Previously sedentary children, aged 7-9 years, participated in a 9-month randomized control trial in which they were assigned to either an after-school physical activity program or a waitlist control group. Participants performed tasks, which manipulated cognitive control requirements including inhibition, working memory, and cognitive flexibility. During these tasks, task performance and ERPs such as the P3 component and contingent negative variation (CNV) were assessed. **Results** Overall, increases in aerobic fitness resulting from the physical activity intervention led to improvements in task performance, larger P3 amplitudes, and larger CNV amplitudes, with no such effect observed for the waitlist control group. Further, disproportionately greater effects of the physical activity intervention were observed during task conditions requiring the upregulation of cognitive control. **Discussion** These findings suggest that regular physical activity leading to increases in aerobic fitness results in more effective attentional allocation (larger P3) and cognitive preparation (larger CNV), which in turn may underlie the production of superior task performance. The disproportionate effect of the physical activity intervention based on the cognitive control requirements imply that physical activity may improve the effectiveness of neural networks including the prefrontal cortex, which show protracted maturation. This study suggests that regular physical activity is associated with brain health and cognition and may assume a crucial role of cognitive development in preadolescent children. **References** Hillman CH, Buck SM, Themanson JR, Pontifex MB, Castelli DM. (2009). *Dev Psychol*, 45, 114-129. Hillman CH, Castelli DM, Buck SM. (2005). *Med Sci Sports Exerc*, 37, 1967-1974. Pontifex MB, Raine LB, Johnson CR, Chaddock L, Voss MW, Cohen NJ, Kramer AF, Hillman CH. (in press). *J Cogn Neurosci*.

#### IN VIVO AND IN VITRO ANALYSES OF EXERCISE-INDUCIBLE FACTORS TO ACTIVATE LIPOLYSIS IN ADIPOCYTES

HASHIMOTO, T.

RITSUMEIKAN UNIVERSITY

Physiological strategies such as exercise training (ET) aimed toward fat loss by active lipolysis in adipocytes and fatty acid (FA) oxidation in muscles (i.e. fat mobilization) have become of great therapeutic interest against metabolic disorders. However, molecular mechanisms underlying augmented capacity of active lipolysis induced by ET are not clear. Lipid-associated proteins (LAP) such as perilipin (PLIN), hormone sensitive lipase (HSL), adipose triglyceride lipase (ATGL) and its co-activator CGI-58, are supposed to play important roles in regulating fat storage and mobilization, by interacting with each other. Additionally, it is possible that the mitochondria have a pivotal role in not only oxidative capacity in muscles but also lipolysis in white adipose tissue, because deficiency of mitochondrial respiration decreased lipolysis. **PURPOSE:** In this study, we examined the effects of ET on the expressions of LAP and mitochondria-related proteins in diet-induced obese (DIO) rats. Furthermore, we assessed putative factors induced by ET to activate lipolysis in differentiated 3T3-L1 adipocytes. **METHODS:** DIO Wistar male rats (20 wk) were divided into sedentary control group (SED, n=7) and exercise training group (EX, n=7). Treadmill running (30 m/min, 1 hr/day, 5 days/wk) was conducted for 6 wk in EX. Epididymal fat (Epi) was dissected and used for protein analyses. 3T3-L1 adipocytes were incubated with media containing 10  $\mu$ M H<sub>2</sub>O<sub>2</sub>, 10 mM lactate, 5 mM caffeine, 2 mM AICAR, or 100  $\mu$ M SNAP (NO donor) for 16 hr, or 1 mM H<sub>2</sub>O<sub>2</sub> for 15 min, followed by the incubation with normal media for up to 24 hr total. Protein expressions were analyzed by Western blotting. Lipolytic activity was biochemically analyzed by glycerol and FA release into media in response to  $\beta$ -adrenergic stimulation in 3T3-L1 cells. **RESULTS:** Epi decreased by 20% in EX as compared to SED. The expression of PLIN, HSL, ATGL, and CGI-58 in EX Epi increased 1.8~2.7 fold as compared to SED. The expression of PPAR $\gamma$  coactivator-1 $\alpha$  (PGC-1 $\alpha$ ) and cytochrome c oxidase (COX) in EX Epi increased 4.0 and 1.9 fold as compared to SED, respectively. In 3T3-L1 cells, the expression of HSL and CGI-58 in any condition (e.g. lactate) increased more than 1.5 fold as compared to control. Furthermore, lactate or caffeine increased 2.3 or 2.2 fold in PGC-1 $\alpha$  expression, respectively, and 10  $\mu$ M or 1 mM H<sub>2</sub>O<sub>2</sub> increased 1.8 or 2.1 fold in COX expression, respectively, as compared to control. Glycerol release was significantly increased by lactate, caffeine, or SNAP incubation. FA release was significantly increased by 1 mM H<sub>2</sub>O<sub>2</sub>, caffeine, or AICAR incubation. **CONCLUSION:** The results suggest the beneficial effects of ET on fat loss through the increases in LAP and mitochondrial biogenesis. Furthermore, it is plausible that ROS, lactate, calcium signaling, AMPK, and NO are potential exercise-inducible factors to activate lipolysis in adipocytes.

**SIGNIFICANCE OF NON-EXERCISE ACTIVITY THERMOGENESIS ON BODY WEIGHT REGULATION**

OHKAWARA, K.

NATIONAL INSTITUTE OF HEALTH AND NUTRITION

It is reported that well-controlled supervised exercise intervention resulted in individual variability for the amount of body fat reduction (Donnelly et al., 2005). This phenomenon may be caused from decreasing physical activity and increasing energy intake after exercise. Nonexercise activity thermogenesis (NEAT) may be associated with compensation of energy expenditure (EE) through a day, and also be an important factor to body weight regulation (Levine et al., 1999). However, the amount of NEAT is difficult to measure in free-living conditions. Study 1: Physical activity level (PAL) was measured in eleven adult men by different protocols in 24-hour calorimeter stays: high-frequency moderate-activity day (M-day) and high-frequency vigorous-activity day (V-day) (Ohkawara et al., 2008). On the other hand, forty-one adults measured PAL in daily living conditions using doubly-labelled water method. In both experiments, step counts per day were also measured by an accelerometer. Study 2: 1) Twenty one Japanese obese men performed 90-min exercise sessions on 3 days per week for 12 weeks. 2) Hundred twenty nine Japanese obese women participated in a randomized controlled trial aimed at studying the effects of group-based support on weight loss. Total physical activity (PA) was measured using a triaxial accelerometer, which automatically classifies time associated with household and locomotive activities (Ohkawara et al., 2010). Study 1: PAL and step counts were  $1.82 \pm 0.14$  and  $29588 \pm 1126$  steps/d (M-day), and  $1.74 \pm 0.15$  and  $23755 \pm 1038$  steps/d (V-day), respectively. In daily living conditions, PAL and step counts were  $1.73 \pm 0.15$  and  $10022 \pm 2605$  steps/d. Study 2: In the exercise intervention, the amount of household activity remained unchanged but locomotive activity significantly increased in nonexercise days through the intervention period. There was a significant negative association between the change in PA during nonexercise days and the change in body weight. In group-based support intervention, there was a significant negative association between the change in body weight and the change in amount of above moderate-intensity locomotive activity and between the change in body weight and the change in amount of low-intensity household activity. The results from study 1 suggest that nonlocomotive activities substantially contribute to maintain higher PAL in daily living in both of sex. The results from study 2 suggest that 1) increased total PA induced by locomotive activity contributes to weight reduction in men, and 2) both of low-intensity household and moderate-intensity locomotive activities contribute to weight reduction in women. Therefore, NEAT could play an important role in body weight regulation. References Donnelly JE et al. (2005). *Exerc Sport Sci Rev*, 33, 169-174. Levine JA et al. (1999). *Science*, 8, 212-214 Ohkawara K et al. (2008). *Am J Clin Nutr*, 87, 1268-1276 Ohkawara K et al. (2010). *Br J Nutr*, in press

**Invited symposia****IS-BN05 Neuroscience of imitation and observational learning****PHYSICAL AND OBSERVATIONAL LEARNING IN THE HUMAN BRAIN AND BEHAVIOUR**

CROSS, E.1, HAMILTON, A.F.C.2, GRAFTON, S.T.3

(1) RADBOLD UNIVERSITY NIJMEGEN, THE NETHERLANDS; (2) UNIVERSITY OF NOTTINGHAM, UK; (3) UNIVERSITY OF CALIFORNIA SANTA BARBARA

**Introduction** When learning any new skill, from dancing the tango to rock climbing, we benefit from physical practice, but watching others perform or learn the same skill can also positively impact new skill acquisition (Hodges et al., 2007). More recently, neuroscientists have turned their attention to the neural underpinnings of physical and observational learning, to explore points of overlap and divergence between both approaches (Cross et al., 2009; Frey and Gerry, 2006). In one such study, we demonstrated that specific components of the human mirror neuron system (MNS; brain regions active during action execution and observation), are modulated in a similar manner by physical and observational learning of simple dance sequences (Cross et al., 2009). In the present study, we aimed to extend these findings by exploring the brain and behavioural components of observational learning of knot tying from non-expert models. **Methods** Participants were assigned a training partner, and practiced tying one group of knots ("tied" condition), and watched their partner tie different knots ("watched" condition) across 5 days. fMRI was obtained prior to and immediately following the week of training while participants performed a knot-matching task. **Results** Functional MRI data indicated that after training, the same parietal and premotor components of the MNS responded when viewing images of knots from the tied and watched conditions compared to knots that were untrained. Activity in these areas represents the neural overlap of observing and physically embodying an action. This is further supported by behavioral data from a post-scanning test where participants tied knots from all three training groups. **Discussion** The neuroimaging data demonstrate the emergence of action resonance processes based on observational learning without concurrent physical practice. These findings also lend further support to the notion that the MNS is modulated by physical and observational practice in a similar manner. Moreover, learning by observing a non-expert model appears to be beneficial in a similar way as learning from an expert model. Cross ES, Kraemer DJ, Hamilton AF, Kelley WM, Grafton ST. (2009): Sensitivity of the action observation network to physical and observational learning. *Cereb Cortex* 19(2):315-26. Frey SH, Gerry VE. (2006): Modulation of neural activity during observational learning of actions and their sequential orders. *J Neurosci* 26(51):13194-201. Hodges NJ, Williams AM, Hayes SJ, Breslin G. (2007): What is modeled during observational learning? *J Sports Sci* 25(5):531-45.

**DIFFERENT PROCESSES UNDERPIN MOTOR LEARNING FROM PHYSICAL PRACTICE AND ACTION-OBSERVATION**

HAYES, S.

LIVERPOOL JOHN MOORES UNIVERSITY

Different processes underpin motor learning from physical practice and action-observation Hayes, S. J., 1 Andrew, M., Elliott, D., 1, 2 and Bennett, S. J. 1 Liverpool John Moores University; 2 McMaster University **Introduction** It has recently been suggested that a lack of motor reafterence during action-observation leads to different learning effects compared to physical practice, and indicates the underpinning processes are different (Ong & Hodges, 2010). However, to further examine the contribution of motor reafterence in action-observation, it is necessary to determine whether there is transfer having practiced or observed a task to the same or opposite effector, and the same or different spatial-sequence. Data from intermanual transfer experiments show transfer to an untrained effector is related to cross-communication between the two hemispheres via supplementary motor area (SMA; Perez et al., 2007). The information processed in SMA is sensory motor reafterence. We predict that transfer to a different spatial-sequence with an opposite effector that recruits homo-

logous muscle groups will be possible after physical practice, but not action-observation because no sensory motor reafference is available during the intervention. Method Thirty-three participants provided consent and were divided into 3 groups: physical practice (PP;  $n=11$ ), action-observation (AO;  $n=11$ ) and control (CTL;  $n=11$ ). After a pre-test (5 trials), the PP group were yoked to AO group, and acted as models whilst practising (60 trials) a spatial-sequence task with their right hand. The CTL group observed a blank screen. All participants performed a post-test (5 trials) and three transfer tests (3 x 5 trials). Transfer 1 involved the right effector and different spatial-sequence (non-homologous muscles); Transfer 2 involved the left effector and same spatial-sequence (non-homologous muscles); Transfer 3 involved the left effector and different spatial-sequence (homologous muscles). Results Compared to controls, PP and AO were more accurate at learning relative ( $p<0.05$ ) and absolute ( $p<0.05$ ) timing. The transfer data for absolute timing revealed that PP and AO were more accurate than CTL in Transfer 1, 2 and 3 ( $p<0.05$ ). For relative timing, PP and AO were more accurate than CTL in Transfer 1. There was no difference between the groups in Transfer 2 ( $p>0.05$ ), whereas in Transfer 3 the PP were more accurate than AO and CTL ( $p<0.05$ ). Discussion These data demonstrate that observational learning facilitates the acquisition and transfer of relative and absolute timing. Yet, intermanual transfer to a condition that recruits homologous muscles is only possible after physical practice. These findings suggest that action-observation recruits similar, but not exact, motor processes as those engaged in physical practice. The role of the mirror system is undoubtedly part of observational learning (Cross et al. 2009), but the reduced role of SMA in action-observation (Zentgraf et al., 2005) attenuates the necessary neural processing that support intermanual transfer.

### THE INFLUENCE OF GOALS ON IMITATION IN ADULTS WITH AUTISM

GOWEN, E., WILD, K., POLIAKOFF, E.  
MANCHESTER UNIVERSITY

Symposium: Neuroscience of imitation and observational learning (Speaker 3) The influence of goals on imitation in adults with autism Gowen.E1, Wild.K1 and Poliakoff.E2 1 Faculty of Life Sciences, University of Manchester; 2 Psychological Sciences, University of Manchester Introduction Voluntary imitation refers to the situation where we intentionally copy another person's actions and is thought to rely on mirror neurons that are active during both observation and execution of an action. Evidence indicates that imitation is affected by the presence or absence of goals (Bekkering et al., 2000). The dual route theory proposes that goal-less actions are imitated via a direct route which maps visual information onto one's own motor system, whereas actions that contain goals are processed via an indirect route that uses stored representations (Rumiati & Tessari, 2002). As imitation and mirror neurons are thought to be important for social understanding it has been proposed that autistic people who are characterised by difficulties with social cognition may have a mirror neuron deficit. In such a case, one would expect autistic individuals to show impaired imitation. However, recent evidence suggests that impairments may only be present during imitation of goal-less actions, suggesting a specific deficit of the direct pathway (Hamilton et al., 2007). Methods The current work took a quantitative approach to investigate whether autistic people were more impaired at imitation of goal-less compared to goal directed actions. Sixteen adult autistic and matched control participants imitated hand actions of different speeds while their own hand movements were recorded using Polhemus tracking equipment. Imitation ability was compared between goal-less and goal directed conditions. Results In contrast to the control group, the autistic group failed to modulate the speed of their movements in the goal-less imitation condition. However, performance was similar for both groups in the goal directed condition, suggesting a selective impairment of goal-less imitation. Discussion These findings highlight that not all aspects of imitation are impaired in autistic individuals, but that imitation of goal-less actions via the direct route of imitation is more affected. This work, together with other recent findings (Hamilton et al., 2007; Dinstein et al., 2010) suggests that the role of mirror neurons in autism needs further refinement. References Bekkering et al., (2000). The Quarterly Journal of Experimental Psychology, 53A, 153–164. Dinstein et al., (2010) Neuron. 2010 May 13;66(3):461-9. Hamilton et al., (2007) Neuropsychologia 45 (2007) 1859–1868 Rumiati & Tessari, A. (2002). Experimental Brain Research, 142, 425–433.

### THE ROLE OF PREFRONTAL CORTEX IN IMITATION AND OBSERVATIONAL LEARNING

VOGT, S., HIGUCHI, S.  
LANCASTER UNIVERSITY

In Symposium: Neuroscience of imitation and observational learning (Speaker 4) Introduction Learning a new skill from a model is not easy. Although the metaphor of an action mirroring system in the human brain might suggest otherwise, imitation learning likely shares aspects with other forms of motor learning (Vogt & Thomaschke, 2007). In previous work (Vogt et al., 2007), we have studied the brain regions involved in the learning of novel hand postures (guitar chords). In addition to the parieto-frontal 'mirror' system (PFMC, Rizzolatti & Sinigaglia, 2010), we found the dorsolateral prefrontal cortex (DLPFC) activated, which is typically involved in the early stages of motor learning. This indicates that the PFMC is not sufficient for learning novel skills and that higher-order, supervisory processes are involved in imitation learning. The main hypotheses of the present study were (1) that DLPFC would be involved in imitation learning in a 'fast' imitation task with minimal requirements to maintain information in working memory, and (2) that learning by observing-only also involves both the DLPFC and PFMC, and not only the PFMC as suggested by earlier studies (Frey & Gerry, 2006; Cross et al., 2009). Methods These were similar to the methods in Vogt et al. (2007), except that we used a 3 Tesla Siemens scanner and a substantially faster paradigm where participants responded to action pictures within the 3 s presentation period. They had practised one set of chords by observation+execution (OEP), and another set by observation-only (OP). In addition, our study is the first to contrast activations during both observation and imitation of actions that had been previously practised by either OP and OEP. Results During imitative execution, the DLPFC and PFMC were strongly activated after the first practice session, confirming hypothesis 1. Further, OP-actions were associated with stronger activations than OEP-actions, which reflected that the OP actions were less well practised and were performed more slowly than the OEP actions. During action observation, only the PFMC plus occipital cortex were activated. However, a correlation analysis across subjects between the functional activations and the benefit that each participant obtained by OP indicated that left inferior parietal cortex (Frey & Gerry, 2006) and bilateral DLPFC were significantly correlated with the behavioural data, confirming hypothesis 2. Discussion The results confirm our hypotheses. However, we only found marginal differences between OEP and OP actions during action observation, which is likely due to the common OP-component in both practice conditions. References Cross E. S., et al. (2009). Cerebral Cortex, 19, 315-326. Frey S. H., Gerry V. E. (2006). J Neurosci, 26, 13194-13201. Rizzolatti G., Sinigaglia C. (2010). Nat Rev Neurosci, 11, 264-274. Vogt S., et al. (2007). Neurolmage, 37, 1371-1383. Vogt S., Thomaschke R. (2007). J Sports Sci, 25, 497-517.

## Invited symposia

### IS-SH06 Migration and Ethnicity in Physical Activity and Sport

#### BORDER CROSSINGS: MAKING SENSE OF MIGRATION AND SPORT

MAGUIRE, J.

LOUGHBOROUGH UNIVERSITY

Several dimensions and issues characterize the study of migration and sport. These include: first, which sports are most involved, why have they been so affected and what structural or cultural changes have thus occurred in those sports and in the societies in which they are located?; second, what are the patterns of global movement and how and why have they developed in this manner?; third, what has been the impact of and on fans in their own migration as 'tourists' or as part of a diaspora, and their perception of the sports they consume; fourth, what has been the impact on 'host' and 'donor' countries more broadly?; fifth, why do 'professional' athletes become labour migrants, how is this process contoured and shaped and what do they experience along their journey; sixth, in what ways does such migration reflect the movement of highly skilled workers more generally; and seventh, what implications are there for sport policy and for the domestic and foreign policies of nation-states more broadly? With the deregulation of the global economy, the blurring of national sovereignty and boundaries, the emergence of 'world class' firms and the rebranding of sport production, the recruitment of elite talent has been deemed essential by the new breed of owners of sport franchises – wealthy entrepreneurs or heavily indebted consortia – from North America, the Middle East or Asia. This recruitment of talent has been viewed as necessary to enable the 'firm' to compete 'on the field' but also 'in the field' – to seek to win but also to enable the 'brand' to have world class status and marketability in the global economy. Hence the recruitment of the 'highly skilled'. Here, then, some observations and suggestions will be offered that illuminate this dimension of global sport and some possible lines of enquiry will be highlighted.

#### SPORT IN MIGRANT COMMUNITIES

PFISTER, G.

UNIVERSITY OF COPENHAGEN

Migrants from non-Western countries are under-represented among the physically active population, a fact which is often explained by religion. This general statement about physical culture in migrant communities obscures the diversity of life styles among migrants, which depend, among other things, on gender, age, social class and ethnic background. In this paper I will provide an overview of existing information about the sport (for all) participation of various migrant groups, using the situations in Denmark and Germany as examples. A focus will be placed on the interrelations between sporting activities and demographic variables, social and ecological environments, countries of origin and impacts of gendered body and movement cultures. Sources will be statistics of sports organisations, population surveys and scientific studies. A main focus will be on suggesting potential explanations for the various ways migrants deal with Western sporting habits and physical cultures. Pierre Bourdieu's approach to habitus and body capital, as well as Judith Whitehead's concept of physical literacy, will provide a theoretical frame for discussing and understanding the appropriation or rejection of Western body cultures by various migrant groups.

#### IDENTITY, DIASPORA AND RELIGION: INTERNATIONAL CASE STUDIES ON MUSLIM WOMEN IN SPORT

BENN, T.,

UNIVERSITY OF BIRMINGHAM

The aim of the presentation is to increase awareness of ways in which Muslim women manage their identity in terms of religion and sport participation. It matters because Muslim women are often perceived as the most marginalised and oppressed group in the sporting field (Hargreaves 2000). This can be related to traditional, cultural expectations of women as well as religious requirements for body modesty, which can affect preferences for dress codes and single sex environments for women's participation. Situations are particularly complex in diaspora communities where groups seek ways to sustain identities connected to cultural heritage, while trying to fit into the host society in which they form a minority group (Dagkas and Benn 2006). Using constructionist identity and body theories, a comparison of findings from empirical case studies on Muslim women and sport are explored. The outcomes indicate the need for greater knowledge, awareness and flexibility of teachers, coaches, researchers and policy-makers as they increasingly meet values and beliefs different to their own. Situation specific solutions and ways of bridging gaps between policy-makers and participants need to be pursued to improve the inclusion of Muslim women in sport. Currently two international approaches are being used to achieve the same goal for inclusion with regard to this issue: 'Accept and Respect' and 'Atlanta+'. They represent divergent paths based on different worldviews and illustrate the contested nature of universals regarding fundamental human rights to sport, gender equality and religion.

## Oral presentations

### OP-BN09 Vibration and Injury

#### RELATIONSHIPS BETWEEN FOOT TYPE AND DYNAMIC REARFOOT MOTION IN BAREFOOT AND SHOD GAIT

CHUTER, V., SMITH, R.

UNIVERSITY OF NEWCASTLE, UNIVERSITY OF SYDNEY

Background The Foot Posture Index (FPI) provides an easily applicable, validated method for quantifying static foot position and has recently been demonstrated to be a strong predictor of dynamic rearfoot motion in a barefoot condition (Redmond 2006, Chuter, 2010). Footwear has been demonstrated to alter foot mechanics during walking gait when compared with a barefoot condition (De Wit et al., 2000). This study aimed to compare the strength of relationship between dynamic rearfoot motion and FPI scores in shod and unshod gait. Methods Thirty-two participants were recruited with equal numbers of pronated and normal foot types as classified by FPI score. Three dimensional rearfoot motion in a barefoot and shod condition was collected for each of the participants and dynamic maximum

rearfoot eversion correlated with total FPI score across all participants and within the normal and pronated foot types. The capacity for the total FPI score to predict maximum frontal plane motion of the rearfoot in each condition was investigated. Results Overall, correlation between total FPI score and maximum rearfoot eversion in the barefoot condition was strongly positive ( $r=0.88$ ). Correlations performed on data subsets in the barefoot condition demonstrated a pronated foot type (FPI +5 to +9) and maximum rearfoot eversion angle (MaxEv) was more strongly positively correlated, ( $r=0.59$ ,  $p<0.05$ ), than the normal foot type and maximum rearfoot eversion ( $r=0.56$ ,  $p<0.05$ ). In the shod group, correlations between the FPI score and MaxEv during gait for all participants was 0.56 ( $p<0.05$ ). Correlation between FPI score and MaxEv in the pronated foot type was less strong compared with a normal foot type ( $r=0.49$   $p=0.05$  and  $r=0.56$ ,  $p<0.01$  respectively). Linear regression analysis demonstrated the FPI score had greater predictive capacity for MaxEv in the barefoot condition (adjusted  $r^2=0.80$ ,  $p<0.05$ ) compared with the shod condition (adjusted  $r^2=0.29$ ,  $p=NS$ ). Conclusions The results of this study suggest the FPI has good predictive ability for an aspect of dynamic rearfoot function in barefoot gait, allowing classification by functional foot type. However, the strength of relationship between FPI score and frontal plane rearfoot motion in shod gait is greatly reduced and this needs to be considered prior to application of this clinical assessment tool. Chuter, V. 2010. J Foot Ankle Res, 3 (9). De Wit, B., de Clercq, D. and Aerts, P. (2000). J of Biomech, 33: 269-78 Redmond, A.C., Crosbie, J., Ouvrier, R.A. (2006). Clin Biomech, 21(1): 89-98.

### NO LONG TERM EFFECTS OF PROPHYLACTIC ANKLE STABILIZERS!

ALT, W., STROHMAIER, K., HELLMANN, N., REULE, C.

UNIVERSITY OF STUTTGART

**Introduction** Effective prevention of sports injuries requires understanding of aetiology and risk factors and development and evaluation of preventive measures. The effectiveness of prophylactic ankle stabilizers (PAS), e.g. bracing or taping, has been proved statistically (Dizon et al. 2009). In biomechanical studies the neuromuscular and mechanical effects of PAS have been investigated (Alt et al., 1999). Little is known about long-term effects of PAS and sometimes atrophy effects are supposed. In this study we investigated long term neuromuscular effects of PAS in male players of team sports before and after 6 months. **Methods** 58 male athletes have been randomized assigned into an intervention (IG) or control group (CG). Athletes with history of ankle or knee injuries or regular usage of PAS during the last 6 months have been excluded. Athletes of the IG selected one of three different ankle stabilizers and were instructed to use it only during every training session and game for the next six months. Functional biomechanical testing included four conditions: treadmill (Zebris FDM-T, Germany) gait (5 km/h) and running (10 km/h); a series of drop jumps; static injury simulation by tilt platform; postural sway by single leg stance (GKS1000, Germany). Neuromuscular activation of lower leg muscles has been evaluated by surface EMG (Noraxon Telemyo 2400 T G2). All methods have been used and validated in previous studies. A pre-post ratio has been calculated. Injuries have been recorded by phone calls weekly. **Results** There was 50% fluctuation of subjects in both groups. Thus, a non-parametric test has been performed and revealed no significant difference between pre – post measurements for all four conditions. The pre-post ratio of neuromuscular activation patterns during gait & running, drop jumps, simulated ankle injury and single leg stance did not differ and was not different between groups. The absolute number of ankle injuries in the PAS group was 6 and 7 in the control group. However, four injured athletes of the IG did not use the ankle stabilizer during the injury and the remaining two suffered from severe contact injuries. **Discussion** Effects of long term use of PAS are still unclear and the rare findings are not consistent. In this study no neuromuscular effects during functional testing could be found after 6 months in a group of male team sport athletes. Hence, it might be suggested to use PAS in combination with additional sensorimotor training in order to compensate for the potential of other postulated negative effects. Alt, W., Lohrer, H., & Gollhofer, A. (1999). Functional Properties of adhesive Ankle Taping. Neuromuscular and Mechanical Effects before and after Exercise. Foot & Ankle International, 20, 238-245. Dizon, J. M. & Reyes, J. J. (2009). A systematic review on the effectiveness of external ankle supports in the prevention of inversion ankle sprains among elite and recreational players. J Sci Med Sport.

### REAL AND SHAM WHOLE BODY MECHANICAL VIBRATION MODULATES SPINAL EXCITABILITY IN HEALTHY YOUNG ADULTS.

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**REAL AND SHAM WHOLE BODY MECHANICAL VIBRATION (WBV) MODULATES SPINAL EXCITABILITY IN HEALTHY YOUNG ADULTS.** Hortobágyi, T.1, Gomez, J.2, Rider, P.2, Lambert, J.2, Mueffelman, R.2, DeVita, P.2 1: University of Groningen, Center for Human Movement Sciences, Groningen, The Netherlands, 2: East Carolina University, Department of Exercise and Sport Science, Greenville, NC, USA **Introduction** Several studies reported that neuromuscular function, including maximal voluntary muscle force (MVF) and power increase after acute and chronic bouts of WBV. These papers also suggested the hypothesis that increases in neuromuscular function after WBV may be due to increases in excitability of supraspinal and spinal reflexes. To test this hypothesis, we conducted two experiments with the purpose to determine the effects of WBV on supraspinal and spinal reflex excitability. **Methods** In Experiment 1 we examined the amplitude of voluntary (V) wave (stimulation at 120% of maximal compound action potential, Mmax) and spinal excitability (Hsuperimposed, Hsup, stimulation at 20% of Mmax) during MVFs before and 0, 2, 4, 6, 8, 10, 12, and 14 min after 5 bouts of 1-min-long real WBV at 30 Hz ( $n = 10$ ) by stimulating the tibial nerve. Experiment 2 examined spinal excitability (H reflex) at rest before and every 5 s during the 1-min-long rest interval after each of 5 bouts of 1-min-long real WBV at 30 Hz ( $n = 10$ ) and 50 Hz ( $n = 10$ ) and sham WBV at 30 Hz ( $n = 10$ ) and during the follow-up at 0, 2, 4, 6, 8, 10, 12, and 14 min after the 5th bout of WBV. Because subjects alternated position between standing (WBV) and lying (H reflex testing), we also evoked a small M wave in conjunction with the H reflexes to control for the potential movement of the electrode and were successful to have statistically similar M wave size across bouts of WBV ( $p = 0.384$ ). **Results** Experiment 1 revealed no changes in V wave and Hsup after WBV at 30 Hz. Experiment 2 revealed that WBV depressed H reflex amplitude relative to baseline 34% (30 Hz), 26% (50 Hz), and 18% (sham) in the rest intervals between 5 bouts of WBV (all  $p < 0.05$ ) and an overall ~15% depression was still present at the end of the 4, 1-min-long rest intervals between 5 bouts of WBV. Compared with sham, the depression was 21% ( $p<0.05$ ) and 11% more at 30 Hz. However, during the 14-min follow-up the reflex depression reversed to an overall ~15% facilitation in all three conditions (30 Hz, 50 Hz, sham). **Discussion** These data suggest that both real and sham WBV affect spinal excitability at rest but not during contraction. WBV's modulatory effects seem to be due to an additive effect of vibration and muscle stretch that is present in the ankle plantarflexors as participants stand on the platform with knees and ankles flexed during WBV. Future studies will have to determine if the cumulative post-vibration facilitation of spinal excitability contributes to acute and chronic increases in neuromuscular function.

## A SYSTEMATIC REVIEW OF THE EFFECTS OF ACUTE STATIC STRETCH ON MAXIMAL MUSCULAR PERFORMANCE

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**Introduction** The benefits of pre-exercise muscle stretching have been recently questioned (Magnusson & Renström, 2006) following reports of significant post-stretch reductions in force and power production. However, methodological issues and equivocal research findings have prevented a clear consensus being reached. As no detailed systematic review exists, the literature describing responses to acute static muscle stretch was comprehensively examined. **Methods** Medline, ScienceDirect, SPORTDiscus, Swetswise and Zetoc were searched with recursive reference list checking. Selection criteria included: randomised, quasi-randomised and intervention-based trials published in peer reviewed journals examining an acute static stretch intervention on maximal muscular strength, power or speed performance published before 2011. **Results** The search revealed 2634 possible articles; one-hundred met the inclusion criteria. Study design was often poor, with many studies not imposing a control condition/group or providing appropriate reliability statistics (31%). There is no evidence that short-duration acute static stretch (<30 s) has a detrimental effect (pooled estimate = -0.5%), with there being overwhelming evidence that stretch durations of 30-45 s also imparted no significant effect (pooled estimate = -2.7%). A clear dose-response effect was evident between stretch duration and both the likelihood and magnitude of significant decrements, with a significant reduction being likely to occur with stretches >60 s. Maximal muscular strength, power and speed performances were similarly affected regardless of stretch duration, with similar trends apparent across lower limb muscle groups and contraction modes. **Discussion** There is strong evidence for a dose-response effect where the likelihood and magnitude of significant impairments exists for stretches ≥60 s, regardless of performance task, contraction mode or muscle group. However, the overwhelming evidence is that short-duration static stretch (≤45 s) does not detrimentally affect maximal muscle efforts (especially speed or power performance) and can be performed in a pre-exercise routine without compromising maximal muscle performance. The detrimental effects of static stretch are mainly limited to longer durations (≥60 s) that are not typically used during pre-exercise routines in clinical or athletic populations and, therefore, have limited practical relevance. No research exists describing the effects of <60 s static stretch on eccentric strength; given that muscle-strain injury risk is typically associated with eccentric muscle actions, this needs to be examined in the future. **References** Magnusson P, Renström P. (2006). *Eur J Sport Sci*, 6, 87-91.

## Oral presentations

### OP-PM16 Training and Testing: Individual Sports

#### ALTERATIONS IN LOWER EXTREMITY MUSCLE FUNCTION DURING SQUASH PLAY

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**Introduction** Most of the research relating to squash has focused on cardiovascular load while less emphasis has been placed on the impact on the musculoskeletal system. Therefore, the focus of this investigation was to quantify the changes in muscle function as a result of repeated squash play. **Methods** Twelve sub-elite squash players who were free from injury were selected to participate. Each player was required to attend one experimental session, during which they performed an original laboratory-based squash-simulation protocol designed specifically for this investigation. The protocol was based on notational analysis for movement patterns and not shot selection. To ensure that players were adequately taxed during the protocol, heart rate was continuously monitored and blood lactate was measured immediately post protocol. Muscle function was quantified using the Cybex 6000 isokinetic dynamometer pre and post simulation. Concentric and eccentric peak torque and work were measured in the quadriceps and hamstrings of both legs at testing speeds of 60o.sec-1 and 180o.sec-1. **Results** Average heart rate ( $164.77 \pm 7.48$  bt.min-1) and blood lactate levels ( $10.73 \pm 5.27$  mmol.L-1) confirmed that all players were sufficiently taxed during the simulation. As a generalisation, the protocol resulted in an all round decrease in muscle function. Significant ( $p < 0.05$ ) decreases were found for concentric and eccentric strength of the quadriceps at 60o.sec-1; while significant differences were found for concentric and eccentric work for both quadriceps and hamstrings at both testing speeds. The slow testing speed produced a greater number of significant torque decrements, particularly in the quadriceps. For example, in the right leg, the concentric strength of the quadriceps decreased from  $228 (\pm 27.48)$  Nm at 60o.sec-1 (a 26Nm decrease). Conversely, the faster, functional speed caused a greater number of significant decrements in work, even though the largest decrement occurred at 60o.sec-1. Overall, a greater number of significant decreases were found for concentric strength and work as opposed to eccentric strength and peak torque respectively. **Discussion** Although more significant differences were found for concentric movements and work, there were similar mean decreases in strength and work for both concentric and eccentric motions; decreases of 7.75% and 9.25% for concentric strength and work respectively and 8.12% and 9.62% for eccentric strength and work respectively. It is therefore evident that risk of injury would be considerably increased in the latter stages of the game and that future research should establish the critical start of these changes. Further, training programmes should be designed considering these decrements in strength and work.

#### THE GROSS MECHANICAL EFFICIENCY OF SIMULATED SWIMMING FRONT CRAWL SWIMMING

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The gross mechanical Efficiency of simulated swimming front crawl swimming Swaine, I. 1, Zamparo, P. 2. 1: CCCU (Canterbury, UK), 2: University of Verona (Verona, Italy) **Introduction** Recently, a new swimming training machine has been used to simulate the front crawl, during which work rate of each limb can be quantified. This type of simulated swimming offers the opportunity to assess gross mechanical efficiency in a much simpler way than has been possible previously. The purpose of this study was to determine the gross mechanical efficiency of incremental whole-body simulated swimming on a new ergometer, using an energy balance approach (Zamparo et al., 2005). **Methods** Ten swimmers with a mean age of  $23.2 \pm 4.1$  (yrs), stature  $1.76 \pm 0.15$  (m) and body mass of  $71.7 \pm 2.9$  (kg) gave informed consent and participated in exercise testing on a novel simulated swimming ergometer. Whole-body simulated swimming commenced at 50 W and increased by 25 Watts per minute. Participants were asked to simulate the movement actions of front crawl swimming, against increasing air-dyne resistance, until volitional exhaustion. Throughout the incremental exercise test heart rate (HR), oxygen uptake (VO2), total power output (PO), stroke frequency (SF) and kick frequency (KF) were averaged and recorded at 30s intervals. Peak values for



HR (HRpeak), VO<sub>2</sub> (VO<sub>2</sub>peak) and PO (POpeak) were determined during the 30s prior to termination of exercise. The VO<sub>2</sub> and PO values at each minute of the incremental test were used to calculate Gross Mechanical Efficiency (ME<sub>gross</sub>). Internal mechanical work (W<sub>int</sub>) was calculated from kick and stroke frequencies. The gross mechanical efficiency was corrected by addition of W<sub>int</sub> values. Results External work of the whole front crawl (sum of arms and legs) ranged from about 50 to 350 W during incremental simulated swimming. The power output produced by the legs ranged from 18 to 180 W (35-50% of total external work). For the arms it ranged from 33 to 173 (65-49% of total external work). For the whole body (sum of arms and legs) internal work was estimated to range from 7 to 87 W. Metabolic power input ranged from 0.8 to 4.5 l.min<sup>-1</sup>. Values for corrected gross mechanical efficiency ranged from 0.21 to 0.28 with a general trend for increasing efficiency as exercise intensity increased. Discussion These values show that gross mechanical efficiency in swimmers, when performing simulated front crawl swimming on this new ergometer, is similar to the gross mechanical efficiency values reported for other sports such as running and cycling. It is much higher than the propelling efficiency values (5-9.5%) obtained for free swimming. References P. Zamparo, D R Pendergast, J Mollendorf, A Termin, A E Minetti An energy balance of front crawl. *Eur J Appl Physiol* (2005) 94: 134–144

## MAXIMAL AEROBIC CAPACITY AND EFFICIENCY IN WORLD CLASS SPRINT SKIERS USING THE DOUBLE POLING AND G3 SKATING TECHNIQUE

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Maximal aerobic capacity and efficiency in world class sprint skiers using the double poling and G3 skating technique Ettema G, Sandbakk Ø, Leirdal S Department of Human Movement Science, Norwegian University of Science and Technology (Trondheim, Norway) Introduction Cross-country skiing is a sport with two different main techniques: classical style and skating. Within those two categories there are several sub-categories exploiting mainly the lower extremities, the upper body or both simultaneously. The aim of the present study was to investigate if the use of different body compartments affects aerobic capacity and gross efficiency (GE) in world class sprint skiers. We therefore compared very different techniques, i.e., the G3 skating (whole body) and the classical double poling (mainly upper body) technique (DP). Methods Six world class sprint skiers performed a maximal aerobic test at 5 % incline in both G3 skating and the double poling. In addition, they performed a submaximal 4 min test at the same inclination at 16km/h. During All tests oxygen consumption was measured using a Jaeger Oxycon Pro (Jaeger, Germany). At the end of each test, heart rate (Polar, Kempele, Finland) and blood lactate (Lactate Pro, Arkray, Japan) was recorded. Work rate was calculated on basis of incline, speed, and rolling friction (Sandbakk et al., 2010). Metabolic rate was estimated on basis of oxygen consumption and lactate levels (Sandbakk et al., 2010). GE was defined as the ratio between the external work rate and the metabolic rate. G3 and DP were compared using the t-test for paired comparisons. Results VO<sub>2</sub>peak in G3 and DP differed significantly (G3: 70.8 vs DP: 63.5ml/kg/min). Also the maximal aerobic work rate differed significantly (402 vs 358W). Thus, 89 % of G3 work rate and VO<sub>2</sub>peak was achieved in DP. During the sub-maximal work rate, oxygen cost did not differ significantly between the two techniques (57.3 vs 55.8ml/kg/min). Blood lactate differed (4.3 vs 8.4mmol/l) as well as heart rate (174 vs 180bpm). GE did not differ between the two techniques (15.37 vs 15.05 %). Discussion World class skiers exploit around 90 % of their skating capacity when using the DP technique (both with respect to VO<sub>2</sub>max and maximal aerobic work rate). The cost of a given sub-maximal work does not seem to be affected by two very different techniques, giving an equal GE for both techniques at the same work rate. GE in both techniques compare with other weight-bearing activities (e.g., speed skating). This may be evidence that GE reflects a basic physiological property of human skeletal muscle, irrespective of technique details and muscle groups that are used. Still, the specifics of the physiological load (i.e., heart rate, lactate levels and energy sources) seem to be affected very clearly. References Sandbakk Ø, Holmberg, H-C, Leirdal S, Ettema .G (2010) *Eur J Appl Physiol* 109, 473-481.

## REPEATED SPRINT VS HIGH-INTENSITY AEROBIC TRAINING IN TENNIS

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Introduction Tennis involves intermittent, high-intensity efforts interspersed with periods of low-intensity activity, during which active recovery (between points) and passive periods (between changeover breaks in play) take place, over an extended period of time (Fernandez-Fernandez et al., 2009). In this situation, tennis players need a mixture of different training systems (i.e., repeated sprint and interval training) for enhancing both the aerobic and anaerobic capacities, in order to achieve high levels of performance. Despite the growing effectiveness from the above-mentioned training strategies for team sports (Iaia et al., 2009), no studies have focused on the specific effects of different high intensity training programs in tennis players. The aim of this study was to compare the effects of a repeated-sprint training (RST) and a high-intensity aerobic interval training (HIT) and on different physical variables of tennis players. Methods 31 competitive male tennis (HIT (n = 11), RST (n = 12) or control group (CON, n = 9)) players took part in a training intervention of 6 weeks. Players completed baseline tests (e.g., VO<sub>2</sub>peak), a specific endurance field test (i.e., Hit and Turn test), 20 m sprint, CMJ, and a RSA test. HIT performed 3 x 90 s runs (90-95%HR<sub>max</sub>) separated by 180 s of active recovery (70%HR<sub>max</sub>), and 8 min of an on-court tennis game (i.e., 2:1 game) between sets. RST performed 3 x 10 shuttle sprints (22 m), separated by 20 s of passive recovery, and 8 min of an on-court tennis game (i.e., 2:1 game) between sets. Results Results showed significant time x intervention interactions for VO<sub>2</sub>peak, with a significant increase in the VO<sub>2</sub>peak level of 6.0% in HIT (p=0.008) and 4.9% in RST (p= 0.010), while no changes occurred in CON. HIT induced greater improvements in tennis-specific endurance (HIT: 28.9% vs RST: 14.5%; p<0.05) and RST led to a significant improvement in repeated sprint ability (i.e., reduction in the mean sprint time of 3.8%; p<0.05). Neither training strategy induced any effects on jumping and sprinting ability. Discussion The inclusion of either HIT or RST programs to normal tennis training sessions represents effective means to increase performance related physical fitness traits in high-level tennis players. It seems that RST represents a time-efficient stimulus for a simultaneous improvement of general and tennis-specific aerobic fitness as well for repeated sprint ability. From a practical point of view, a combination of different training strategies seems to be more effective since several physiological systems are involved during tennis. References Fernandez-Fernandez et al. A review of the activity profile and physiological demands of tennis match play. *Strength Cond J* 31:15-26, 2009. Iaia et al. High-intensity training in football. *Int J Sports Physiol Perform* 4(3):291-306, 2009.

**ACUTE EFFECTS OF REPEATED SPRINT AT MAXIMAL INTENSITY OF 40, 60 AND 80 METERS IN HIGH LEVEL SPRINTERS**

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**Introduction** In response to the need to adjust training loads of sprinters in speed sessions, caused by great variability in the number of series that coaches use and ignorance about how many series realize, when to stop training or what tool to use to control optimally speed session training, was carried out this study, in which we tried to approach the relationship between the degree of load and the fatigue, measured through speed losses and jump capacity and for the metabolic stress. **Methods** Eighteen high level sprinters (age  $23.1 \pm 4.4$  yr, body mass  $73.7 \pm 4.6$  kg, height  $177.6 \pm 5.9$  cm; body fat  $9.6 \pm 2.9\%$ ) took part in the study. They realized sprints of 40, 60 and 80m made to the maximum speed possible up to lose 3% of the speed. It was carried out in three different sessions separated by a week. Before and after each run they made 3 "Countermovement jumps" (CMJ) and blood lactate and ammonia were measured each two repetitions performed. **Results** The losses produced in the successive sprints presented a high relation between the distances and reduction in CMJ height. In 40m this loss was equivalent to the speed loss, 3.1 % for 40m, but it increased 6.7 % in 60m and to 8.3 % in 80m. The fatigue, measured as a decrease in vertical jump's height, increases with distance traveled, and, is strongly correlated to lactate ( $r = 0.93$ ) and ammonia ( $r = 0.89$ ). **Discussion** The mechanical and metabolic response to repeated sprint at maximal intensity had been previously analyzed by Gorostiaga et al. (2010) which examined CMJ height loss following typical sprint-training workouts in 400m elite runners in distances between 60 and 300m although were not performed at maximal intensity. Our study focus on distances of 40, 60 and 80m performed at highest possible speed. Relationship between reduction in CMJ height and distances could be used as indicator of the degree of fatigue produced by various types of efforts, and therefore would be useful for the control and dose of training load. The metabolic stress developed during the effort can be estimated by controlling the CMJ because of the high correlation between CMJ and blood and ammonia concentrations. The high correlations found between mechanical (speed and CMJ height losses) and metabolic (lactate and ammonia) measures of fatigue support the validity of using CMJ to objectively quantify neuromuscular fatigue during sprint training. **References** Gorostiaga, E.M., Asiain, X., Izquierdo, M., et al. Vertical jump performance and blood ammonia and lactate levels during typical training sessions in elite 400-m runners. *J Strength Cond Res.* 2010;24(4):1138-49.

**PLYOMETRIC TRAINING EFFECTS IN DANCERS' JUMP TEST**

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**PLYOMETRIC TRAINING EFFECTS IN DANCERS' DROP JUMP TEST** Santana, J. E.1; Diehl, M.1; Campos, M. H.2; Moura, F. A.1; Cunha, S. A.1 1: FEF-UNICAMP (Campinas, BR), 2: FEF-UFG (Goiânia, BR) **Introduction** A successful ballet dancer it is not only evaluated by a perfect execution of techniques during steps, but it's also taken in consideration its capacity of performing more complex steps. Mikhail Baryshnikov, i.e., is known by his high vertical jumps. However, dancers are not used to train muscular power (Wyon et al., 2006) to improve jumps performance. The aim of this study was to verify if ballet dancers trained in plyometry improve their performance in drop jump test compared to non-trained. **Methods** Were recruited 8 female ballet dancers from the Institute of Arts (Campinas State University). Four participants performed plyometric training for 8 weeks (mean of 662 jumps per week, loads raised progressively), composing the trained group (TG:  $56.9 \pm 5.9$  Kg,  $1.64 \pm 0.04$  m,  $19.2 \pm 1.5$  years). Others 4 participants composed the non-trained group (NT:  $54.8 \pm 6.7$  Kg,  $1.5 \pm 0.05$  m,  $21.7 \pm 0.9$  years) and remained daily activities. Each participant performed 3 drop jump trials to test training effect. The highs were obtained by kinematical analysis of a sacrum marker (2 digital cameras, 300Hz frequency). The marker position was obtained using Dynamic Posture® (Campos, 2010). Cameras' calibration and 3D reconstruction were performed by DLT (Abdel-Aziz e Karara, 1971). **Results** are expressed in medians (MED) and confidence intervals range (CIr), pre and post-training (PreT/PostT) (Mcgill et al., 1978). **Results** The TG presented no differences in their highs (MED 0.27cm, CIr from 0.24 to 0.30cm at PreT and 0.35cm, 0.29-0.40cm at PostT). The NT showed major values in PostT highs (0.35cm, 0.33-0.38cm) compared to PreT values (0.284 cm, 0.25-0.31cm). However, the values obtained PostT to NT raised with a mean of 27% from PreT and 10% to NT. **Discussion** NT may have increased the highs at PostT test due to demanding classes at their daily activities. TG showed no differences with the training, in which the low number of participants may explain this result. Nevertheless, plyometric training improved jump performance in 27%, suggesting that training benefited most muscular power to TG than NT, despite the results found to NT. This kind of training develops muscular power and is important to dancer fitness. **References** Abdel-Aziz, Y. I, et al. Direct linear transformation from comparator coordinates into object space coordinates in close-range photogrammetry. In: *Proceedings of the Symposium on Close-Range Photogrammetry*, Illinois, 1-18. 1971. Campos, M. H. Movement analysis system for evaluation of the spinal posture during running in the incremental maximum effort test. FEF, Unicamp, Campinas, 2010. McGill, R., et al. Variations of box plots. *Am Stat*, v.32, 12-16. 1978. Wyon, M., et al. Anthropometric Factors Affecting Vertical Jump Height in Ballet Dancers. *J Dance Med Sci*, v.10, n.4, 106-110. 2006.

**Oral presentations****OP-PM24 Nutrition: Protein****ACUTE N-ACETYLCYSTEINE SUPPLEMENTATION ATTENUATES FATIGUE FOLLOWING REPEATED BOUTS OF INTERMITTENT EXERCISE**

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**Introduction** - Reactive Oxygen Species (ROS) production during exercise may be key regulators of cellular adaptation and thus supplementation with antioxidants may be unwise (1). However, it is also known that ROS increase exercise-induced muscle damage and may be endogenous mediators of fatigue (2). In situations where performance/recovery is essential and adaptation is inconsequential, for example during a football tournament, antioxidant supplementation may be an effective means to maximise performance. This study investigated N-acetylcysteine (NAC) supplementation on Yo-Yo level one performance (YIRT-L1) following repeated-bouts of intermittent exercise. **Method** - Twelve males were randomly allocated into a supplement (NAC, 50mg/kg body weight, n=6) or a placebo group

(n=6). Following a one day loading phase subjects completed three testing sessions, on alternate days (Day 1, 3 and 5), consisting of a pre-exercise blood sample, an intermittent exercise protocol typical of team sports such as rugby/football, YIRT-L1 and a post-exercise blood sample. Results and Discussion – There was a significant difference in YIRT-L1 performance between the 2 groups ( $P<0.0005$ ) with the NAC group performing ~25% better on day 1 compared with the placebo group. Moreover, whereas the placebo group's performance deteriorated on day 3 and 5 (~10%) compared with day 1, the NAC group maintained their performance throughout the trial. Plasma creatine kinase values increased markedly over time ( $P=0.002$ ) in both groups, however CK values were significantly greater in the NAC group ( $P=0.029$ ). Conclusion - These data suggest that ROS are endogenous mediators of fatigue following intermittent exercise and NAC supplementation maintains performance. Furthermore, the intermittent exercise resulted in muscle damage on day 3 and 5, and although antioxidant supplementation did not attenuate this damage, supplementation with NAC did improve YIRT-1 performance on these test days. These data would suggest that athletes engaged in repeated intermittent exercise and not looking for training adaptations may benefit from NAC supplementation. References 1. Close et al., (2005). *Comp Biochem Physiol*, 142:257-66 2. Reid (2008), *Free Radic Biol Med*, 44:169-79

## STIMULATION OF MUSCLE ANABOLISM BY SIMULTANEOUS AND SEPARATE INGESTION OF ESSENTIAL AMINO ACIDS AND CARBOHYDRATE FOLLOWING RESISTANCE EXERCISE

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Introduction: Given the delayed response of net muscle protein balance (NBAL) to carbohydrate (CHO) ingestion post exercise, we proposed that by postponing ingestion of amino acids relative to CHO, it may be possible to enhance the anabolic response of muscle to co-ingestion of amino acids and CHO. Hence, this study compared the post exercise response of NBAL to the combined (COMB) or separated (SEP) ingestion of essential amino acids (EAA) and CHO. Methods: Eight recreationally-trained subjects completed two trials in random order, COMB (drink one contained CHO plus EAA, drink two contained placebo) and SEP (drink one contained CHO, drink two contained EAA). In both conditions, drink one was administered 1 h following an acute exercise bout ( $10 \times 8$  repetitions of leg extension) and 1 h prior to drink two. A primed, continuous infusion of L-[ring- $^{13}C_6$ ]-phenylalanine was combined with collection of muscle biopsies and multiple femoral arterial and venous blood samples for determination of the response of muscle protein metabolism. Results: Elevated muscle protein synthesis rates were primarily responsible for the change from net release to net uptake of amino acids across the leg following post exercise EAA ingestion in both conditions. Arterial amino acid concentrations peaked 30-40 min after ingestion of the EAA-containing drink (COMB, drink one; SEP, drink two) in both conditions. No differences in arterial insulin concentrations were detected between COMB and SEP, nor did area under the curve (AUC) for phenylalanine delivery to the leg differ between COMB ( $162 \pm 23$   $\mu\text{mol}/\text{min}/100\text{mL}$  leg vol/6 h) and SEP ( $152 \pm 21$   $\mu\text{mol}/\text{min}/100\text{mL}$  leg vol/6 h). Likewise, mixed muscle protein fractional synthesis rates were similar between conditions (COMB:  $0.086 \pm 0.007$  %/h; SEP:  $0.089 \pm 0.009$  %/h). The response of phenylalanine NBAL following post exercise drink ingestion in COMB was biphasic, whereas only a single, albeit more marked, peak in NBAL was observed following drink two in SEP. As a result, phenylalanine exchange across the leg, determined 1 h following ingestion of EAA-containing drinks, was ~50% higher in SEP vs. COMB ( $P<0.05$ ). However, calculated over the total acute 6 h recovery period, phenylalanine exchange across the leg from the AUC of NBAL was not different between conditions (COMB:  $110 \pm 19$  mg phenylalanine/6 h vs. SEP:  $117 \pm 24$  mg phenylalanine/6 h). Conclusions: These data suggest that delayed ingestion of EAA 1 h following CHO does not augment the anabolic response of muscle to post exercise co-ingestion of EAA and CHO. Thus, separation of amino acid and CHO ingestion following resistance exercise is unnecessary for optimizing muscle anabolism. Funded by National Institutes of Health

## THE EFFECT OF PROTEIN SUPPLEMENTATION ON THE GAINS IN ELBOW FLEXOR MUSCLE STRENGTH AND SIZE WITH RESISTANCE TRAINING

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THE EFFECT OF PROTEIN SUPPLEMENTATION ON THE GAINS IN ELBOW FLEXOR MUSCLE STRENGTH AND SIZE WITH RESISTANCE TRAINING Erskine R.M., Fletcher G., Hanson B., Folland J.P. Loughborough University, UK Introduction It is thought that protein supplementation may enhance the gains in muscle strength and size that occur with resistance training (RT) but the scientific evidence is equivocal. Previous studies have been confounded by small sample sizes, imprecise measures of muscle size or no control of prior exercise or habitual protein intake. The purpose of this study was to comprehensively compare the changes in elbow flexor muscle size and strength in response to 12-wk of RT with or without protein supplementation. Methods Thirty-three previously untrained, healthy men (18-30 yr) completed an initial 3-wk RT period without nutritional supplementation and then 6-wk of no training. The initial RT period provided extensive familiarisation and facilitated neural adaptations that might confound muscular responses. Participants were then pair-matched for habitual protein intake and isometric strength response to the initial 3-wk RT and randomly assigned to protein (PRO; n = 17) or placebo (PLA; n = 16) supplementation groups. Participants subsequently completed 12-wk of supplemented RT during which they received a PRO (20g protein, 7g carbohydrate, 250ml H<sub>2</sub>O) or PLA (7g carbohydrate, 250ml H<sub>2</sub>O) supplement immediately before and after each training session in a double-blind manner. Elbow flexor training was performed 3 x per wk with unilateral and bilateral 'preacher curls' (2-3 sets of each exercise; 8-10 repetition maximum (RM)). Muscle strength (unilateral preacher curl 1-RM and isometric elbow flexion force at a joint angle of 120°) and size (1.5T magnetic resonance imaging of the dominant arm to measure total volume and sum of maximum anatomical cross-sectional areas (ACSA) of the biceps brachii, brachialis and brachioradialis muscles) were assessed before and after the 12-wk of supplemented RT. Results PRO and PLA demonstrated similar increases in elbow flexor muscle volume (PRO,  $17.0 \pm 7.1\%$  vs PLA,  $14.9 \pm 4.6\%$ ;  $P = 0.32$ ), ACSA (PRO,  $16.2 \pm 7.1\%$  vs PLA,  $15.6 \pm 4.4\%$ ;  $P = 0.80$ ), 1-RM lifting strength (PRO,  $41.8 \pm 21.2\%$  vs PLA,  $41.4 \pm 19.9\%$ ;  $P = 0.97$ ) and isometric force (PRO,  $12.0 \pm 9.9\%$  vs PLA,  $14.5 \pm 8.3\%$ ;  $P = 0.43$ ). Dietary protein intake during the 12-wk supplemented RT, including training and non-training days, was  $1.56 \pm 0.33$  and  $1.35 \pm 0.47\text{g}/\text{kg}/\text{d}$  for PRO and PLA, respectively ( $P = 0.12$ ). Discussion In the present study, protein supplementation did not augment the muscle strength and size changes that occurred after 12-wk RT. Future studies should investigate whether the adaptations to RT in different circumstances (e.g. whole body exercise, or previously well-trained participants) may be more responsive to protein supplementation. Acknowledgement This study was sponsored by GlaxoSmithKline Nutritional Healthcare.

## WHEY PROTEIN STIMULATES POSTPRANDIAL MUSCLE PROTEIN ACCRETION MORE EFFECTIVELY THAN CASEIN AND CASEIN HYDROLYSATE IN OLDER MEN

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Background: Sarcopenia has been attributed to a diminished muscle protein synthetic response to food intake. Whey protein ingestion results in greater postprandial muscle protein accretion when compared with the ingestion of casein (1). The greater anabolic properties of whey versus casein have been attributed to its faster digestion and absorption kinetics (2). However, whey and casein also markedly differ in their amino acid composition. Recently, we observed that when intact casein is hydrolyzed, in vivo protein digestion and absorption kinetics can be modulated to resemble a fast protein while retaining its amino acid composition (3). This provides us with an important tool to define the characteristics responsible for the proposed anabolic properties of whey versus casein. Objective: To compare protein digestion and absorption kinetics and subsequent postprandial muscle protein accretion following ingestion of whey, casein, and casein hydrolysate in healthy, older adults. Design: A total of 48 older men were randomly assigned to ingest a meal-like amount (20 g) of intrinsically L-[1-13C]phenylalanine labeled whey (WHEY), casein (CAS), or casein hydrolysate (CASH). Protein ingestion was combined with continuous intravenous L-[ring-2H5] phenylalanine infusion to assess in vivo digestion and absorption kinetics of dietary protein and subsequent mixed muscle protein fractional synthetic rates (FSR). Results: The peak appearance rate of dietary protein-derived phenylalanine in the circulation was greater with WHEY and CASH when compared with CAS ( $P < 0.05$ ). FSR values, calculated from the ingested tracer, were higher following WHEY ( $0.15 \pm 0.02$  %/h) compared with CAS ( $0.08 \pm 0.01$  %/h;  $P < 0.01$ ) and CASH ( $0.10 \pm 0.01$  %/h;  $P < 0.05$ ) ingestion. FSR values showed a strong positive correlation with the postprandial increase in plasma leucine concentrations ( $r = 0.66$ ;  $P < 0.01$ ). Conclusions: Ingestion of 20 gram whey protein stimulates postprandial muscle protein accretion more effectively than the same amount of intact casein or casein hydrolysate in older men. The greater anabolic properties of whey versus casein are likely attributed to a combination of faster digestion and absorption kinetics as well as a greater leucine content. 1. Tang JE and Phillips SM. Maximizing muscle protein anabolism: the role of protein quality. *Curr Opin Clin Nutr Metab Care* 2009;12:66-71. 2. Boirie Y, et al. Slow and fast dietary proteins differently modulate postprandial protein accretion. *Proc Natl Acad Sci U S A* 1997;94:14930-5. 3. Koopman R, et al. Ingestion of a protein hydrolysate is accompanied by an accelerated in vivo digestion and absorption rate when compared with its intact protein. *Am J Clin Nutr* 2009;90:106-15.

## SEVEN DAYS ORAL INGESTION OF PANTOTHENIC ACID AND CYSTEINE DOES NOT ALTER MUSCLE CO-ENZYME A CONTENT, EXERCISE METABOLISM OR EXERCISE PERFORMANCE IN HUMANS

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Pantothenic acid and cysteine are precursors for co-enzyme A (CoA) biosynthesis and are routinely sold as nutritional supplements purported to improve endurance exercise performance, presumably by altering muscle fuel selection during exercise. Here we determined the effects of 7 days of pantothenic acid and cysteine ingestion on muscle total CoA (acetyl-CoA + free CoA) content, muscle fuel selection during prolonged sub-maximal exercise and endurance exercise performance in healthy volunteers. On 3 occasions, each separated by 3 wks, 8 healthy male volunteers (age  $22.9 \pm 1.4$  yr, BMI  $24.2 \pm 1.5$  kg.m<sup>2</sup>) performed 60 min cycling exercise at 75% VO<sub>2</sub>max followed by intermittent cycling to exhaustion (for a total exercise time of  $91.3 \pm 3$  min) at 75% VO<sub>2</sub>max, which was then followed by a 15 min work output cycling performance trial. On each occasion, muscle biopsies were obtained at rest, after 60 min of exercise and at the point of exhaustion (following intermittent exercise). Following the first experimental visit (baseline), a 2 wk recovery period was followed by 1 wk of volunteers ingesting either 3 g of placebo control (glucose polymer; CON) per day or 1.5 g of D-pantothenic acid and 1.5 g of L-cysteine (CP) per day in a randomised, counter-balanced, double blind manner. The order of supplementation was then reversed 1 week prior to the third experimental visit. Resting muscle total CoA content was not different between baseline, CON and CP visits;  $101.9 \pm 11.4$ ,  $88.0 \pm 9.0$  and  $82.8 \pm 11.7$   $\mu$ mol.kg<sup>-1</sup>, respectively. Muscle glycogen content was depleted by 60 min of exercise at 75% VO<sub>2</sub>max (to 29%, 35% and 37% [all  $P < 0.001$ ] of the resting value in baseline, CON and CP visits, respectively) and at exhaustion (to 12%, 16% and 11% of the resting value [all  $P < 0.001$ ] in baseline, CON and CP visits, respectively), but there was no difference in glycogen utilisation between treatment groups. Similarly, there was no difference in muscle lactate accumulation during exercise or the mean RER response during exercise when comparing treatment groups. Finally, work output during the performance trial was no different between CON and CP visits. The present study demonstrates that 7 days of dietary supplementation with pantothenic acid and cysteine does not elevate muscle total CoA content and does not alter muscle fuel selection or exercise performance during prolonged sub-maximal intensity exercise in humans.

## TRIGONELLINE CAN PREVENT SKELETAL MUSCLE LOSS

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Introduction: Trigonelline is a natural derived niacin-related compound which can be found in many plants like e.g. fenugreek (*Trigonella foenum-graecum*), and coffee beans. It has been demonstrated to have several biological activities like preventing dental caries by preventing the bacteria *Streptococcus mutans* from adhering to teeth or to regenerate neurons which improved the memory in rats. In this study we tested the effects of Trigonelline in skeletal muscle cells in vitro and in vivo. Methods: C2C12 mouse myoblast cells were cultured under normal conditions (3 days, at 37°C, with 5% CO<sub>2</sub>, 10% Foetal Calf Serum until 100% confluency) and then differentiated with 2% FCS differentiation medium for 24h. The cells were then treated for 24h with 10 $\mu$ g/ml Trigonelline and the differentiation of the cells was determined using high content screening (as primary antibody alpha-myosin was used). In an established atrophy animal model (hindlimb unloading / tail suspension model) we tested whether the substance is able to prevent skeletal muscle loss. Ten weeks old female C57BL/6J mice (n=10) were treated by gavage for 3 weeks with Trigonelline (300 mg/kg bw/d). Control group (n=10) was only treated with gelatine. At the end of the study bodyweight, body composition (NMR, Bruker Minispec) and computer tomography (pQCT, Stratec) was determined and the skeletal muscle weight of the gastrocnemius, plantaris and soleus muscles were measured. Results: The in vitro data showed that Trigonelline at dose of 10 $\mu$ g/ml increased the differentiation of C2C12 mouse myoblasts, which led to elongation and fusion into multinucleated myocytes, as indicated by alpha-myosin marker staining. 45% more differentiation of the cells in the first experiment and respectively 37% in the second experiment were observed. In the in vivo test, the animals treated with Trigonelline at 300mg/kg bw/d dose showed less decline of lean body mass after 3 weeks of hind limb unloading compared to the control

group. The pQCT results showed tendencies to a higher total lower leg (by 4%) and muscle cross-sectional area. The weight of the gastrocnemius muscle was significantly higher compared to the not treated but suspended control group. We could observe an 11% increase of the gastrocnemius muscle weight. The in vivo results indicated that Trigonelline was able to reduce the decline of the skeletal muscle mass caused by inactivity. In Summary, Trigonelline was able to increase the differentiation of muscle cells to myotubes in-vitro and to reduce skeletal muscle loss in the in-vivo model. Conclusion: These results suggest that Trigonelline is able to increase the differentiation of C2C12 cells and to prevent skeletal muscle loss in the hindlimb unloading animal model, therefore, trigonelline, may act as a health ingredient to promote skeletal muscle health.

## Oral presentations

### OP-PM33 Physical Activity and Health 2

#### LONG-TERM EFFECTS OF LEISURE-TIME PHYSICAL ACTIVITY ON DEPRESSIVE SYMPTOMS IN EARLY MIDLIFE: THE CARDIOVASCULAR RISK IN YOUNG FINNS STUDY

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1: LIKES (JYVÄSKYLÄ, FINLAND), 2: JYU (JYVÄSKYLÄ, FINLAND), 3: HYU (HELSINKI, FINLAND), 4: TYU (TURKU, FINLAND)

Introduction Research on the role of past and current leisure-time physical activity (LTPA) as correlates or predictors of depressive symptoms is scarce and there is a lack of prospective data that are able to show such association. The purpose of this study was to examine the effects of sustained participation in LTPA over 6 years on depressive symptoms among early-middle-aged men and women. Methods Participants were 1396 healthy adults (555 men and 841 women), aged 30 – 45 years in 2007, from the ongoing Cardiovascular Risk in Young Finns Study. LTPA was assessed using a self-report questionnaire completed in connection with a medical examination in 2001 and 2007. The participants were grouped into four categories according to tertiles of LTPA index at two phases: persistently active, increasingly active, decreasingly active and persistently inactive. Depressive symptoms were assessed by using a revised version of Beck's Depression Inventory in 2001 and 2007. Results LTPA and depressive symptoms correlated negatively at baseline and follow-up among men and women. The change in 6-year LTPA was inversely associated with depressive symptoms in both sexes in the final model when age, education, occupation, smoking and body mass index were entered simultaneously. Men and women who were persistently inactive were more likely to develop depressive symptoms (OR 1.94, 95% CI 1.04–3.61 for men and OR 2.84, 95% CI 1.63–4.95 for women) than those who were persistently active over 6 years. In women, the persistent inactivity and decreasing activity were associated with the depressive symptoms irrespective of the confounders, but was not any more significant when adjusted for the baseline depressive symptoms. In men, the association was explained by occupation. Discussion The major finding of the present study was that there is a significant relationship between LTPA and depressive symptoms in adults over 6 years which maybe bidirectional. These prospective findings give evidence of the effectiveness of long-term LTPA in the prevention of depressive symptoms in adulthood. Although the significance between LTPA and depressive symptoms disappeared when adjusted for the baseline depression, our findings suggest that not only current LTPA but also LTPA history, specifically persistent LTPA across the 6 years, may be important for the prevention of depressive symptoms in early midlife. Participation in regular physical activity during leisure may help middle-aged adults to cope with depressive symptoms. Another important finding was that the decreasing physical activity was related with depressive symptoms in women. A long-term LTPA may play a beneficial role in the development of psychological well-being and can be used as a means to prevent or reduce depressive symptoms, particularly in women.

#### ACTIVE MOTHERS GIVE BIRTH TO HEALTHIER CHILDREN

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ACTIVE MOTHERS GIVE BIRTH TO HEALTHIER CHILDREN Delia, S. Msc, Andersen, L.B Prof, Pano, G. Msc, Delia, B. PhD, Çuko, E. Msc Abstract Introduction PA is an important public health tool used in the treatment and prevention of various physical diseases, as well as in the pregnant women during pregnancy. In Albania, benefits of PA during pregnancy do not appear to be widely publicized, and some consider the theme a taboo. At birth, fetal weight is viewed as the crucial parameter that is directly related to the health and nutrition of the mother, and also as an important determination of the chances of the newborn to survive and experience healthy growth and development. Objectives First objective was to show whether there is a relationship between PA levels of pregnant women during pregnancy with baby birth weight. Second objective was to identify which factors influence the baby's weight at birth. Methods We analyzed the Maternity Hospital Statistical datas from January-February; May- June to October 2009. Women 18-45 years old (n =648) that have had the first pregnancy were eligible for this study. Both qualitative and quantitative research methodology was utilized in this study. Preliminary statistical methods as well as polychotomous logistic regression (PLR) analysis were conducted to investigate the relationship between baby's birth weight and mother's attributes which included employment status and type of employment which were taken as surrogates for mother's level of activity during pregnancy. Discussion Inactive mothers were more likely to give birth to unhealthy babies and active mothers gave birth to healthier babies. Analysis of dispersion results (i.e variance, risk), show that mothers who were inactive gave birth to babies whose birthweight was more varied than the birthweights of the babies delivered by active mothers. Obese and overweight mothers were more likely to give birth to overweight babies, while mothers experiencing normal delivery were less likely (OR = 1.88) to deliver overweight babies. Unemployed mothers were more likely (OR = 4.1) to deliver underweight babies while employed mothers were more likely (OR = 1/0.21) to deliver overweight babies. Results This study was important in shedding some light on how baby's weight at birth was influenced by some of the mother's attributes, especially physical activity. Healthy active women give birth to healthier babies who grow to be healthier children and adults, hence, a better and a healthier society. References COG, American College of Obstetricians and Gynecologists. Exercise during pregnancy and the postpartum period. Washington DC: American College of Obstetricians and Gynecologists, 1994. ACOG. Exercise during pregnancy and the postpartum period. ACOG Committee Opinion No.267.Obstet Gynecol . 2002;99;171-3. ACSM.American College of Sports Medicine, Impact of physical activity during pregnancy and postpartum on chronic disease risk.Med Sci Sports Exerc. 2006;38(5):989-1006.

### IMPACT OF THE USE OF AN ACTIVITY WATCH ON STAGES OF READINESS AND T2D-RISK VARIABLES

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**INTRODUCTION** Recently, a new activity watch (AW200, Polar Electro Oy, Kempele, Finland) was introduced for energy expenditure assessments during activity sessions (Brugniaux et al. 2010). Because no study investigated the impact of such a device on physical activity behavior and T2D risk factors we investigated if subjects at high risk of T2D can improve in stages of readiness for PA, and T2D-risk factors during 6 mo intervention. **METHODS** 82 high-risk subjects (40-60 yrs) who participated in DE-PLAN (Diabetes Europe – Prevention using Lifestyle, physical Activity and Nutrition) were randomly assigned to an intense intervention (14 hrs lifestyle education, LSE) with and without AW200 (IG-AW, 18m/11f; IG, 10m/16f), as well as to a light intervention (LG, 2 hrs LSE; 10m/10f). After LSE the participants were contacted by a motivational letter every 6 wks. At baseline and after 6 mo stages of readiness were determined by one question according to Marcus et al. (1992). Body mass, height, waist, fasting glycosylated hemoglobin, fasting insulin and 2h-glucose were assessed at the same time. Pre-post differences were measured with non-parametric (Mann-WhitneyTest) and parametric tests (MANOVA). Group differences in stages of exercise readiness were tested with Kruskal-Wallis Test. Significance level was set  $p < .05$  and all tests were conducted separately for sex. **RESULTS** No group effects were found in all tested variables in both sexes. At baseline most of the subjects were in pre-contemplation and contemplation (>80%) stages, whereas after 6 mo more than 80% shifted to preparation and action stages. The change in exercise readiness was significant in males (IG-AW, IG;  $p < .001$ ), and in females (IG-AW,  $p = .001$ ; LG,  $p = .04$ ). No significant changes were found in T2D-risk factors. **DISCUSSION** Although the AW200 is a valid device to monitor energy expenditure it was not superior to the intense or light LSE to improve activity behavior. This is in accordance with Aittasalo et al. (2005) who found no impact of self-monitoring methods on exercise behavior after 6 months. Furthermore, the administered LSE was too weak to change T2D risk factors. However, our results indicate that mail contacts every 6 weeks additionally to 14 hourly sessions LSE improved exercise readiness. We conclude that a more intense intervention seems necessary to improve T2D risk factors in high-risk adults. **REFERENCES** Brugniaux JV, Niva A, Pulkkinen I., Laukkanen R, Richalet J-P, Pichon AP (2010). Br J Sports Med, 44(4), 245-249. Marcus BH, Selby VC, Niaura RS, Rossi JS (1992). Res Q Ex and Sport, 63(1), 60-66.

### BODY MASS INDEX AND PHYSICAL FITNESS CHARACTERISTICS OF 6-10 YEAR OLD CHILDREN- A RURAL SPORT DEVELOPMENT INITIATIVE.

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Body Mass Index (BMI) and physical fitness characteristics of 6-10 year old children- A Rural Sport Development Initiative. M.M van Gent and L. Miza, University of Fort Hare, Alice, South Africa Introduction BMI is used in many studies to establish prevalence of overweight and obesity. However, studies among rural children in South Africa have revealed conflicting findings (Monyeki et al, 1999; Armstrong et al. 2006; UN 2006). This has serious implications for sport development in rural areas, thus the aim is to establish the prevalence of overweight and obesity among rural children, the differences in physical fitness among children according to BMI classification and the relationship between BMI and physical fitness characteristics. Method Sample consisted of 6-10 year old children ( $n=100$ ). Descriptive statistics were used to classify the children into three groups; normal weight ( $-1SD$  score to median), overweight ( $>+1SD$ ) and obesity ( $>+2SD$ ) (WHO, 2007). ANOVA was used to establish differences between groups (BMI classification) in terms of physical fitness. Correlation was established by using Pearson's correlation coefficient. Results There was 13% occurrence of obesity and 23% of overweight. Statistical differences between the BMI classification groups were found for 10m speed ( $p=0.03$ ) and 20m speed ( $p=0.04$ ). Obese 9 year olds outperformed the other groups in agility ( $10.5 \pm 0.83$ ), speed ( $2.28 \pm 0.44$ ) and muscle endurance ( $27 \pm 6.03$ ). In general the overweight group outperformed the other groups in terms of physical fitness characteristics. BMI correlated poorly with all physical fitness characteristics. Discussion It seems that overweight and obesity is increasing among rural children when using BMI as reference (Armstrong et al, 2006, UN 2006). However, BMI and physical fitness characteristics present poor correlation, thus BMI might possibly not be suitable for use in sport development programs as an indicator of fatness. Support previous finding of BMI being an indicator of heaviness rather than fatness (Monyeki et al, 1999) and that in rural settings BMI might possibly suggest muscle mass instead of fatness (Malina et al., 1998). References ARMSTRONG, M.E.G., LAMBERT, M.I., SHARWOOD, K.A. & LAMBERT, E.V. (2006). South African medical journal. 96(5): 439-444. MALINA, R.M., KATZMARZYK, P.T & SIEGEL, RS. (1998). Basel: Karger; Med. Sport Science. 43, 13-26 MONYEKI, K.D., VAN LENTHE, F.J. & STEYN, N.P. (1999). International journal of epidemiology, 28(2):287-292. United Nations, Food and agriculture organisation of the United Nations (2006). The double burden of malnutrition-case studies of six developing countries. Rome: Government printer. World Health Organisation. Multicentre Growth Reference Study Group. (2007). WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: World Health Organization.

### DOES A CLASSROOM PHYSICAL ACTIVITY INTERVENTION HELP PRIMARY 6 CHILDREN ATTAIN THE RECOMMENDED 60 MINUTES OF PHYSICAL ACTIVITY EACH DAY?

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**Introduction** The school environment plays an important role in influencing physical activity behaviour, as it is a compulsory aspect of children's lives. Low cost classroom based physical activity breaks interspersed throughout the normal school day have the potential to increase the proportion of children who meet daily physical activity targets. **Methods** 91 children (47 intervention, 44 control) aged 9-10 years participated in a 12 week classroom physical activity intervention involving 3x5 minute high intensity exercise breaks spread across the day. Children wore an accelerometer for 7 days before and then again after the programme to ascertain moderate to vigorous physical activity (MVPA) levels. Height, weight and skin fold measurements were also taken at these time points. A 2x2 mixed design ANOVA was used to compare MVPA across group and time. Results An interaction effect was observed between time and group ( $F(2,89)=6.04, P=.016, \eta^2=.064$ ). Time spent in MVPA significantly changed from 58.8 ( $\pm 17.4$ ) to 66.31 ( $\pm 26.5$ ) minutes per day in the intervention group. There was no increase in daily activity in the control group. No significant differences were found for BMI or skin fold. Before the intervention 36.2% of children met the daily physical activity guidelines, this increased to 44.8% post intervention. **Conclusions** A low cost classroom based intervention of high intensity physical activity increased daily MVPA in primary school children to help them meet the current physical activity recommendations for health.

## CLUSTERED CARDIOMETABOLIC RISK AND CARDIORESPIRATORY FITNESS IN 10-11.9YR OLD SCHOOLCHILDREN: THE REACH Y6 PILOT STUDY

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CLUSTERED CARDIOMETABOLIC RISK AND CARDIORESPIRATORY FITNESS IN 10-11.9YR OLD SCHOOLCHILDREN: THE REACH Y6 PILOT STUDY Boddy, L.M.1-3, Thomas, N.E.4, Fowweather, L.1,2, Gobbi, R.1,3, Graves, L.E.F.1,2, Hopkins, N. 1,2, Green, D.J. 2,5, Stratton, G.1,2. 1: The REACH Group, 2: RISES, LJMU, UK, 3: ECL, LJMU, UK, 4: Swansea University, UK. 5: The University of Western Australia. Introduction Cardio-respiratory fitness [CRF] is a key component of health, and a number of studies have shown links between CRF and cardiometabolic risk in children (Andersen et al., 2008; Ekelund, et al., 2007). Cardiometabolic risk is often assessed using features of the metabolic syndrome, with few studies incorporating markers of systemic inflammation, circulating cytokines or non-invasive markers of cardiovascular structure and function into risk scores. The aim of this cross-sectional pilot study was to estimate clustered cardiometabolic risk and investigate the relationship between risk and CRF in 10-11.9yr old children. Methods Sixty-two (n = 28 boys) Year 6 (mean age 11.32yrs) schoolchildren took part in the study. Participants completed assessments of CRF (VO<sub>2</sub>peak), cardiovascular structure and function (blood pressure [BP], flow mediated dilation [FMD%], left ventricular mass index [LV mass index]), body composition (DEXA), and anthropometrics. Fasting blood samples were assayed for: high sensitivity C-reactive protein, adiponectin, insulin, glucose, high-density-lipoprotein cholesterol, low-density lipoprotein cholesterol, and triglycerides. Systolic BP, FMD%, LV mass index, trunk fat (kg) and blood markers were used to create a clustered risk score. Differences between the sexes were examined using analysis of variance. Participants were then assigned to a 'normal' or 'high' risk group, and differences in VO<sub>2</sub>peak were assessed by risk group controlling for sex and maturation using analysis of covariance. Logistic regression was completed to assess the odds of being at high risk if classified as unfit. Results Boys were; fitter, had higher HDL levels, and had lower; body fat, LV mass index, insulin and triglyceride levels than girls ( $p \leq 0.05$ ). There were no significant differences in clustered risk score between boys and girls. Participants in the 'at risk' group were less fit than those in the 'normal' risk group ( $p \leq 0.05$ ). The odds of being in the high risk group were 10.75 for those classified as unfit compared to the fit reference group. Discussion These findings provide more evidence that fitness is related to clustered cardiometabolic risk, and highlight the importance of promoting fitness in children. Future studies are required to assess the link between physical activity and clustered cardiometabolic risk in youth. References Andersen L., Sarhinha L, Froberg K, Riddoch C, Page A, Andersen S. (2008). *IJPO*, 3: 58-66. Ekelund U, Andersen S, Froberg K, Sardinha L, Andersen L, Brage S. (2007) *Diabetologia*, 50: 1832-1840.

## Oral presentations

### OP-PM46 Physiology: Respiratory / Hypoxia

#### CAN FOUR NORMOBARIC HYPOXIC EXPOSURES ENHANCE PERFORMANCE IN HYPOXIA?

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INSTITUTE JOZEF STEFAN

Introduction While the ability of longer intermittent hypoxic exposures to improve performance at altitude is well established, the results regarding short protocols remain indefinite (Powell et al. 2000). In particular, the minimal dose required to induce beneficial adaptations for altitude performance is unknown (Muza, 2007). This study aimed to investigate whether four intermittent normobaric exposures (SIH) have the ability to improve performance and modulate ventilatory responses during hypoxic exercise. Methods Nineteen healthy male subjects participated in the single blind, placebo controlled, randomised study and were randomly assigned to either experimental (SIH; n=10) or placebo control (SHAM; n=9) group. They underwent four consecutive intermittent exposures (4 h•day<sup>-1</sup>) under hypoxic (FIO<sub>2</sub>: 0.120) or normoxic condition (FIO<sub>2</sub>: 0.209), respectively. Prior to (PRE) and after the exposures (POST) all subjects performed a constant power test to exhaustion (CP) in hypoxic condition at a work load corresponding to 75% of the previously determined normoxic VO<sub>2</sub>max. Oxygen saturation (SpO<sub>2</sub>), heart rate (HR) and minute ventilation (VE) were measured continuously. Results After the SIH neither group significantly improved the CP performance time. Despite the unchanged CP time, only the EXP group showed significant increases in both VE (+ 15%;  $P < 0.05$ ) and SpO<sub>2</sub> (+ 4%;  $P < 0.05$ ) during the POST CP test. No significant differences were observed between groups and testing periods in HR during the CP test. Discussion Compared to the SHAM group, the tested SIH protocol significantly enhanced the hypoxic exercise ventilation and blood oxygen saturation without a concomitant improvement in performance time. Our obtained data are in agreement with the findings of Katayama et al. (2001) and Ricart et al. (2000) who showed that increased hypoxic chemosensitivity following short intermittent hypobaric hypoxia can lead to ventilatory adaptations during hypoxic exercise. In conclusion, this study shows that four intermittent normobaric hypoxic exposures can induce certain ventilatory acclimatization, while the effects on subsequent performance is more unclear. References Katayama K, Sato Y, Morotome Y, Shima N, Ishida K, Mori S, Miyamura M. (2001). *J Appl Physiol*, 90(4), 1431-40. Muza, SR. (2007). *Med Sci Sports Exerc*, 39(9), 1625-31. Powell, FL, Garcia N. (2000). *High Alt Med Biol*, 1(2), 125-36. Ricart A, Casas H, Casas M, Pages T, Palacios L, Rama R, Rodriguez F, Viscor G, Ventura JL. (2000). *Wilderness Environ Med*, 11(2), 84-8.

#### THE EFFECTS OF NORMOBARIC HYPOXIA ON MITOCHONDRIAL ADAPTATIONS IN RATS.

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Introduction In response to stays at high altitude, contrasting mitochondrial changes have been reported. An early study reported increases in cytochrome c oxidase, while more recent research has observed decreases in oxidative capacity [I]. Consistent with this latter study, researchers have also observed decreases in mitochondrial volume, which were accompanied by increases in lipofuscin [I]. However, none of these studies directly measured mitochondrial respiration and little research has investigated changes in the expression of mitochondrial proteins. The purpose of this study was to investigate the effects of 30 days of normobaric hypoxia on mitochondrial respiration, citrate synthase (CS) activity, and the expression of mitochondrial proteins belonging to the electron transport chain complexes. Methods Twenty Wistar rats were randomly assigned to 30 days of either normobaric normoxia (CON; 21% O<sub>2</sub>) or hypoxia (HYP; 10% O<sub>2</sub>). Immediately after being sacrificed, maximal (2 mM ADP) ADP-stimulated mitochondrial respiration was determined on permeabilised muscle fibres from the left (LV) and right ventricle (RV), and the soleus (SOL) and extensor digitorum longus (EDL). The remaining muscle was stored at -80 oC and subsequently analysed for CS activity (spectrophotometer) and the expression of mitochondrial proteins

(Western blot). Result Maximal ADP-stimulated respiration was significantly greater in HYP for SOL and LV, and tended to be higher for RV ( $p=0.06$ ). These differences remained significant when respiration was corrected for citrate synthase activity (an indicator of mitochondrial mass). The changes in the expression of the mitochondrial proteins tended to mirror those of the changes in mitochondrial respiration. Discussion The significantly greater mitochondrial respiration in the LV of HYP (26%;  $P<0.05$ ) was similar to a previous study (16%, ns) [2]. The non-significantly greater mitochondrial respiration in the RV of HYP is also consistent with previous research and the lack of significance can probably be attributed to greater mass of the RV in HYP [2]. We have shown for the first time however, that there is a greater mitochondrial respiration in the soleus of rats exposed to 30 days of hypoxia. Interestingly, there was a 10% decrease in CS activity in SOL, suggesting that there was a decrease in mitochondrial volume (consistent with previous research), but an increase in mitochondrial function (respiration). References 1. Hoppeler H, Vogt M. Muscle tissue adaptations to hypoxia. *J Exp Biol.* 2001;204:3133-9. 2. Novel-Chat   V, Mateo P, Saks VA, Hoerter JA, Rossi A. Chronic Exposure of Rats to Hypoxic Environment Alters the Mechanism of Energy Transfer in Myocardium. *J Mol Cell Cardiol.* 1998;30(7):1295-303.

## THE EFFECTS OF SHORT-TERM USE OF INHALED SALBUTAMOL ON ANAEROBIC AND AEROBIC EXERCISE PERFORMANCE

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**Purpose** The main purposes of this project were to determine the effects of short term (3 weeks) inhaled salbutamol (SAL) use on aerobic and anaerobic performance in non-asthmatic athletes **Methods** This project used a randomized, double-blind, controlled research design. A total of 50 subjects were screened for lung function with three subjects screened out due to abnormal resting values. All remaining subjects underwent a eucapnic voluntary hyperpnea (EVH) test to screen for susceptibility to bronchospasm. A total of six subjects demonstrated a positive EVH response and of the remaining 41 subjects, five subjects were excluded due to a  $VO_{2max}$  score of  $< 55$  ml/kg/min or 5 L/min leaving 36 subjects in the study (18 per group). Treatment was 200µg SAL three times daily over a period of ~3 weeks. Aerobic performance was measured using an incremental exercise test and mean power output in a 20km time trial while anaerobic performance was measured via vertical jump, and 5 second peak and 30 second mean power in a Wingate cycle test. **Results** Mean time trial performance was similar in both groups pre and post treatment (~313 watts). A slight training effect was observed over the course of the study resulting in higher post values for both Wingate 5 second peak power and absolute  $VO_{2max}$  but this did not differ between treatment groups. Furthermore, there was no difference in peak power at  $VO_{2max}$ . Wingate 30 second mean power output also did not differ between groups. Incidence of compromised lung function (drop in FEV1 of  $>10\%$  following EVH test or abnormal resting spirometry) in this study group was 18%. There was no relationship observed between degree of bronchospasm (% change in FEV1) and change in 20km time trial and Wingate performance following SAL treatment. **Discussion** Short term use of inhaled SAL (600µg daily for 3 weeks) does not have an ergogenic effect on either aerobic or anaerobic performance in trained athletes. This is in agreement with the majority of the literature examining inhaled SAL and is the first examination of the effects of its short term use on exercise performance. These results are also in contrast to findings regarding short term use of oral SAL. This difference would suggest that the current WADA stance in allowing SAL treatment by inhalation only remains appropriate. An interesting finding in this study was that the incidence of compromised lung function in cyclists and triathletes, not previously diagnosed with asthma, was 18%. This is in agreement with our previous findings and the percentage of athletes applying for an abbreviated TUE at the Olympic Games for these two sports. **Acknowledgements** This study was funded by a World Anti-Doping Agency research grant.

## THE ERGOGENIC EFFECT OF 800µG AND 1600µG INHALED SALBUTAMOL ON REPEATED SPRINT PERFORMANCE FOLLOWING A FOOTBALL SPECIFIC TREADMILL RUN AT MODERATE AND HIGH AMBIENT TEMPERATURES

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**Introduction:** The World Anti-Doping Agency (WADA) stipulates that athletes who declare the use of salbutamol in order to treat asthma should not exceed an accumulated dose of 1600µg over a 24 hour period. There is limited data available investigating the ergogenic effect of inhaled supratherapeutic doses of salbutamol on intermittent sports such as football. The purpose of the present study was to investigate the effect of inhaling supratherapeutic doses of salbutamol on repeated sprint performance following a football specific run at moderate and high ambient temperatures. **Methods:** Five male non-asthmatic football players (mean±SD; age 24.4±4.0 years; weight 71.2±3.6 kg; height 174.6±5.1 cm) volunteered and provided written informed consent prior to taking part in this study. Participants attended the lab on six occasions to inhale either a placebo (PLA), 800µg of salbutamol (800SAL) or 1600µg salbutamol (1600SAL) and complete a football specific run on a motorised treadmill at either 18°C (moderate) or 30°C (hot). Following the football specific run participants completed twelve 17.5m sprints with a 10 second rest interval on a non-motorised treadmill. Performance and physiological variables total time, peak power, average power, peak HR and peak blood lactate were recorded. Repeated measures ANOVA were performed to investigate the differences between sprint performance following inhalation of PLA, 800SAL and 1600SAL. Significance was assumed if  $p<0.05$ . **Results:** At moderate temperatures there was no significant difference between PLA, 800SAL or 1600SAL in the performance and physiological variables: total time (52.8±1.6 s; 52.8±1.8 s; 52.5±0.5 s), peak power (1541.0±296.4 w; 1490±423.8 w; 1409.3±242.7 w), average power (560.8±104.3 w; 561.5±96.1 w; 555.5±72.1 w), peak HR (180.0±8.1 b.min<sup>-1</sup>; 183.5±6.0 b.min<sup>-1</sup>; 184.8±7.1 b.min<sup>-1</sup>) or peak blood lactate (11.4±3.2 mmol.l<sup>-1</sup>; 8.0±6.6 mmol.l<sup>-1</sup>; 13.9±2.8 mmol.l<sup>-1</sup>). At hot temperatures there was no significant difference between PLA, 800SAL or 1600SAL in the performance and physiological variables: total time (52.6±0.5 s; 52.0±0.4 s; 53.0±1.7 s), peak power (1032.0±680.2 w; 1010.8±567.1 w; 1468.3±351.9 w), average power (411.3±271.2 w; 380.5±232.3 w; 556.8±88.6 w), peak HR (185.3±8.0 b.min<sup>-1</sup>; 188±6.0 b.min<sup>-1</sup>; 188.3±2.1 b.min<sup>-1</sup>) or peak blood lactate (7.2±1.5 mmol.l<sup>-1</sup>; 10.4±4.0 mmol.l<sup>-1</sup>; 8.5±2.8 mmol.l<sup>-1</sup>). **Discussion:** Our data suggest the WADA position to allow athletes to inhale up to 1600µg in a 24 hour period does not result in any physiological benefits or improvements in sprint performance in non-asthmatic football players in moderate or hot ambient temperatures.



## THE EFFECT OF DEEP, SLOW BREATHING ON LOCOMOTION DURING MODERATE INTENSITY WALKING AND RUNNING

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Respiration, primarily under autonomic control is tightly coupled with locomotion, via the 'Locomotor-Respiratory Coupling' (LRC). Locomotion is thought to dictate respiratory patterns via neuro-mechanical and chemical stimuli but evidence of a bi-directional link exists (Rabler and Kohl, 2000). Considerable evidence supports pulmonary limitation to exercise via various mechanisms (Dempsey, 2006), meriting investigations into possible methods of improvement. Respiratory pattern is an easily manipulated extrinsic parameter, as autonomic control may be consciously overridden. The aim of the present study was to compare the effects of two different breathing patterns on locomotion, SB (spontaneous breathing) and DSB (deep and slow breathing) in people exercising at moderate intensities. A heterogeneous group ( $n=23$ ) of healthy male ( $n=14$ ) and female ( $n=9$ ) subjects, aged between 20 and 52 were recruited. Subjects were either trained runners or untrained with  $\text{VO}_{2\text{peak}}$  ranging from 2.102L/min to 5.124L/min. Following baseline assessment of pulmonary function, aerobic capacity ( $\text{VO}_{2\text{peak}}$ ) and lactate threshold (LT), subjects performed two 20 minute exercise trials at constant load, eliciting a blood lactate level (bLa) of 1mmol/l above LT. SB trial preceded DSB so that a learned effect of DSB would not affect SB trial. Statistical analysis using SPSS used paired sample t-tests and repeated measures ANOVA to examine mean differences in all parameters between trials. The level of significance was set at  $P<0.05$  and all significant 't' and 'F-ratios' were reported with significance level. DSB produced significant changes in respiratory pattern, respiratory rate (RR) decreased by  $34.69 \pm 12.68\%$  ( $p<0.001$ ), VT increased by  $43.62 \pm 6.35\%$  ( $p<0.001$ ) and total time (Ttot) increased by  $84.53 \pm 63.87\%$  ( $p<0.001$ ). Altered LRC was evidenced by an increase in stride rate to respiratory rate ratio (SR:RR) of  $1.17 \pm 0.69$  strides/breath ( $p<0.001$ ) due to a relatively smaller decrease in stride rate (SR) of  $1.48 \pm 2.19$  strides/min ( $p<0.01$ ). Interestingly, DSB resulted in a significant mean decrease in ventilation (VE) of  $5.87 \pm 6.49\text{L/min}$  ( $p<0.001$ ),  $10.32 \pm 11.41\%$  lower than SB, and  $\text{VO}_2$  decreased by  $4.96 \pm 8.97\%$  ( $0.138 \pm 0.249\text{L/min}$ ,  $p<0.05$ ), suggesting that the same mechanical output can be afforded with lower oxygen consumption. This study suggests that a deep, slow breathing pattern affects stride frequency and improves locomotory economy at moderate exercise intensities. Rabler, B. and Kohl, J. (2000). 'Coordination-related changes in the rhythms of breathing and walking in humans', *Eur J Appl Physiol*, 82: 280-288. Dempsey, J.A., Romer, L., Rodman, J., Miller, J. and Smith, C. (2006). Consequences of exercise-induced respiratory muscle work. *Resp Phys & Neuro*, 151(2-3), 242-250.

## THE ATHLETE BIOLOGICAL PASSPORT FOR THE DETECTION OF AUTOLOGOUS BLOOD DOPING IN A LONGITUDINAL BLINDED STUDY

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UNIVERSITY HOSPITAL FREIBURG / UNIVERSITY OF LAUSANNE

**Introduction** - The most promising attempt to screen for otherwise untraceable autologous blood transfusions is the Athlete Biological Passport (ABP) and its adaptive model that enables a longitudinal monitoring of haematological measures to identify patterns of blood manipulations. So far, few studies analysed various blood passport approaches to detect autologous transfusions. Standardised testing protocols were applied with the event of manipulation always known as a reference point. Hence, it remains questionable if these results mirror the true detection sensitivities that can be expected in the field. The purpose therefore was to evaluate the performance of the ABP for the detection of autologous blood transfusions in a blinded setting. **Methods** - Twenty-one subjects were divided into a doped group (multiple transfusions of 1-2 units of erythrocyte concentrates at various time points,  $N=11$ ) and a control group ( $N=10$ ), who were observed over 42 weeks. Up to 10 venous blood samples were ordered per subject by a blinded investigator without knowledge about the group allocation and time point of transfusions. Mimicking an "intelligent testing" approach, the investigator based his testing regime on the haematological data treated by the adaptive model (haemoglobin concentration (Hb) (g/L), reticulocytes (ret%) (%), OFF-hr and respective sequences) and had to identify the doped subjects ("identification" was defined as values beyond the 99% or 99.9% probability thresholds of the ABP). **Results** - Analysis allowed the identification of 4 (probability  $>99\%$ ) or 3 (probability  $>99.9\%$ ) doped subjects using Hb and 8 (probability  $>99\%$ ) or 5 (probability  $>99.9\%$ ) subjects using OFF-hr. One false-positive value for Hb was observed in the control group at both probability levels. Three doped subjects (27%) presented an abnormal Hb sequence and 4 doped subjects (36%) an abnormal OFF-hr sequence, there were no false positive sequence results. The best possible sensitivity was 82% when a combination of all tests was used as 2 of 11 subjects of the doped group remained undetected when applying the above criteria. **Discussion** - This investigation provides evidence that the adaptive model allows detection of autologous blood transfusions with a good sensitivity in a longitudinal blinded setting. An intelligent testing approach and the adherence to WADA's ABP operating guidelines are determinant in the success.

## Oral presentations

### OP-SH06 Statistics and Coaching

## ASSOCIATION BETWEEN ANTHROPOMETRIC CHARACTERISTICS AND RESISTANCE AGAINST PEAK EXTERNAL WEIGHT DURING EGGBEATER KICK IN WATER-POLO.

BOTONIS, P.G., PLATANOU, T.

UNIVERSITY OF ATHENS

**Introduction** The eggbeater kick is a cyclical movement of the lower limbs, which is performed by the knees with similar and symmetrical actions of the right and left sides, but with alternating leg phases (Platanou 2005). Resistance against opponent's pressure is a very important ability for water-polo players, as it contributes to execute various actions. This ability is dependent on the forces generated upwards to raise the body reacting on the rival's pressure and on the weight of the player acting downwards. In addition, it is known that the force generated is dependent on the pressure differences of the fluid acting on the limbs. However, it is unknown, whether this ability is dependent on players' anthropometric characteristics. The aim of the present study was to exam the association between anthropometric characteristics and the peak external pressure that a player can resist, during an eggbeater kick. **Methods** Twenty-eight water-polo players were tested. In the beginning, 12 anthropometric variables (body mass, stature, arm length, forearm length, hand length, lower limb length, knee length, the length from the ankle to the ground and the perimeter of biceps at rest and after contraction) were measured. Thereafter, each participant performed the eggbeater kick that lasted 20 sec. initially without any external loads and then with a progressive increase of external pressure with hands out of the water. The weights were placed in special sheaths of a zone and were

positioned on the subject's shoulder. The inability of the participant to keep his hands out of the water during the eggbeater with external pressure was considered as the peak external load that a player could resist. Pearson correlation was employed to identify significant correlations between anthropometrics and maximal external weight. Results The analysis revealed that participants' ability to resist peak external weight ( $14.68 \pm 3.43$  kg) was significantly correlated with body mass ( $84.14 \pm 10.03$ ,  $r=0.58$ ,  $P<0.05$ ), stature ( $182.16 \pm 7.54$  cm,  $r=0.61$ ,  $P<0.05$ ), arm length ( $80.46 \pm 5.61$  cm,  $r=0.64$ ,  $P<0.05$ ), lower limb length ( $93.15 \pm 5.40$  cm,  $r=0.39$ ,  $P<0.05$ ) and forearm length ( $47.13 \pm 3.86$  cm,  $r=0.41$ ,  $P<0.05$ ). Moreover, contracted biceps perimeter ( $35.5 \pm 4.44$  cm) and the difference between biceps perimeter at rest and after contraction were significantly correlated with water polo players' ability to resist against the peak external load ( $r=0.46$  and  $r=0.38$ , respectively,  $P<0.05$ ). Discussion In conclusion, the ability to resist peak external loads seems to be dependent on the anthropometric and dynamic characteristics of water polo players. The present data are useful in determining loads during leg training. Platanou T. (2005). J Sports Med Phys fitness. 45(1), 26-31.

## DOES DATE OF BIRTH INFLUENCE PERFORMANCE OF SWISS TRACK AND FIELD ATHLETES?

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Introduction Identifying talented athletes at an early age has become one of the major issues in many competitive sports. The relative age, which refers to the difference in age between children in the same selection year, has a significant influence in the talent identification process (Cobley et al., 2010). The primary purpose of this study was to determine, if the date of birth influences performance of Swiss track and field athletes. Methods 840 female and 840 male athletes who achieved one of the best 30 results (Top 30) in their age category (U10 to elite) in the year 2010 were evaluated. The year was divided into four quarters (Q1: Jan. to Mar.; Q2: Apr. to June; Q3: July to Sept. and Q4 Oct. to Dec.). The percentage of athletes born in the respective quartiles was compared to the distribution of all registered members (RM) in the federation and to all respective births in Switzerland (BP). Sprint, middle-distance, long jump and javelin throw performance were examined for each age group. Statistical comparisons were calculated using chi2-tests. Results Relative age effects (RAEs) were found with a distribution of Q1=38.2%, Q2=26.3%, Q3=20.0%, Q4=15.5% for female and Q1=42.5%, Q2=30.8%, Q3=16.5%, Q4=10.2% for male athletes. The month of birth distribution differed significantly from the BP and the RM for the respective years in both groups ( $p<0.001$ ). RAEs are more pronounced in the U10-U14 age group than in the older athletes, whereas no differences between U10-U14 boys and girls (except for middle-distance) RAEs could be found. No significant differences were found by comparing events. Discussion RAEs exist in many competitive sports worldwide and are clearly evident in athletics in Switzerland. In particular, the chance of achieving a Top 30 male result is 4-fold higher for athletes born in Q1 compared to Q4. Our results suggest, that a significant part of Top 30 results may be explained by RAEs. It seems that Athletes born in Q1 take advantage of their larger experience, enhanced mental and physical skills and hence perform at a higher level (Armstrong & McManus, 2010). Especially for Switzerland, which has a rather shallow talent pool due to the small number of inhabitants, any reduction of RAEs may produce a substantial performance enhancement at elite senior level in future. References Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual Age-Grouping and Athlete Development A Meta-Analytical Review of Relative Age Effects in Sport. Sports Medicine, 39(3), 235-256. Armstrong, N. & McManus, A.M. (2010). Physiology of elite young male athletes. Med Sport Sci., 56:1-22.

## MODELING THE PROGRESSION OF COMPETITIVE PERFORMANCE OF AN ACADEMY'S FOOTBALL TEAMS

MALCATA, R.1, HOPKINS, W.G.1,2, RICHARDSON, S.2

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Introduction "Have our athletes improved?" is an important question for coaches and support staff, but there appears to have been no published research on this topic with team sports for periods longer than a season. Here we report the progression of three teams of the ASPIRE Academy over five seasons using a novel analytic approach based on generalized mixed modeling. Methods The Aspire teams consisted of players born in 1991, 1992 and 1993; they played totals of 115, 107 and 122 games in Asia and Europe between 2005 and 2010 against teams differing in age by up to 3 years. Game scores predicted by the mixed model were assumed to have an over-dispersed Poisson distribution. The fixed effects in the model estimated annual linear progression of ASPIRE and of the other teams (grouped as a single opponent) adjusted for a home-ground advantage and for a linear effect of age difference between the competing teams. Games played against the same team were accounted for by including a random effect representing each team's mean score. All effects were estimated as factors via log-transformation and presented as percent differences in scores. Inferences were based on the span of 90% confidence intervals in relation to thresholds for small and moderate factor effects of  $\times/\div \pm 1.10$  and  $\times/\div \pm 1.40$  (+10%/-9% and +40%/-29%). Results Most effects were clear only when data for the three teams were combined. Scores of teams playing at home and of teams one year older than their opponents were higher by 27% (90% confidence interval 13 to 42%) and 23% (7 to 42%), both representing small effects. After adjustment for these effects, the Aspire teams scored on average 1.5 goals per match, with little change in the five years of their existence, whereas their opponents' scores fell from 1.4 in their first year to 1.1 in their last. The difference in progression was trivial over 1 year (7%, -4 to 20%), small over 2 years (15%, -8 to 44%), but unclear over >2 years. Conclusion The generalized mixed model has marginal utility for estimating progression of football team scores, owing to the uncertainty in the estimates of single teams. The estimates are likely to be more precise and useful for teams in sports with higher game scores.

## VELOCITY AND ACCELERATION BEFORE THE TACKLE IN REAL MATCH SITUATIONS

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Background: The tackle event in rugby union, at all levels of play (amateur to professional, juniors to seniors) places both ball-carrier (BC) and tackler (T) at high risk of injury compared to any other facet of play. The velocity at which the BC and T enter the tackle (and the velocity difference between the two) is regarded as a risk factor for injury. For this reason, a better understanding of the dynamics of the tackle is warranted. To date, only velocity and acceleration measurements for the tackle have been conducted in controlled settings. Aim: To determine the velocity and accelerations profiles before the tackle in real match situations at 3 different playing levels. Methods: Ten Front-on and 10 side-on tackle situations in the 2010 Super 14 (S14), Varsity Cup (VC), and Currie Cup Under 19 (U19) matches were analysed. Thereafter, using a novel video analysis system, the BC and T were tracked for 0.5 seconds (s) before contact in each tackle situation. The 0.5s were further divided into 0.1s segments (T1 to T5). The displacement covered by the BC and T were measured for each 0.1

segment. Accordingly, velocity (m/s) and acceleration (m/s<sup>2</sup>) were calculated for the BC and T. Data are reported as mean (over T1-T5)  $\pm$  standard deviation. Results: Velocity profiles for the BC during front-on tackles were; S14;  $4.80 \pm 2.90$ , VC;  $5.20 \pm 1$ , U19;  $4.88 \pm 1.72$  m/s. Velocity for the T during front-on tackles were; S14;  $4.97 \pm 1.78$ , VC;  $6.43 \pm 2.55$ , U19;  $5.73 \pm 1.85$  m/s. Velocity profiles for the BC during side-on tackles were; S14;  $4.85 \pm 2.09$ , VC;  $5.75 \pm 1.78$ , U19;  $4.72 \pm 1.29$  m/s. Velocity for the T during side-on tackles were; S14;  $5.40 \pm 2.20$ , VC;  $5.50 \pm 2.13$ , U19;  $3.86 \pm 1.13$ . Acceleration profiles for the BC during front-on tackles were S14;  $-1.24 \pm 4.88$ , VC;  $1.98 \pm 4.98$ , U19;  $-0.76 \pm 8.56$  m/s<sup>2</sup>. Acceleration profiles for the T during front-on tackles were; S14;  $-1.62 \pm 9.62$ , VC;  $-6.49 \pm 10.64$ , U19;  $-2.65 \pm 8.84$  m/s<sup>2</sup>. Acceleration profiles for the BC during side-on tackles were; S14;  $-1.26 \pm 8.67$ , VC;  $-2.02 \pm 6.24$ , U19;  $-0.95 \pm 9.99$  m/s<sup>2</sup>. Acceleration profiles for the T during side-on tackles were; S14;  $-2.44 \pm 10.12$ , VC;  $-5.28 \pm 6.30$ , U19;  $2.67 \pm 3.59$  m/s<sup>2</sup>. No statistical significant differences were found between the different levels of play and between the BC and T (for each group) Conclusion: Our results are comparable with studies conducted in controlled settings. Surprisingly, no differences for velocity and acceleration were found between the different levels of play. This can be attributed to 1) the variable nature of the tackle, 2) Entering the tackle at a high velocity or positive acceleration is not necessarily a pre-requisite for success in contact, 3) Although the levels of play are different, speed training, ball-carrying and tackle training habits may be the same.

## VISUAL SEARCH STRATEGIES OF VOLLEYBALL PLAYERS IN LIVE ACTION SCENARIOS: A COMPARISON ACROSS DIFFERENT AGE GROUPS

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Visual search strategies provide useful insight into decision-making in sport. However, researchers have typically gathered data using laboratory-based protocols rather than collecting data in situ. We examined differences in the visual search strategies employed by female volleyball players varying in age using a field-based test protocol. Twenty-seven participants (twelve under-15 years, nine under-17 years, and six adults), belonging to top-ranked teams within their respective age group were recruited. Participants wore an ASL@3000 eye tracking system during live-action defensive tasks in the backcourt region (six trials each). The opposing team developed various offensive sequences and blockers were employed to enhance the similarity to the competition demands. Separate One-way ANOVAs showed differences across the three groups in the mean number of fixations, total and average fixation duration, and number of fixation locations ( $p \leq 0.05$ ). Post-hoc procedures (Scheffe) showed that the U-15 participants performed fewer fixations and gazed upon fewer locations than both the U-17 and adult players, thus potentially using less sources of information. In contrast, the U-15 group employed longer total and average fixation durations. With respect to the areas fixated upon, chi-square showed differences across the age groups ( $p \leq 0.05$ ). The U-15 participants fixated less often the middle-attacker's action before the setting, while adult players frequently attend to this area. The faster attacks conducted by adult teams may induce a stronger need to attend to such action. In conclusion, younger participants focused on fewer sources of information than older players, but fixated for longer periods of time on each location, suggesting that they needed more time to retrieve meaningful information. Furthermore, the fixation or absence of fixation on the middle-attacker's action may point towards greater attunement to the constraints specific to the level of play at which they perform. Acknowledgements: Financed by the Foundation for Science and Technology – Ministry of Science, Technology and Superior Teaching of Portugal (SFRH/BD/45428/2008).

## WORLD RECORD TIMES IN TRACK CYCLING – THE IMPORTANCE OF ALLOWING FOR CHANGES IN ENVIRONMENTAL CONDITIONS

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Introduction Air temperature, barometric pressure and relative humidity can have a significant effect on track cycling performance, which makes the comparison of world record performances that are achieved under different environmental conditions, unfair. The UCI and some national cycling associations acknowledge that altitude and temperature can affect track cycling performance. However, these acknowledgments ignore the important effects of barometric pressure and humidity, both of which vary daily and seasonally, and also affect air density, aerodynamic drag and performance in pursuit and time trial events. There does not appear to be a comprehensive allowance made for the effect of environmental conditions on track cycling performance that is consistently applied to new performances that are close to world record times. The present study highlights this issue by illustrating the important effect of changes in barometric pressure and humidity on pursuit performance. Methods A case study approach was taken whereby a 3000m pursuit performance, recorded officially at a World Cup event, was modelled to quantify the power output of the athlete throughout the race. Mathematical modelling was performed using published cycling specific equations that relate drag and power to velocity and therefore pursuit time (1,2). Subsequently, by keeping the power output of the athlete constant in the model, the effect of temperature, pressure and humidity on pursuit velocity can be assessed by varying these three environmental factors in a stepwise process. Results Mathematical modelling of the effect of varying ambient conditions indicates that each degree of increase in temperature above 20°C results in a decrease in pursuit time of 0.07 s/1000 m, each 10% increase in humidity above 50% decreases pursuit time by 0.4 s/1000 m and each 6.6 hPa decrease in barometric pressure increases pursuit time by 0.13 s/1000 m. When the actual changes in all three ambient conditions are compared, the relative magnitude of their contribution to the total change in pursuit performance is; temperature 49%, barometric pressure 37% and humidity 14%. Discussion/Conclusion The present calculation of the effect of temperature on pursuit performance is very close to that predicted by Cycling Australia (0.07 vs. 0.08s/1000m). The combined effect of all three factors can account for a difference of up to 6 s between two 4000 m pursuits performed in different conditions, where the difference has nothing to do with the skill, power output or drag coefficient of the athlete. It may be necessary to adjust track times to standard conditions, to allow fair comparison between performances that are close to current world records. References 1. Martin, J. et al. Validation of a mathematical model for road cycling power. *Journal of Applied Biomechanics*, 1998, 14, 276-291. 2. Davis, R.S.P. Equation for the determination of the density of moist air (1981/91) *Metrologia*, 1992, 29, 67-70.

## Oral presentations

### OP-SH08 Sport Psychology 2

#### TRAINING TIME EFFECTS ON PSYCHO-PHYSIOLOGICAL RESPONSES TO EXERCISE IN MASTER ATHLETES

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Training time effects on psycho-physiological responses to exercise in Master athletes Piacentini M.F.,<sup>1</sup> Ferragina A.,<sup>2</sup> Ammendolia A.,<sup>2</sup> Cibelli G.,<sup>3</sup> Capranica L.<sup>1</sup> <sup>1</sup>DISMUS, University of Rome Foro Italico, Italy. <sup>2</sup>School of Medicine, University of Catanzaro, Italy <sup>3</sup>School of Medicine, University of Foggia, Italy Introduction Because most physiological and psychological parameters exhibit circadian rhythms, it is important to understand daily variations of athletic performance components (Cappaert, 1999). This issue is crucial for master endurance athletes who adjust their training schedule according to work and family duties. Therefore, the purpose of the present study was to evaluate psycho-physiological and performance responses to a training performed during morning (M), afternoon (A) and evening (E) sessions. Methods 8 master athletes (45±7yrs) performed three (i.e., M: 6-8h, A: 12-14h, and E: 19-21h pm), running sessions consisting of one 3000m at 80% of the individual maximal aerobic speed, 5-min recovery, and one all-out 1000m. An ANOVA for repeated measures was used to verify differences ( $p < 0.05$ ) between daily sessions in session-ratings of perceived exertion (session-RPE), profiles of mood state (POMS), salivary cortisol (sC), and performance parameters. Moreover, sC concentrations were compared with time-matched values collected during a resting day. Results No difference was found for all-out 1000m performances (M: 17.2±1.3km/h; A: 17.5±0.9km/h; E: 17.5±1.1km/h). Lower ( $p = 0.037$ ) session-RPE emerged only for E (259.3±69 AU) with respect to M (359.7±111AU). Higher post-exercise sC increases were observed for E (169%) with respect to A (80%) and M (89%). However, the AUC was significantly lower ( $p = 0.001$ ) in the E trial (28.8±9.2 AU) compared to M (41±6 AU) and A (41±13 AU) ones. After the 1000m and during 30-min and 60-min of recovery exercise sC was always significantly higher than time-matched resting values. Although no difference was found for post-exercise POMS sub-scales and total mood disturbance, pre-exercise fatigue was higher ( $p = 0.03$ ) in E (11.5±6.8pt) with respect to M (9.1±5pt) and A (10±7pt). Discussion Despite daily variations were expected (Trine and Morgan 1995, Dimitriou et al 2002), in our study performance and total mood did not differ. Conversely, E showed a higher pre-exercise fatigue perceptions and a trend toward higher sC increases due to training, indicating a cumulated fatigue from previous daily activities. However, the lower session-RPE and cortisol AUC observed at the end of E training might indicate a perceived relief effect of exercise, which could be of interest for athletes and coaches. References Trine MR and Morgan WP (1995) *Sports Med* 20 (5):328-337 Cappaert TA (1999) *J Strength Cond Res* 13(4), 412-421 Dimitriou L. Sharp NCC, Doherty M (2002) *Br J Sports Med* 36:260-264

#### DEVELOPMENT OF BURNOUT AMONG ADOLESCENT HIGH LEVEL ATHLETES: CAUSAL RELATIONSHIPS BETWEEN THE THREE DIMENSIONS

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Introduction Raedeke (1997) have identified three dimensions that define the athlete burnout: reduced sense of accomplishment (RA), sport devaluation (SD), and physical and emotional exhaustion (PEE). In the organizational domain, it has been assumed that it may exist causal relationships between the three dimensions of burnout. Taris, Leblanc, Schaufeli and Schreurs (2005) have shown that emotional exhaustion can lead to depersonalization which may lead to a reduced personal accomplishment. Emotional exhaustion could also have a direct impact on reduced personal accomplishment. To our knowledge, in the sports domain, only two studies tried to share some light on this aspect, they highlighted that sport devaluation is the last step and that physical and emotional exhaustion is the key component of athlete burnout. However, they used retrospective interviews with a small number of athletes (Cresswell & Eklund, 2007; Gustafsson, Hassmén, Kenttä, & Johansson, 2008). Therefore, the objective of this study is to test relationships between the three dimensions of burnout. We postulate that physical and emotional exhaustion is the first symptom of athlete burnout, and that it would have an influence on the sport devaluation, which in turn should have an impact on reduced accomplishment. Methods The study enrolled a total of 919 handball players (438 girls and 481 boys) aged from 13 to 19 years old. The athletes completed a French version of the Athlete Burnout Questionnaire (Questionnaire du Burnout Sportif; QBS; Isoard-Gauthier, Oger, Guillet & Martin-Krumm, 2010) twice a year during three seasons. Results Results of latent growth analyses revealed that RA is higher for players with more PEE and SD, and this difference is constant across time. Among individuals with low SD, PEE rises slowly till 19 years old, and among individuals with high SD, PEE rises till 16 years old then decreases till 19 years old. Among players with higher RA, SD rises more than among individuals with lower RA. Finally, for players with higher PEE, SD rises slower than for players with lower PEE. Discussion The results of the current study highlight the process of athlete burnout among young high level handball players in elite training centers. The development of sport devaluation is influenced by reduced accomplishment and physical and emotional exhaustion and have a reciprocal influence on the development of physical and emotional exhaustion. References Cresswell & Eklund (2007). *The Sport Psychologist*, 21, 1-20. Gustafsson, H., Hassmén, P., Kenttä, G., & Johansson, M. (2008). *Psychology of Sport and Exercise*, 9, 800-816. Isoard-Gauthier, S., Oger, M., Guillet, E., & Martin-Krumm, C. (2010). *Journal of Psychological Assessment*, 26(3), 203-211. Raedeke, T. D. (1997). *Journal of Sport & Exercise Psychology*, 19, 396-417 Taris, T. W., Leblanc, P. M., Schaufeli, W. B., & Schreurs, P. J. G. (2005). *Work & Stress*, 19(3), 238-255

#### GENDER DIFFERENCES IN STRESS AND COPING DURING EXECUTION OF A COMPLEX MOTOR TASK

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Introduction Recent reviews have suggested that male and female athletes might utilize different coping strategies when dealing with stressful encounters (e.g., Nicholls & Polman, 2007). However, due to past methodological limitations, and lack of theory driven studies, it is not clear whether gender differences in coping are due to the appraisal process (role constraint theory- Rosario, Schinn, Morch, & Huckabee, 1988) or actual coping behaviour (dispositional hypothesis- Tamres, Janicki, & Helgeson, 2002). Therefore we investigated gender differences in coping using an experimental paradigm. Method 17 Males and 14 females participants aged between 18 and 45 years old (M age = 23.35 years; SD = 7.30), completed a novel golf task under control and stress conditions. Stress responses were assessed in terms of heart rate, task completion time, and state anxiety. Stress appraisal in terms of nature of stressors and coping was

assessed online using a think aloud protocol. Results Similar stress responses were found for males and females, in terms of increased heart rate, task completion time, and cognitive state anxiety. Significant gender differences in relation to the frequency of stressors cited and the coping strategies used were found. Differences in coping strategies observed between the genders were likely to be a consequence of different stress appraisals, in particular the frequency of the stressors reported. Discussion The findings of the present study provide tentative support for the situational hypothesis theory, as males and females have a tendency to use similar coping strategies if they appraise the same stressors within the same situation. It is recommended that future research investigating gender differences in coping in sport considers stress appraisal to a greater extent. References Nicholls, A. R., & Polman, R. C. J. (2007). Coping in sport: A systematic review. *Journal of Sport Sciences*, 25, 11-31. doi: 10.1080/02640410600630654 Rosario, M., Shinn, M., Morch, H., & Carol, B. H. (1988). Gender differences in coping and social supports: Testing socialization and role constraint theories. *Journal of Community Psychology* 16, 55-69. doi: 10.1002/1520-6629(198801) Tamres, L.K., Janicki, D., & Helgeson, V.S. (2002). Sex differences in coping behavior: A meta-analytic review and an examination of relative coping. *Personality and Social Psychology Review* 6, 2-30. doi: 10.1207/S15327957PSPR0601\_1

## APPROACH-AVOIDANCE GOALS IN TEAM SPORT ATHLETES': THE PREDICTIVE ABILITY OF THE MOTIVATIONAL CLIMATE

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Introduction: The motivational climate is an important determinant of athletes' achievement goals. The relationship between the motivational climate and athletes' achievement goals is also well examined within the dichotomous achievement goal framework. However, the relationship between the motivational climate and athletes' approach-avoidance achievement goals (Elliot, 1999) is still an unexplored area in competitive sports. The only study to date in competitive sports included the higher order dimensions, mastery and performance climate, not the six underlying dimensions (Morris & Kavussanu, 2008). The purpose of this study was to examine whether motivational climate dimensions can predict team sport athletes' approach-avoidance achievement goals. Methods: 319 team-sport athletes' (males=156, females=163, mean age=20 years, SD=3.6) completed measures of the perceived motivational climate (PMCSQ-2) and approach-avoidance achievement goals (AGQ-S). Hierarchical regression analyses for each of the four achievement goals were performed, while controlling for the effect of age and gender. Two sets of analyses were performed: (1) using the higher order dimensions as predictors; and (2) using the six underlying dimensions as predictors. Results: The first set of analyses showed that mastery-approach goals were positively predicted by a mastery climate; mastery-avoidance goals were positively predicted by a performance climate and also influenced by age and gender; performance-approach goals were positively predicted by a mastery climate and a performance climate; and performance-avoidance goals were positively predicted by a performance climate and also influenced by age. The second set of analyses showed that mastery-approach goals were positively predicted by Effort/Improvement; mastery-avoidance goals were positively predicted by Punishment for Mistakes and also influenced by age and gender; performance-approach goals were positively predicted by Intra-Team Member Rivalry; whereas performance-avoidance goals were only influenced by age. Discussion: These findings indicate differential relationships between the motivational climate dimensions and competitive athletes' approach-avoidance goals. The cross-over effects from social-environmental to individual achievement goals (e.g., that a performance climate predicted mastery-avoidance goals) highlight the need for future research to develop measures addressing both approach and avoidance aspects of the motivational climate. References Elliot, A.J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist*, 34, 169-189. Morris, R. L. & Kavussanu, M. (2008). Antecedents of approach-avoidance goals in sport. *Journal of Sports Sciences*, 26, 465-476.

## EFFECTS OF TYPE-D PERSONALITY ON STRESS APPRAISAL, COPING AND COPING EFFECTIVENESS IN ATHLETES

POLMAN, R., KAISELER, M., BORKOLES, E.  
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The distressed or Type D personality has received significant attention in the health literature. Type D personality is characterized by high levels of negative affectivity and social inhibition (Denollet, 2005). Type D has been shown to be associated with maladaptive coping patterns. We investigated the role of Type D on the appraisal of a self-selected stressor, coping and coping effectiveness in a sample of athletes. We predicted that Type D athletes would perceive a stressful event with higher levels of stress intensity and lower levels of control. Also, such athletes would use more emotion focused and avoidance coping strategies and would rate these as less effective. Method: Participants were 426 athletes (age 20.21 years; SD = 2.07 years) of which 259 were males and 167 females. The athletes completed a questionnaire pack consisting of demographic information, the DS14 and the modified MCOPE in response to a self-selected stressor. Participants also indicated how stressful they perceived this event to be as well as the control they perceived to have over the event. Results: 28.9% (n = 123) could be classified as having the Type D personality whereas 71.1% (n = 303) was classified as not possessing Type D. The MANOVA for stress appraisal was significant ( $P = .03$ ;  $\eta^2 = .02$ ). Follow-up ANOVA indicated that Type D individuals rated the self selected stressors with higher levels of stress intensity ( $P = .008$ ;  $\eta^2 = .02$ ). However, no difference was found in perceived control ( $P = .74$ ). The MANCOVA (controlling for stress intensity) for coping was significant ( $P < .001$ ;  $\eta^2 = .14$ ). Follow-up ANCOVA showed that Type D individuals were more likely to use Active Planning ( $P < .001$ ;  $\eta^2 = .03$ ), Behavioral Disengagement ( $P < .001$ ;  $\eta^2 = .03$ ), Venting Emotions ( $P < .001$ ;  $\eta^2 = .3$ ), and Wishful Thinking ( $P = .01$ ;  $\eta^2 = .02$ ) but less Seeking Informational Social Support ( $P = .02$ ;  $\eta^2 = .02$ ) and Increasing Effort ( $P < .001$ ;  $\eta^2 = .05$ ). The MANCOVA for coping effectiveness was also significant ( $P = .001$ ;  $\eta^2 = .08$ ). The Strategies which were used less by the Type D individuals were also rated as less effective (SISS  $P = .04$ ;  $\eta^2 = .01$ ; Increasing Effort  $P < .001$ ;  $\eta^2 = .04$ ) whereas the strategies which were reported to be used more by Type D individuals were rated to be rated as more effective except Active Planning. Conclusion: The higher levels of stress intensity for Type D individuals indicate that competing in sport is more stressful for them than non Type D individuals. Also, as predicted, Type D athletes were more likely to adopt coping strategies which are considered maladaptive or less effective to deal with acute stressors in sport. In particular, Type D was associated with more use of avoidance and emotion-focused coping strategies but less problem-focused coping strategies. Although not investigated in the present study this could have consequences for performance and satisfaction. Denollet, J. (2005). DS14: Standard assessment of negative affectivity, social inhibition, and Type D personality. *Psychosomatic Medicine*, 67, 89-97.

**BENEFICIAL EFFECTS OF PSYCHOLOGICAL INTERVENTIONS WITH YOUNG FOOTBALL PLAYERS**

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**INTRODUCTION** Considering that we live in a country marked by deep social inequalities, where young people dream to become football players expecting to achieve personal success and improvement in life's material conditions, it's necessary to investigate special devices of psychological treatment for the beginner athletes. Based on current research about the psychological conditions of female athletes (Brink, Visscher, Coutts & Lemmik, 2010; Patel, Omar & Terry, 2010; Resch, 2010), we create a program of psychological care according to a psychoanalytic approach (Winnicott, 1996). This program is characterized by the proposition of a large range of playful activities and appreciation of the bonds between athlete, group and psychologist. This research aims to evaluate the clinical efficacy of this program focusing on female soccer players, aged between eighteen and twenty-four years old, who were treated over twenty-eight weeks. **METHODS** For verification of clinical effects, we used two of the "Psychopathological Indicators" (Caligor, Kernberg & Clarkin, 2007) – integration of self and forms of defense against anxiety –, qualitatively considered in two moments: before and after participation in the program. **RESULTS** We observed a significant reduction from baseline athletes' levels of anxiety and also their conducts became more mature throughout the process, showing a value contribution to the strengthening of the tendency of personal integration. **DISCUSSION** The girls showed the use of strategies that have become more mature, gaining access to athletic identity as a very important aspect, but not central in terms of personality. These changes are consistent with improved knowledge in the field of psychoanalytic psychopathology of the self, proving that the psychological care given can be considered clinically effective enabling the personal growth of athletes. **REFERENCES** 1-Brink, MS, Visscher C, Coutts AJ, Lemmink KA. Changes in perceived stress and recovery in overreached young elite soccer players. *Scand J Med Sci Sports*. 2010. 2-Calligor, E, Kernberg, O Clarkin, JU. *Handbook of Dynamic Psychotherapy for Higher Level Personality Pathology*. New York, American Psychiatric Publishing, 2007. 3-Kernberg O *Borderline Conditions and Pathological Narcissism*. New York, Aronson, 2000. 4-Patel DR, Omar H, Terry M Sport-related performance anxiety in young female athletes. *J Pediatr Adolesc Gynecol*. 2010. 5-Resch M Psychological factors affecting athletic performance [Article in Hungarian]. *Pszichiatrai és Mentálhigiénés Osztály, Gyógy. Orv. Hetil.* 2010. 6-Winnicott, D.W. *Maturational Processes and the Facilitating Environment: Studies in the Theory of Emotional Development*. London, Karnac, 1996.

**10:15 - 11:45****Oral presentations****OP-PM42 Muscle: Damage and Recovery****EFFECTS OF FATIGUE ON THE FUNCTIONAL HAMSTRINGS-TO-QUADRICEPS RATIO IN AMATEUR FEMALE SOCCER PLAYERS**

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Epidemiological studies have revealed that females are two to ten times more likely than males to have anterior cruciate ligament (ACL) injuries (4). Among the risk factors for ACL sprains, the imbalance between the strength developed by the hamstrings and the quadriceps, usually calculated as the functional hamstrings-to-quadriceps ratio (Hecc:Qcon, ratio of peak eccentric torque of the hamstrings to peak concentric torque of the quadriceps) has been evidenced as a crucial modifiable parameter (5). In soccer, the high incidence of ACL sprains towards the end of games suggests an effect of fatigue on the strength characteristics of the thigh muscles. However, the effect of soccer-specific fatigue on imbalances of the thigh muscles has only been studied in male players (1,2,3). Therefore the aim of this study was to investigate the effects of fatigue induced by a field test representative of soccer-specific movements on the functional hamstrings-to-quadriceps ratio (Hecc:Qcon) in the dominant and non-dominant legs. Fourteen female soccer players (age, 26.1±4.6 years; height, 168±12 cm; body mass, 62.7±5.5 kg; body fat, 23.7±2.2%) volunteered for this study. They took part in the Loughborough Intermittent Shuttle Test (LIST) to induce fatigue. Isokinetic strength assessments of the hamstrings and quadriceps on the dominant and non-dominant legs at 120°•s<sup>-1</sup> were performed before and immediately after the LIST. Peak torque measurements allowed to calculate Hecc:Qcon. A two-way univariate analysis of variance (ANOVA) was used to assess the effect of time and leg dominance on Hecc:Qcon. The main results showed that the modified LIST led to a significant decrease in Hecc:Qcon in both legs ( $P = .02$ ). However, this decrease was not significantly different between dominant and non-dominant legs (-14.1% vs. -8.0%,  $P = .42$ ). Hecc:Qcon decreases with fatigue, by the same extent in both legs. The decrease in the Hecc:Qcon reflected a greater risk of ACL injuries at the end of soccer games, mainly due to the effects of fatigue on eccentric torques of the hamstrings. This suggests the need to implement screening sessions throughout the season to characterise muscle imbalances in female soccer players. The subjects at risk could then be given a specific strengthening programme focused on eccentric strengthening of the hamstrings. **References** 1. Greig M. *Am J Sports Med*. 2008; 36: 1403-1409. 2. Rahnema N, Reilly T, Lees A. *J Sports Sci*. 2003; 21: 933-942. 3. Small K, McNaughton L, Greig M, Lovell R. *J Sci Med Sport*. 2010; 13: 120-125. 4. Soderman K, Pietila T, Alfredson H, Werner S. *Scand J Med Sci Sports*. 2002; 12: 65-68. 5. Woo SL, Hollis JM, Adams DJ, Lyon RM, Takai S. *Am J Sports Med*. 1991; 19: 17-225.

**EFFECT OF SET-REPETITION CONFIGURATION IN ECCENTRIC EXERCISE ON MUSCLE DAMAGE AND REPEATED BOUT EFFECT**

CHAN, R.

EDITH COWAN UNIVERSITY

**EFFECT OF SET-REPETITION CONFIGURATION IN ECCENTRIC EXERCISE ON MUSCLE DAMAGE AND REPEATED BOUT EFFECT** Roy Chan, Michael Newton, Kazunori Nosaka Edith Cowan University (Australia) **Introduction** The number of eccentric contractions is a factor determining the magnitude of muscle damage; however, it is not known if a different set-repetition configuration for the same number of eccentric contractions (e.g. 3 sets of 10 repetitions vs 10 sets of 3 repetitions) would result in different magnitudes of muscle damage. Muscles become

more resilient to damage after a single exercise bout (repeated bout effect) with as little as two maximal eccentric contractions [1], but it is unknown how the repeated bout effect can be minimised or reduced. The present study tested the hypothesis that altering the set-repetition configuration would affect the magnitude of muscle damage and the repeated bout. Methods Ten non-resistance trained men ( $26.1 \pm 4.1$  y) performed two bouts of eccentric exercise of the elbow flexors for each arm (4 bouts in total). One arm performed 3 sets of 10 maximal eccentric contractions (3x10) followed 4 weeks by 20 sets of 3 maximal eccentric contractions (20x3). The contralateral arm performed 10 sets of 3 maximal eccentric contractions (10x3) followed 4 week by the 20x3 exercise. The order of the exercise (3x10,10x3) and the use of arm (dominant, non-dominant) were counterbalanced amongst subjects. Changes in maximal voluntary isometric and concentric contraction strength, range of motion, cross-sectional area using extended-field-of-view ultrasonography technique, muscle soreness and plasma creatine kinase activity for 4 days after the first and second exercise bouts were compared between arms by a two-way repeated measures ANOVA. Results The torque produced over 30 eccentric contractions was similar between the 3x10 and 10x3 bouts, and the changes in torque during the 20x3 exercise were similar between arms. All criterion measures changed significantly ( $P<0.05$ ) after the first and second bouts without significant differences between 3x10 and 10x3, and changes following the 20x3 bout were similar between arms. No significant difference was evident for the changes in any measures between the first and second bouts. Discussion The results showed that the set-repetition configuration had little effect on muscle damage. This was likely due to the same peak torque produced during exercise between the 3x10 and 10x3 bouts. The repeated bout effect was similar between arms, suggesting that the set-repetition configuration in the first bout did not influence the effect. The similar changes in criterion measures between the first and second bouts showed that the repeated bout effect was attenuated by increasing the number of contractions. It is concluded that the number of contractions rather than the set-repetition configuration affect the magnitude of muscle damage and repeated bout effect. References 1. Nosaka K et al. (2001) *Eur J Appl Physiol*, 85, 34-40

### **FAM FREQUENCY RESPONSE METHOD AS A TOOL TO ASSESS MUSCULAR AND PHYSIOLOGICAL RECOVERY AFTER ECCENTRIC EXERCISE**

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Introduction Definition of optimal recovery between training sessions is difficult because it depends for example on the type of exercise. After eccentric exercise (EE) the recovery may last for several days. Traditionally the assessment of muscular and physiological recovery requires invasive measurements and laboratory settings. Frequency analysis method (FAM) is a non-invasive tool to measure the recovery of tissue balance after exercise. The purpose of the present study was to examine if the recovery after EE measured by FAM method is related to muscular and physiological recovery. Methods Twelve male subjects ( $28 \pm 6$  yrs, BMI  $23.9 \pm 2.3$ ) performed 45 min of EE at 40% of maximal load with cycling ergometer. Before, 2 hours and 2 days after EE FAM measures, plantar flexion and knee extension maximal force (MVC) and rate of force development (RFD) were performed and blood samples were drawn for serum IL-6, creatine kinase (CK), blood lactate, leukocytes, lymphocytes and neutrophils. FAM sensory -, motor - and pain thresholds were recorded from left and right legs with 10, 50, and 100 Hz stimulations which were then averaged for final analyses. Results EE induced an increase in La ( $1.2 \pm 0.5$  vs.  $2.0 \pm 0.7$  mmol/l,  $p<0.001$ ), CK ( $151 \pm 107$  vs.  $182 \pm 130$   $\mu$ l  $p<0.05$ ) and IL-6 ( $0.9 \pm 2.4$  vs.  $2.4 \pm 1.4$  pg/ml,  $p<0.01$ ) 2h after. Similarly, leukocytes and neutrophils increased ( $p<0.001$ - $0.05$ ) 2h after. Furthermore, 2h after decreases ( $p<0.05$ ) were observed in plantar flexion MVC and RFD and knee extension RFD. After 2d leukocytes, lymphocytes and neutrophils were lower ( $p<0.05$ ) than before EE. FAM values from both legs were higher 2 h after (right  $42.3 \pm 9.1$  vs.  $46.9 \pm 9.3$  mA,  $p<0.05$ ; left  $40.3 \pm 7.9$  vs.  $43.9 \pm 7.8$  mA,  $p<0.001$ ) and were still elevated after 2 days (right  $49.1 \pm 11.2$  mA,  $p<0.05$ ; left  $44.8 \pm 9.8$  mA,  $p<0.05$ ). Relative changes in right leg FAM correlated negatively with relative changes in knee extension RFD ( $r=-0.79$ ,  $p<0.01$ ) 2h after and after 2d positively ( $r=0.70$ ,  $p<0.05$ ) with CK. Conclusion EE led to significant changes in muscular strength and physiological variables measured from blood especially when measured two hours after the exercise. Even though muscle strength had recovered already two days after the exercise this was not the case for several physiological parameters. The recovery after EE assessed by frequency analysis method (FAM) followed the behaviour of muscular and physiological variables such knee extension forces, lactate and CK suggesting that FAM method can be used as a noninvasive technique when evaluating individual recovery after eccentric exercise. Due to large individual variation in recovery the final conclusions should, however, be made with caution.

### **TWO MAXIMAL ISOMETRIC CONTRACTIONS ATTENUATE MAGNITUDE OF ECCENTRIC EXERCISE-INDUCE MUSCLE DAMAGE**

NOSAKA, K., CHEN, H.L., CHEN, T.C.

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Introduction Muscles become resilient to eccentric exercise-induced muscle damage after performing only a few eccentric contractions [1]. Animal studies [2,3] have shown that isometric contractions also confer this type of protective effect. It is not known whether small number of isometric contractions still produces such effect against maximal eccentric exercise. This study tested the hypothesis that 2 or 10 maximal isometric contractions would attenuate the magnitude of muscle damage induced by 30 maximal eccentric contractions of the elbow flexors performed 2 days later. Methods Thirty-nine untrained men ( $22.5 \pm 1.7$  y) were placed into three groups ( $n=13$  per group) by matching the pre-exercise maximal concentric strength among the groups; two experimental groups and one control group. The subjects in the experimental groups performed either 2 or 10 maximal isometric contractions of the elbow flexors at a long muscle length ( $20^\circ$  elbow flexion) 2 days prior to 5 sets of 6 maximal isokinetic ( $90^\circ$ .s-1) eccentric contractions of the elbow flexors from a flexed ( $90^\circ$ ) to a fully extended angle using the non-dominant arm. The subjects in the control group performed the eccentric contractions without isometric contractions. Changes in isokinetic ( $60^\circ$ .s-1) concentric strength of the elbow flexors, optimum angle, range of motion, upper arm circumference, plasma creatine kinase activity and myoglobin concentration, muscle soreness, and echo intensity of B-mode ultrasound images were assessed before and for 10 days following the eccentric contractions, and compared among the groups by a two-way repeated measures ANOVA. Results The isometric contractions did not result in any changes in the dependent variables, and no significant differences in any of the variables were evident amongst the groups before the eccentric exercise. All dependent variables showed significant ( $P<0.05$ ) changes following the eccentric contractions; however, the changes were smaller ( $P<0.05$ ) for the experimental groups compared with the control group. The changes in the dependent variables after eccentric contractions were smaller ( $P<0.05$ ) for the group that performed 10 maximal isometric contractions compared with the group that performed 2 maximal isometric contractions. Discussion These results suggest that only a few maximal isometric contractions attenuate muscle damage induced by maximal eccentric contractions. It appears that the protective adaptation is induced without any indication of muscle damage, and every

muscle contraction counts for the adaptation. References 1) Nosaka K et al. (2001) Eur J Appl Physiol, 85, 34–40 2) Koh TJ, Brooks SV. (2001) Am J Physiol Regul Integr Comp Physiol, 281, R155–61 3) Pizza FX et al. (2002) J Appl Physiol, 92, 1973–78

### POST-MATCH CHANGES IN NEUROMUSCULAR CONTRACTILE PROPERTIES AS RELATED TO PHYSICAL MATCH DEMANDS IN COMPETITIVE RUGBY LEAGUE.

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**Introduction** Although a range of time-motion data exists for football codes, these data describe physical movement demands without detailing the presence, development or mechanisms of skeletal muscle fatigue. The aim of this study was to investigate the change in neuromuscular contractile properties following competitive rugby matches and determine the relationship between physical match demands and these neuromuscular changes. **Methods** Ten trained, male rugby league players participated in 2-4, in-season, competitive home matches (n=30). Prior to, immediately following (within 15-min) and 2 h post-match, players performed isokinetic tests on the right knee extensors for maximal voluntary (MVC) and evoked force (VA) and twitch contractile properties; including peak twitch force (Pt), rate of torque development (RTD) and relaxation rate (RR). During each match, players wore 1Hz Global Positioning Satellite (GPS) devices to record distance and velocity of movement. GPS data was analyzed based on classification as low-intensity activity (LIA;<14km/h), high-intensity running (HIR;>14km/h) and very-high intensity running (VHIR;>20km/h). Further, each match was filmed and coded for number of tackles and collisions. Changes in neuromuscular properties were assessed with a repeated measures ANOVA; while Pearson's correlation coefficient analyses assessed the association between neuromuscular properties and match physical demands. **Results** Mean±SD total distance, LIA, HIR, VHIR and relative distance covered were 5785±1078m, 5023±935m, 761±265, 216±121m and 75±14m/min, respectively. Mean MVC was significantly reduced immediately and 2 h post-match by 9±15 and 12±16% respectively (P<0.05). Moreover, twitch contractile properties indicated a suppression of Pt, RTD and RR both immediately and 2h post-match (P<0.05). However, VA was not significantly altered from pre-match (90±6%), either immediately (89±10%) or 2h post (88±8%) (P>0.05). Correlation analyses indicated that total playing time (r=-0.50) and relative distance (r=-0.40) were related to the change in post-match MVC. However, total distance, LIA, HIR, VHIR and tackle count were not correlated with change in voluntary force (r<0.10). **Conclusion** The present study highlights that the physical demands of competitive rugby league result in a post-match suppression of voluntary force and skeletal contractile function, without significant alterations to voluntary activation. Further, post-match suppression of voluntary force may be partially associated with the time spent on field and the relative distance covered during the match (m/min), respectively.

### VARIATIONS IN PAIN PERCEPTION AFTER AN EXHAUSTIVE EXERCISE

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**Introduction** Pain perception modulation induced by physical exercise is relevant for exercise physiology, sport medicine, and clinical practice. For example an increase in pain perception may result in a interruption of exercise, while its reduction may contribute to improve mood, motivation and Rate of Perceived Exertion (RPE). The issue has been widely investigated with controversial results. Increase in pain perception threshold has been reported after exercises with both external and internal load. In contrast, the use of animal models has shown a positive relation between hyperalgesia and exhausting exercises. What seems to emerge from these studies is that a number of factors are involved in the exercise related pain modulation, such as different types and intensities of exercise, and age, gender, health and food intake of the subject. Also the mechanism of this kind of pain modulation is still under study. **The study** Subjects (age 22±1, sex M) all in a good state of physical fitness, were invited to pedal to exhaustion with power increasing in steps of 20 W every minute, starting from the power of 80W to activate aerobic metabolism (4 minutes). Pain threshold was measured both before the physical exercise and at exhaustion. Pressure stimuli were delivered to the left hand of the subjects through a plastic or metal point, at intervals of 30 s for 4 minutes. Pressure was measured by means of a load cell and, to identify pain threshold, it was constantly increased during each trial of stimulation until the subject reported pain. **Results** The first results point to a high inter-individual variability in perception of pain threshold. The threshold increased at the end of the exercise suggesting a reduced pain perception and quickly decreases during the first minutes of the recovery phase. **References** Sakamoto A, Maruyama T, Naito H, Sinclair PJ. Acute effects of high-intensity dumbbell exercise after isokinetic eccentric damage: interaction between altered pain perception and fatigue on static and dynamic muscle performance. J Strength Cond Res. 2010 Aug;24(8):2042-9. PubMed PMID: 20634739. Hollander DB, Reeves GV, Clavier JD, Francois MR, Thomas C, Kraemer RR. Partial occlusion during resistance exercise alters effort sense and pain. J Strength Cond Res. 2010 Jan;24(1):235-43. PubMed PMID: 19935100

## Oral presentations

### OP-PM25 Nutrition: Supplementation

#### MICRONUTRIENT INTAKE OF YOUNG ELITE GERMAN ATHLETES

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**Introduction** A balanced, varied nutrition with respect to individual needs (e.g. age, gender, training and season phase) can make a positive difference in an athlete's ability to train and compete and will contribute to good health (IOC Medical Commission). However, limited research on the nutrition requirements of young athletes exists (Meyer et al., 2007). Despite this, studies on nutritional status of young athletes in particular with respect to the intake of micronutrient are rare. Therefore the aim of the present study was to evaluate the nutritional status of young athletes with special focus on micronutrient intake. **Methods & Subjects** Between March 2007 and August 2010, 303 young athletes between 13 and 18 years of age reported their diet using a validated 7-d food and activity record (KoeHLer et al. 2010). Energy Intake (EI) and Micronutrient intake was estimated based on the German food database (Bundeslebensmittelschlüssel II.3) using Ebispro Software. Energy expenditure (EE) was calculated based on the activity record. The present study includes data from 151



male ( $15.6 \pm 1.6$  y,  $69.9 \pm 14.9$  kg,  $179 \pm 11$  cm,  $100 \pm 47$  min/day (training)) and 152 female ( $15.4 \pm 1.3$  y,  $58.3 \pm 9.2$  kg,  $168 \pm 8$  cm,  $104 \pm 59$  min/day (training)) athletes from 28 different sports. Results Based on the German recommended daily allowances (RDA), mean intake of vitamin D (males (m):  $2.0 \pm 1.6$  µg; females (f):  $1.9 \pm 2.7$  µg) and folic acid (m:  $313 \pm 112$  µg; f:  $249 \pm 88$  µg) was systematically below recommendations in both male and female athletes. Additionally at least half of the female group did not reach the RDA for panthotenic acid (80%), vitamin B12 (58%), iron (68%), calcium (56%), potassium (52%). Mean Energy intake (EI) for males was  $2970 \pm 833$  kcal ( $43.5 \pm 12.2$  kcal/kg bw) and for females  $2263 \pm 673$  kcal ( $39.6 \pm 12.6$  kcal/kg bw) and matched EE by  $92 \pm 22\%$  (m) and  $89 \pm 25\%$  (f). Discussion In the present study, a wide range of athletes did not meet the RDA for selected micronutrients. Vitamin D and folic acid are identified as the most critical micronutrients according to intake. Since individual requirements are not known, this does not imply an inadequate status. However, it indicates that the individual dietary intake of some micronutrients in young German athletes may be low for some individuals and more so in female athletes than in male. Therefore more individual nutritional education and consulting are necessary to improve diet quality. References Meyer F., O'Conner H., Shirreffs S. (2007). J Sp Sci, 25 (S1), S73-S82 Koehler K., Braun H., de Marees M., Fusch G., Fusch C., Mester J., Schaezner W. (2010). J Sp Sci, 28(13): 1435–1449

## THE EFFECTS OF EXERCISE AND DIET COMPOSITION OF DIET-INDUCED OBESE MICE ON EXPRESSION OF MCP-1 AND OXIDATIVE STRESS-RELATED MRNA OF ADIPOSE TISSUE

KIM, K., KO, J., AHN, N., KIM, J., BYUN, J., HONG, C., JOO, Y., KIM, H., CHANG, I., PARK, J.

KEIMYUNG UNIVERSITY

THE EFFECTS OF EXERCISE AND DIET COMPOSITION OF DIET-INDUCED OBESE MICE ON EXPRESSION OF MCP-1 AND OXIDATIVE STRESS-RELATED mRNA OF ADIPOSE TISSUE Kim, K.I, Ko, J.I, Ahn, N.I, Kim, J.I, Byun, J.I, Hong, C.I, Joo, Y.I, Kim, H.I, Chang, I.I, Park, J.I 1: KMU (Daegu, Korea), 2: KMC (Daegu, Korea), 3: CUD (Daegu, Korea), 4: GJU (Gyeongsangju, Korea) Introduction The subjects with long term and regular exercise showed lower oxidative stress than those without exercise, and this has been proposed to be caused by the increase of endogenous antioxidants, such as Mn-SOD and GPX. Research, particularly on the antioxidant effects of exercise to effectively reduce MCP-1, which induces the inflow of macrophage into adipose tissue, is insufficient. Therefore, the purpose of this study is to analyze how a high-fat diet, diet composition change, and long term exercise on C57BL/6 mice influence the expression of MCP-1, HIF-1α, NOX2, ERK1&2, and Mn-SOD mRNA of white adipose tissue (WAT). Methods Obesity is induced using a high-fat diet (45% fat) for five weeks, and this research analyzed how the change of diet composition for eight weeks and long-term exercise training affected the expression of mRNA in epididymal WAT. For the experiment, 56 four-week-old C57BL/6 mice were used. Their epididymal WAT was extracted and used in real time (RT)-PCR analysis to find the expression level of mRNA. Results A high-fat diet for 13 weeks showed a significant increase in the expression of MCP-1, HIF-1α, NOX2, and ERK1 mRNA in epididymal adipose tissue. Change of diet composition and exercise decreased the expression of MCP-1, HIF-1α, NOX2, and ERK1 mRNA. Particularly, the group combining a high-fat diet and exercise had a significant increase in the expression of Mn-SOD mRNA in epididymal adipose tissue; however, it had a significant decrease in MCP-1, HIF-1α, and NOX2. Discussion This study shows that mice treated by both a high-fat diet and exercise treatment have a significant decrease in MCP-1 mRNA. In the MCP-1 mRNA increased tissue, it can be estimated that the accumulation of macrophage is increased due to the pivotal role of MCP-1 in mobilizing macrophage into obese adipose tissue (Weisberg et al., 2003). Regular exercise and diet composition change can reduce the accumulation of macrophage influencing the expression of inflammatory genes in WAT. Mn-SOD increased in WAT has a high possibility of making MCP-1 expression reduced by ROS reduction rather than weight loss. Antioxidant effects and improvement of hypoxia through exercise can significantly reduce the expression of MCP-1 in WAT (Sakurai, et al., 2009). This result means that the independent antioxidant effect of exercise decreased inflammation and oxidative stress. References Sakurai T, Izawa T, Kizaki T, Ogasawara J, Shirato K, Imaizumi K, et al. (2009). Biochem Biophys Res Commun, 379(2), 605-609. Weisberg S, McCann D, Desai M, Rosenbaum M, Leibel R, & Ferrante A. (2003). J Clin Invest, 112(12), 1796-1808.

## THE EFFECTS OF CAFFEINE INGESTION ON POWER OUTPUT DURING INTERVAL TRAINING COMMENCED WITH NORMAL OR LOW MUSCLE GLYCOGEN CONTENT

LANE, S.I, COFFEY, V.I, ARETA, J.I, BIRD, S.I, HAWLEY, J.I

RMIT UNIVERSITY

Introduction: Commencing selected training sessions with low muscle glycogen content augments several markers of training adaptation compared to undertaking the same sessions with normal (or high) glycogen availability (Hansen, et al., 2005; Yeo, et al., 2008). However reduced glycogen availability also reduces the capacity to perform high intensity workouts (Yeo, et al., 2008) which are crucial to promoting training adaptation. Hence, the aim of this study was to investigate whether caffeine, a proven ergogenic aid, could 'rescue' part of the deleterious effects on self-selected power output previously observed when individuals commenced high intensity interval training with low compared to normal glycogen availability (Yeo, et al., 2008). Methods: Twelve endurance trained cyclists/triathletes performed four trials according to a double blind randomised Latin square crossover design. Prior to each trial muscle glycogen content was manipulated using standardised exercise-diet manipulations to ensure two trials were commenced with reduced (LOW) or normal (HIGH) muscle glycogen content. Sixty minutes prior to the experimental trials (8 x 5 min at maximal self selected intensity; HIT) subjects ingested an opaque capsule containing anhydrous caffeine (CAFF; 3 mg/kg.bm) or a placebo capsule (PLBO). Mean power output (MPO) was monitored during each performance trial along with blood caffeine, glucose, and lactate concentrations. Results: There was a significant main effect for both pre-exercise glycogen content and caffeine ingestion on MPO ( $P < 0.05$ ). Caffeine increased power output by 2.8% and 3.5% in both HIGH and LOW trials respectively. Commencing HIT with low muscle glycogen availability reduced MPO for both LOW-CAFF and LOWPLBO trials by 8.1% and 8.6% when compared to their respective HIGH trials. Conclusions: Performing high intensity interval training with reduced muscle glycogen significantly reduces self selected MPO. However, caffeine (3 mg/kg) administered 60 min prior to exercise enhances power output independently of muscle glycogen concentration. Hansen, A. K., Fischer, C. P., Plomgaard, P., Andersen, J. L., Saltin, B., & Pedersen, B. K. (2005). J Appl Physiol, 98(1), 93-99. Yeo, W. K., McGee, S. L., Carey, A. L., Paton, C. D., Garnham, A. P., Hargreaves, M., et al. (2010). Exp Physiol, 95(2), 351-358. Yeo, W. K., Paton, C. D., Garnham, A. P., Burke, L. M., Carey, A. L., & Hawley, J. A. (2008). J Appl Physiol, 105(5), 1462-1470.

## Oral presentations

### OP-PM17 Training and Testing: Performance Testing

#### ESTABLISHING REFERENCE RANGES FOR THE YO-YO INTERMITTENT RECOVERY TEST IN JUNIOR RUGBY LEAGUE

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**Introduction** The Yo-Yo Intermittent Recovery Level 1 (Yo-Yo IRI) test is well established as a field-based measure of endurance fitness (Bangsbo et al. 2008). Endurance capacity is considered an important attribute of fitness in rugby league (Gabbett et al. 2008). However there are no published reference ranges for this test in junior rugby league players for different playing positions or information on magnitudes of variability. The aim of this study was to analyse a large representative set of Yo-Yo IRI test scores in junior rugby league players and establish position-specific reference ranges. **Methods** A total of 759 Yo-Yo IRI tests were conducted at the Australian Institute of Sport on male junior rugby league players (age  $16.8 \pm 0.6$  y) over a seven year period. Player's performances were categorised according to their normal playing position: prop forward (n=121), back row (n=289), halves (including the hooker, n=150), and outside backs (n=189). **Results** The mean, standard deviation and coefficient of variation of Yo-Yo IRI test scores were: all players ( $17.1 \pm 1.2$  levels, 7.0%); prop forward ( $16.2 \pm 1.2$ , 7.4%), back row ( $17.1 \pm 1.1$ , 6.4%), halves ( $17.7 \pm 1.7$ , 6.8%) and outside backs ( $17.1 \pm 1.0$ , 5.8%). Test scores for prop forwards were substantially lower than other positions. Variability was substantially lower for the outside backs compared with the prop forwards (ratio of %CV=1.27). **Discussion** The substantial differences in Yo-Yo IRI test scores between different playing positions in rugby league is similar to other sports (Ben Abdelkrim et al. 2010). The mean and standard deviation can be used directly to establish a reference range (showing levels or metres) for each playing position – assuming a normal distribution the approximate range for each group is estimated as the mean score  $\pm 2$  standard deviations. The larger variability and lower mean Yo-Yo IRI test score for prop forwards reflects their poorer endurance fitness. These data should be useful for rugby league coaches and researchers interested in fitness characteristics, and determining magnitudes of improvement in endurance needed from specific training interventions. **References** Bangsbo J, Iaia FM, Krstrup P. (2008) Sports Med, 38, 37-51. Gabbett T, King T, Jenkins D. (2008). Sports Med. 38, 118-138. Ben Abdelkrim N, Chaouachi A, Chamari K, Chtara M, Castagna C. (2010). J Strength Cond Res, 24, 1346-1355.

#### RELIABILITY AND VALIDITY OF EXPLOSIVE PUSH-UP POWER TEST

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**Reliability and Validity of Explosive Push-Up Power Test** Markovic, S.I, Radonjic, V., Koprivica, V.I, Mirkov, D.I 1: Faculty of Sport and Physical Education, University of Belgrade (Serbia) **Introduction** Successful performances in sports often require high power output movements of both the upper- and lower-extremities. The assessment of muscular power is essential for understanding the performance capacity of an individual (Newton et al, 1997). Because of limitations of various tests for upper-body power assessment, we developed a simple test based on push-up movements that requires the same equipment as the standard maximum jumping tests (i.e., either a contact mat or a contactless mat with infrared beams). The aim of this study was to establish reliability and validity of the novel test for the assessment of upper-body power. **Methods** Nineteen male junior basketball players (national junior team) performed explosive push-up power test (EPPT) for height, chest pass (CP) and bench press throw (BPT) with loads of 40, 60 and 80% of 1RM. The chest pass and bench-press throw were used as criterion measures. **Results** The maximal height of the explosive push-up test (data averaged across three consecutive trials) were 19.8 cm, 19.0 cm and 19.4 cm, respectively, and no significant differences among them were found. The intraclass correlation coefficient revealed 0.994. Coefficient of variation of 6.2% suggested a low intra-subject variability. Concerning the validity of the evaluated test, significant correlations were obtained between the height in EPPT and distance in CP ( $r=0.51$ ) and the maximal power in BPT with all of the applied loads (0.69, 0.72, 0.70, respectively, for 40%, 60% and 80% of 1 RM). The highest correlation of the evaluated test was obtained with maximal power in BPT ( $r=0.73$ ). **Discussion** In general, when studying sport specific abilities, the development of the assessment tools is of particular concern. The evaluation of upper-body power may be accomplished through a multitude of assessment techniques or tests, like chest pass or bench press throw (Cronin and Owen, 2004). High intraclass correlation, low intra-subject variability and high correlations between trials (Hopkins, 2000) and significant correlations with criterion measures, suggest that the evaluated explosive push-up test could be a valid and reliable test for the upper-body power assessment. Taking also into account its simplicity and cost-effectiveness, the explosive push-up test could provide coaches and strength and conditioning professionals important information concerning both the individual abilities and the choice of training programs. **Acknowledgment:** This study was supported in part by a grant #175037 from the Serbian Research Foundation. **References** Newton RU, Murphy AJ, Humphries BJ, Wilson GJ, Kraemer WJ and Hakkinen K (1997). Eur J Appl Physiol, 75, 333-342. Cronin JB and Owen GJ (2004). J Strength Cond Res, 18, 401-404. Hopkins WG (2000). Sports Med, 30, 1-15.

#### HIGH-INTENSITY INTERMITTENT RUNNING PERFORMANCE IN RELATION TO AGE AND MATURATION IN HIGHLY-TRAINED YOUNG SOCCER PLAYERS

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ASPIRE

**Introduction** The aim of the present study was to examine high-intensity intermittent running performance in highly-trained young soccer players with regard to age and selected physical performance variables. **Methods** Twenty-seven Under 14 ( $13.0 \pm 0.7$  y;  $-3.1$  to  $0.3$  y to/from age at peak height velocity (PHV),  $154.7 \pm 9.7$  cm;  $41.5 \pm 7.2$  kg), 19 U16 ( $14.9 \pm 0.5$  y;  $-0.1$  to  $2.0$  y from PHV,  $169.2 \pm 7.4$  cm;  $56.8 \pm 9.1$  kg) and 16 U18 ( $16.7 \pm 0.8$  y;  $1.0$  to  $2.9$  y from PHV,  $171.2 \pm 5.9$  cm;  $61.1 \pm 6.8$  kg) highly-trained soccer players performed an incremental running test to estimate maximal aerobic speed (MAS), an incremental intermittent running test (straight-line version of the 30-15 Intermittent Fitness Test, Buchheit, 2008) to estimate maximal intermittent running performance (VIFT) and a 40-m sprint with 10-m splits to estimate maximal sprinting speed (MSS). Anaerobic speed reserve (ASR) was calculated as MSS – MAS. The difference between VIFT and MAS was used as a specific index of intermittent effort ability (IINT, km/h). **Results** There was no correlation between IINT and any of the physical performance, anthropometric or maturation-related variables. There was no age-group difference in IINT ( $19.0 \pm 5.3$ ,  $18.8 \pm 5.1$  and  $19.1 \pm 2.9$  % of MAS for U14, U16 and U18, respectively,  $P = 0.98$ ), even after adjustments on either age from PHV or ASR. MAS and VIFT were largely correlated for each age group:  $r = 0.66$ , 90% CL (0.41-0.89),  $0.73$  (0.48-0.87) and  $0.87$  (0.70-0.95) for U14, U16 and U18,

respectively. Discussion The lack of association between INT and any of the selected variables confirms that INT could be used as a specific index of intermittent effort ability. However, there was no difference in INT between the three groups, which contrasts with the idea that the younger, the better the ability to repeat high-intensity exercise (Ratel et al. 2006). The fact that the expected maturation/age differences in inter-effort recovery capacities (Ratel et al. 2006) did not translate into different INT values could however be related to the particular training background of our players (Mendez-Villanueva et al. 2011). We also observed that the strength of the correlation between MAS and VIFT increased with age. While in the older players, cardiorespiratory function is likely the major determinant of maximal intermittent running performance, the performance of the younger players is more likely explained/confounded by other parameters (e.g., motor coordination and stride patterns during the intervals at higher running speeds). References Buchheit M. (2008). J Strength Cond Res, 22(2):365-74. Ratel, S., Duché, P., Williams, C.A. (2006). Sports Med, 36(12):1031-65. Mendez-Villanueva, A., Buchheit, M. (2011), J Appl Physiol. 2011, In press.

### **PEAK TORQUES OF THE QUADRICEPS AND HAMSTRING MUSCLES OF PROFESSIONAL SOCCER PLAYERS PARTICIPATING IN DIFFERENT LEVELS.**

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UNIVERSITY OF NICOSIA-CYPRUS

Parpa, M.I., Koulla, Michaelides, A.I., Marcos, Hadjicharalambous, P.I., Marios. 1: University of Nicosia (Nicosia/Cyprus). Introduction Muscular strength is considered to be an important component of exercise performance in soccer players. The purpose of the present study was to examine the peak torques of the quadriceps (Q) and hamstring muscles (H), and their torque-ratio (H/Q) in professional soccer players competing in different league divisions. Methods Sixty participants of the 1st (n=14), 2nd (n= 20), 3rd (n= 16) and 4th (n=11) divisions were evaluated at slow velocities (60 degrees.sec<sup>-1</sup>) using an isokinetic dynamometer. Results It was found that players of the 1st division produced significantly greater torques in both the right and left Q compared with the players of the other divisions (F (57)=3.16, p<0.05 and F (57)=2.83, p<0.05 for right and left Q respectively). No significant differences were observed in H torques or H/Q ratio among the players of different divisions. Players participating in the 1st division demonstrated that the H/Q ratio for the right leg (M=64.78 ± 5.56) was closer to the "optimal ratio" (63%) compared with players of other divisions (M=68.90±8.37, 69.19±9.40 and 72.18±7.01 for divisions 2nd, 3rd and 4th respectively). Discussion It is concluded that players of the 1st division have stronger quadriceps but not stronger hamstring muscles, in terms of peak isokinetic torque production compared with the players of the 2nd, 3rd and 4th divisions. Isokinetic evaluation of the lower extremities may provide the coaching team with valuable evidence regarding potential asymmetries between Q and H that may progressively contribute in performance deterioration and increase the risk of muscle injuries development but this asymmetry may be eliminated by incorporating the appropriate training into the habitual exercise routines of soccer players.

### **THE EFFECT OF A SOCCER-SPECIFIC NEUROMUSCULAR TRAINING PROGRAM ON STABILITY, AGILITY AND INJURY OCCURRENCE IN ELITE YOUTH SOCCER PLAYERS**

BORGHUIS, A.J.

UNIVERSITY MEDICAL CENTER GRONINGEN

THE EFFECT OF A SOCCER-SPECIFIC NEUROMUSCULAR TRAINING PROGRAM ON STABILITY, AGILITY AND INJURY OCCURRENCE IN ELITE YOUTH SOCCER PLAYERS Borghuis, A.J., Lemmink, KAPM.1,2, Hof, A.L., Visscher, C.I. 1: Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands 2: School of Sports Studies, Hanze University of Applied Sciences, Groningen, the Netherlands Introduction Various studies have investigated the injury-preventive and performance-enhancing effect of neuromuscular training programs (NMTP's), showing varying results. To get insight into the underlying mechanisms, research should focus on the influence of these training programs on improving stability. Therefore, the main aim of this study was to investigate the effect of a soccer-specific NMTP on improving whole-body and core stability in elite youth soccer players. Besides, the effect of such an intervention on agility and injury occurrence was evaluated. Methods In this group-randomized controlled intervention study, 90 elite youth soccer players (ages 10-16) were team-randomized into an intervention (INT) and control (CON) group. The INT group performed a 15 min NMTP on average twice a week for 23 weeks. Prior to, during and after the intervention, all players performed a standing balance task to measure whole-body stability, two sitting balance tasks to measure core stability and a slalom sprint test to measure agility. New non-contact time-loss injuries sustained during the intervention period were recorded. Repeated Measures ANOVA's were conducted to find any differences between INT and CON on the stability and agility test results. Possible differences in injury severity were evaluated using a Mann-Whitney U test. Results Relevant trends were found in the data, indicating a positive effect of the NMTP on standing balance capacity, reactive core stabilizing control and slalom sprint performance in the elite youth soccer players. Results of the Repeated Measures ANOVA's indicated no significant differences in improvement on the stability and agility test results between INT and CON. With respect to injury, no significant difference in incidence or severity was found between both groups. Discussion Based on the positive trends in the data, further research is recommended to further elucidate the effect of the soccer-specific NMTP on improving stability. In the present group of highly trained elite youth soccer players, the small differences found between INT and CON can be very important for a successful career. To amplify the positive effect of the NMTP, the volume and intensity of the exercises should be increased and exercises should be performed on a regular and continuous basis. Furthermore, measurement instruments can be made more sensitive and it would be interesting for future research to study the effect of the NMTP in lower level or female athletes.

### **AGE-RELATED DIFFERENCES IN SPRINTING SPEED AND THE ABILITY TO CHANGE DIRECTION IN HIGHLY-TRAINED YOUNG SOCCER PLAYERS**

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Introduction This study investigated age-related differences in the relationships among straight line sprinting speed and the ability to change direction in 71 highly-trained young male soccer players (U14; n=31, U16; n=23 and U18; n= 17). Methods Players were tested for 20-m sprint (straight line sprinting speed) and the ability to change direction (20-m course with 2 10-m sections set out at 90° angle) times. The results of the ability to change direction test were expressed as a percentage of the straight sprinting time over 20-m. A lower percentage (i.e., a smaller relative increase in the ability to change direction test running time) was interpreted as a higher ability to change direction. Results There was age-based differences in 20-m sprint time (3.39 ± 0.16, 3.10 ± 0.11, 2.97 ± 0.07 s for U14, U16 and U18, respectively) and the ability to change direction (33.2 ± 3.7, 38.0 ± 5.6, 42.4 ± 4.6 % of 20-m sprint time, respectively). Straight line

sprinting speed and the ability to change direction were positively correlated for each age group:  $r = 0.81$  90% confident limits (0.63-0.90), 0.45 (0.00-0.71) and 0.25 (-0.29-0.63) for U14, U16 and U18, respectively. Discussion In highly-trained young soccer players, the magnitude of decreases in locomotor speed associated with turning increased with age. This suggests that developing soccer players trade-off the ability to change direction against straight line sprinting speed as growing older. We also observed that the strength of the correlation between straight line sprinting speed and the ability to change direction decreased with age. This loss of linearity in the older groups suggests substantial differences in individual performances with fast individual showing good ability to change direction and vice versa. Future studies should look at the potential factors explaining these individual differences in older players.

## Oral presentations

### OP-PM19 Cardiovascular: Stem Cells

#### ACTIVITY STATUS OF RESIDENT ADULT CARDIAC STEM CELLS DETERMINES THEIR STEM CELL PROPERTIES AND GROWTH KINETICS

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**Introduction:** The identification of a small population of stem cells resident in the adult mammalian heart, with robust regenerative capacity, indicates the potential to develop new strategies using these cells for cardioprotective and regenerative purposes. Exercise training results in resident cardiac stem cell (eCSC) activation, multiplication and differentiation into the cardiomyocyte and endothelial lineages, which results in new cardiomyocyte and capillary formation, respectively. Here we compared the properties and growth kinetics of quiescent eCSCs with activated eCSCs in vitro. **Methods:** To induce tissue damage and resultant eCSC activation, 5mg kg<sup>-1</sup> Isoproterenol (ISO) was injected (s.c.) into 2-month-old adult Wistar rats (~250g). Saline was injected as control (CTRL; quiescent eCSC group). c-kitpos CD45neg eCSCs were isolated by retrograde coronary enzymatic perfusion, 24 hours post-ISO or saline injection. Quiescent and activated eCSCs were analysed for number, proliferative markers, multipotency genes, growth kinetics, clonogenicity and proliferation index using flow cytometry, immunocytochemistry, qRT-PCR, real time lapse cell culture imaging, and BrdU incorporation assay, respectively. **Results:** ISO-induced injury significantly ( $P < 0.05$ ) increased c-kitpos eCSC number ( $22 \pm 2\%$  of the CD45neg small cardiac cell population, compared to  $8 \pm 2\%$  in controls). Most of these cells were actively proliferating, being 62% Ki67 positive, compared to only 10% Ki67 positive in the quiescent CTRL eCSCs. Activated c-kitpos eCSCs showed increased clonogenicity ( $24 \pm 4\%$  vs.  $2 \pm 4\%$ ), cardiosphere formation and proliferation, measured by BrdU incorporation over 48 hours in culture ( $32 \pm 8\%$  vs.  $5 \pm 2\%$ ). Furthermore, activated and quiescent c-kitpos eCSCs showed differential multipotency gene expression. **Conclusion:** Activated c-kitpos CD45neg eCSCs show enhanced stem cell properties and growth kinetics, compared to quiescent c-kitpos CD45neg eCSCs, in vitro. These data imply that pre-activation of stem cells could improve their cardioprotective and regenerative ability. Identifying factors that influence the activation of eCSCs and the maintenance of this state is of paramount importance for the design and optimisation of cardiac regenerative therapies.

#### EXERCISE-INDUCED UP-REGULATION OF MYOCARDIAL GROWTH FACTORS DIFFERENTIALLY GOVERN RESIDENT CARDIAC STEM CELL BIOLOGY AND FATE

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**Introduction:** The adult mammalian heart was traditionally viewed as a post-mitotic organ. Increased cardiac mass and contractility following exercise training was thought to occur through physiological hypertrophy of existing myocytes. On the contrary, we have shown that intensity-controlled treadmill exercise training increases myocardial mass through both myocyte hypertrophy and hyperplasia in the rat. The latter is due to activation, proliferation and associated differentiation of the resident (endogenous) c-kitpos cardiac stem cells (eCSCs). Here we elucidated the mechanism of these adaptations and specifically the role of myocardial growth factors, up-regulated with exercise training, in governing myocyte and c-kitpos CSC fate in vitro. **Methods:** To this aim, 9 male Wistar rats (~230g) were exercised at 80-85% of their VO<sub>2</sub> max for 30min/day 4 days/wk for up to 2 weeks. Untrained rats acted as age matched sedentary controls (CTRL). CTRL animals were sacrificed at day 0 while exercised animals were sacrificed at 3, 7 and 14 days ( $n=3$ /time point), and expression of an array of 26 different growth factors and cytokines in isolated myocytes was determined by quantitative RT-PCR analysis. From another 3 CTRL rats, c-kitpos CSCs and myocytes were isolated by coronary retrograde enzymatic perfusion. The effects of the growth factors identified in the qRT-PCR gene array as being significantly elevated above CTRL were determined on myocyte proliferation, c-kitpos CSC proliferation, clonogenicity and differentiation in vitro. **Results:** High intensity treadmill exercise training significantly ( $P < 0.05$ ) up-regulated myocyte expression of IGF-1 ( $+0.4 \pm 0.1$ , fold increase over CTRL), TGF- $\beta$ 1 ( $+0.5 \pm 0.1$ ), Periostin ( $+1.6 \pm 0.2$ ), Neuregulin-1 ( $+1.8 \pm 0.3$ ) and BMP-10 ( $+4.3 \pm 0.7$ ), compared to sedentary CTRL. Supplementation of these growth factors to c-kitpos CSCs revealed differential roles on c-kitpos CSC proliferation, clonogenicity and differentiation. Specifically, IGF-1 enhanced c-kitpos CSC proliferation, while TGF- $\beta$ 1 promoted differentiation of c-kitpos CSCs into the myocyte lineage. Furthermore, none of these growth factors promoted myocyte proliferation in vitro. **Conclusion:** The adaptive response of the adult heart to exercise-induced physiological stress depends on the hypertrophy and hyperplasia of its myocyte population. The latter is specifically dependant on the exercise-induced increase in myocardial growth factor expression which acts upon c-kitpos eCSCs to result in increased myocyte number.

#### C-KIT-POSITIVE CARDIAC STEM CELLS REPLENISH ADULT MAMMALIAN CARDIOMYOCYTES DURING CARDIAC ADAPTATION TO EXERCISE TRAINING

VICINANZA, C., GEORGINA, G.M., LEONE, A., AQUILA, I., IACONETTI, C., BOCHICCHIO, A., GALUPPO, V., INDOLFI, C., NADAL-GINARD, B., TORELLA, D.

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**Introduction** It is widely accepted that regular exercise impacts favorably cardiovascular diseases. Traditionally, it has been considered that exercise improves cardiac function by increasing myocardial mass and contractility through physiological hypertrophy of existing myocytes. Recent data on myocardial cell homeostasis and the identification of cardiac stem-progenitor cells (CSCs) in the adult mam-

malian heart could challenge this concept. Indeed, we have recently demonstrated that c-kit positive cardiac stem cell (c-kitposCSC) activation and new myocyte formation contributes to left ventricular physiologic remodeling induced by exercise training. However, the key issue of a precursor(CSCs)-product(new cardiomyocytes) relationship in vivo cannot be accurately ascertained from these experiments. Thus, in the present study, we sought to assess whether new myocyte formation during exercise training is the direct progeny of the activation of the endogenous resident c-kitpos CSCs. Methods: C57/BL6 mice underwent a program of controlled swimming and were sacrificed at different time points over 28 days. Untrained mice acted as sedentary controls. To track new myocardial generation, BrdU was daily administered i.p. At different time points, the animals were sacrificed and their hearts processed for CSC isolation or immunohistochemistry and confocal microscopy analysis. To ascertain c-kitposCSCs→new myocytes (BrdUpos) relationship, a lentiviral vector carrying Cre-Recombinase under the control of the c-kit promoter (Lenti-c-kit/Cre) or a lentiviral empty vector (control) were myocardially released in male LacZ floxed-stop YFP mice (B6.129X1-Gi(ROSA)26Sortm1(EYFP)Cos/J mice, which carry a floxed 'stop' signal to YFP expression). This strategy permanently labels c-kitpos CSCs and allows to track their cell fate. Seven days following Lenti-c-kit/Cre or lenti-empty injections, mice underwent the 28 day program of swimming exercise. Results: Transcription of GATA-4 and Nkx2.5 progressively increased in the c-kitpos/CD45neg CSCs over the 28 day exercise protocol, showing rapid activation of a myogenic differentiation pathway in CSCs during exercise training. Accordingly, RT-PCR also showed increased transcription over time of contractile protein genes (beta-MHC, c-Actin, cTnI) in c-kitpos/CD45neg CSCs from swimming animals but not in the sedentary controls. The activation and differentiation of CSCs through exercise training was followed by an increased number of small newly-formed myocytes (BrdUpos). Importantly, through the genetic fate-mapping strategy based on cre/lox recombination in vivo, we demonstrated that all new myocyte formation during exercise training was the direct progeny of c-kitpos CSC differentiation. Discussion: Exercise training results in adult myogenesis in the physiologically-conditioned mouse heart. The latter process is directly due to the activation and ensuing differentiation of resident c-kitpos CSCs into newly-formed myocytes.

### THE EFFECTS OF GATA4 GAIN AND LOSS OF FUNCTION ON ENDOGENOUS CARDIAC STEM CELL BIOLOGY AND RE-GENERATIVE POTENTIAL

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LIVERPOOL JOHN MOORES

The Effects of GATA4 Gain and Loss of Function on Endogenous Cardiac Stem Cell Biology and Regenerative Potential Sam Impey, Andrew Smith, Bernardo Nadal-Ginard, Daniele Torella, Georgina M. Ellison Stem Cell and Molecular Physiology Laboratory, Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, Liverpool, UK. Introduction: Exercise training increases cardiac IGF-1 expression, endogenous c-kitpos cardiac stem cell (eCSC) number, and new cardiomyocyte formation. CSCs with a specific molecular signature, expressing high levels of the cardiac transcription factor GATA4, show enhanced cardiomyocyte differentiation and exert a pro-survival autocrine/paracrine effect on adult cardiomyocytes through induction of the IGF-1R-dependent signalling pathway. These data identify a specific CSC type for potential use in cardiac repair and regenerative therapies. Here we manipulated the expression of GATA4 in c-kitpos CSCs and established two stable cell lines which were either high or low for GATA4 expression. These CSC lines were then used to test for a cause-effect relationship among GATA4 expression, regenerative potential, IGF-1 secretion and the autocrine/paracrine protective effects of c-kitpos CSCs on adult cardiomyocytes. Methods: c-kitpos CSCs were isolated from the adult rat heart through retrograde coronary enzymatic perfusion. A clonal c-kitpos CSC line was generated (named C5 c-kitpos CSCs) and characterised for stemness properties, GATA4 expression and differentiation potential. GATA4 expression in C5 c-kitpos CSCs was manipulated through GATA4 over-expression or specific shRNA transfection to knock down GATA4. These GATA4 manipulated CSC lines were evaluated for their GATA4 expression through Western blot, immunocytochemistry and qRT-PCR. The GATA4 manipulated CSC lines were characterised over culture time for the principle properties of stem cells; clonogenicity, self-renewal and multipotency. Results: The expression of GATA4 was normalised to the level of non transfected parental C5 c-kitpos CSCs, given the value of 1. C5 c-kitpos CSCs that underwent GATA4 knock-down (C5 c-kitpos CSC GATA4KD) showed decreased GATA4 expression at the gene and protein level (0.3 of the parental C5 c-kitpos CSC). On the other hand, C5 c-kitpos CSC that were manipulated to over-express GATA4 (C5 c-kitpos CSC GATA4high) showed increased GATA4 expression, at the gene and protein level (4 fold over of the parental C5 c-kitpos CSC). C5 c-kitpos CSC GATA4KD and GATA4high lines showed significant differences in stem cell properties. In differentiation medium, C5 c-kitpos CSC GATA4high showed enhanced cardiomyocyte differentiation, compared to C5 c-kitpos CSC GATA4KD. Conclusion: Manipulating the expression of GATA4, in c-kitpos CSCs alters their cardiomyocyte differentiation potential and suggests GATA4 as a key factor in defining the optimal cell type for use in cardiomyocyte regenerative therapy.

### THE IMPACT OF NEURONAL NITRIC OXIDE SYNTHASE ON SKELETAL MUSCLE PHYSIOLOGY IN RESPONSE TO ENDURANCE EXERCISE

BAUM, O., ENGELI, A., VIEREGGE, M., RENG, M., MEIER, P., AALDIK, D., KOCH, P., FELICITAS HUBER-ABEL, F., HOPPELER, H. UNIVERSITY OF BERN

Introduction Nitric oxide (NO) is an important signaling molecule effective in many cells and tissues. In skeletal muscle, high concentrations of NO are generated by neuronal NO synthase (nNOS), which is expressed at the sarcolemma of the muscle fibers. Due to this site of localization in close contact to the endomysial microcirculation we hypothesized that the nNOS/NO-system contributes to the adaptation of skeletal muscle to endurance exercise, in particular to the angiogenic response. Methods Human vastus lateralis muscle biopsies (VL) were derived from ten sedentary male subjects before and after moderate training (four 30 minute weekly jogging sessions for six months, with a heart-rate corresponding to 75% VO2max). Murine extensor digitorum muscles (EDL) were collected from cohorts of C57BL/6-mice (10 weeks old) either trained on a treadmill (5 weeks at 18-24 m/min; 5-10° incline; 45 minutes daily) or remaining untrained. These mice as well as additional C57BL/6-mice treated with the specific nNOS inhibitor S-methyl-thiocitrulline (SMTC; approx. 0.0125 mg/day dissolved in tap water) were subjected to a performance test on the treadmill (2 m/min increase of velocity each 90 sec; start at 16 m/min) before and after the training period. The mRNA levels of nNOS in the VL biopsies and the murine EDL were quantified by Realtime-PCR and related to the capillary-to-fiber ratio and the numerical density of capillaries specified by light microscopy. Results The mRNA levels of nNOS were significantly up-regulated (+128%; p≤0.05) in VL biopsies of those five subjects that exhibited significant (p≤0.05) elevations in the capillary-to-fiber ratio (+25%) and the numerical density of capillaries (+21%) and positively correlated (r=0.8; p≤0.01) to the extent of angiogenesis. The treadmill training significantly increased nNOS mRNA expression (+122%; p≤0.05) and capillarity (+19%; p≤0.05) in EDL of C57BL/6-mice (correlation: r=0.6 and 0.8 before and after the training period with p≤0.05 both). The post-exercise performance was significantly higher in the trained than the untrained C57BL/6-mice (+15%; p≤0.05) but lower in the SMTC-

treated mice (-10%;  $p \leq 0.05$ ). Discussion The mRNA expression levels of nNOS were statistically linked to capillarity after exercise in human and murine skeletal muscle. Administration of the chemical nNOS inhibitor led to a reduced performance capacity indicating that the integrity of the nNOS/NO system is important for the capability of C57BL/6-mice to run persistently on a treadmill. Taken together, we that nNOS contributes in the angiogenic response in skeletal muscle to training.

## Oral presentations

### OP-BN11 EMG

#### REPEATABILITY OF MINIMUM MEAN FREQUENCY OF EMG POWER SPECTRUM DURING CONSECUTIVE SERIES OF DYNAMIC ELBOW EXTENSIONS UNTIL EXHAUSTION

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**Introduction** The past research showed that the mean frequency of power spectrum of the EMG signal (MNF) detected during repetitive dynamic contractions until exhaustion, decreases similarly to the MNF obtained during sustained isometric contraction; it decreases more rapidly at the beginning, while at the point of exhaustion the MNF values approached to some plateau asymptotic value (Gerdle et al., 1988; Ament et al., 1993). The aim of our study was to investigate whether the lowest MNF obtained during three consecutive series of repeated dynamic contractions until exhaustions, with one minute rest in-between, was repeatable. **Methods** Twelve volunteers performed dynamic elbow extensions from the 90° elbow flexion to full extension. The load was set to the 80 % of maximal load and the extensions were executed with frequency one extension and flexion per two seconds. When subject couldn't keep the pace, the load was gradually reduced to 60 %, 40%, 30% and finally to 20 % of maximal load without interrupting the working tempo. The EMG of long head (TBLoH), lateral head (TBLaH) and medial head (TBMeH) of m. triceps brachii were collected. Muscle activation within each extension was used for frequency analysis. A 5th order polynomial model was fitted to the MNF time series. Minimum values of polynoms were labelled MNF0LoH, MNF0LaH and MNF0MeH for the long, lateral and medial head of TB, respectively. **Results** Repeated measures ANOVA showed that MNF0 obtained in 1st series of contractions were lower with respect to MNF0 obtained in the 2nd and 3rd series ( $P < 0.05$ ), however ICC(2,1) values were 0.89, 0.95 and 0.72 for the MNF0LoH, MNF0LaH and MNF0MeH respectively. **Discussion** An exponential decrease of MNF was usually observed in the literature, however in our study a MNF decrease showed different pattern which was best fitted by a polynomial curve. Minimum instead of plateau values were obtained. Our results showed that the lowest MNF0, obtained from the repetitive dynamic elbow extensions until exhaustions, was achieved in the first series. However absolute differences in MNF0 obtained in three consecutive series were small and high ICC values were obtained. Results imply that MNF0 obtained of three consecutive fatiguing series presented a stable parameter. This might be interesting when considering MNF0 as a measure for the normalisation of MNF in fatigue studies. **References** Ament W, Bonga GJJ, Hof AL, Verkerke GJ. (1993). J Electromyogr Kinesiol 3 (4), 214-220. Gerdle B, Eriksson NE, Hagberg C. (1988). Eur J Appl Physiol and Occup Physiol 57, 404-8.

#### MEAN AND PEAK FREQUENCY IN THE SEMG POWER-SPECTRUM IS NOT DIFFERENT BETWEEN LAND AND WATER

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**MEAN AND PEAK FREQUENCY IN THE SEMG POWER-SPECTRUM IS NOT DIFFERENT BETWEEN LAND AND WATER** Olstad, BH.1, Cabri, J.1, Zinner, C.2, Nunes, N.3, Kjendlie, PL.1,4 1: NSSS (Oslo, Norway), 2: GSU (Cologne, Germany), 3: UNL (Lisbon, Portugal), 4: VUC (Toensberg, Norway) **Introduction** The use of surface electromyography (sEMG) in water is slightly different from dry land conditions and some challenges are prevalent. Therefore, the aim of this study was to investigate the mean and peak frequency in the power-spectrum between land and water conditions. **Methods** sEMG of isometric maximal voluntary contractions (MVC) on land and in water were collected in six subjects, after a familiarization process, and according to recommendations of the SENIAM project (Hermes et al., 1999). MVC testing consisted of three five seconds maximal contractions separated by approximately 60 seconds of recovery in standardized exercises. The standardized exercises were designed so they could easily be performed in a field setting on the pool deck and in the swimming pool with no stationary machines. Visual feedback of the sEMG signal and verbal encouragement were given to facilitate participants' maximal effort. During the MVC testing in water the water depth for each exercise was set to ensure that the electrodes were fully submerged. Muscles tested were biceps brachii, triceps brachii, trapezius (pars descendens), pectoralis major (pars clavicularis), rectus femoris, biceps femoris, tibialis anterior and gastrocnemius. The waterproof electrodes were covered with insulating tape around the outside perimeter and connected to waterproof emg active sensors for sEMG (Plux Ltd, Lisbon Portugal) with a band pass filter of 25-500Hz (-6dB) and with a gain of 1.000. The sensors were connected to the bioPlux Research (Plux, Lisbon, Portugal) inside a waterproof pouch with 8 analogue channels (12 bit) and sampled at a rate of 1.000Hz. The power spectrum was analyzed using fast Fourier transform. **Results** Mean average frequency on land were 138Hz (SD 28,04) and in water 134Hz (SD 31,11). Peak average frequency on land were 69Hz (SD 24,16) and in water 61Hz (SD 29,21). A paired sampled t-test showed no significant differences either for the mean frequency ( $p=0,31$ ) or the peak frequency ( $p=0,09$ ). **Discussion** The high SD was a result of the different frequencies among the eight different muscles. The results of the present study showed that the sEMG recordings between land and water were not significantly different indicating a good similarity without any additional waterproofing of the electrodes. **References** Hermes, HJ., Freriks, B., Merletti, R., Stegeman, D., Blok, J. Rau, G. et al. (1999). European recommendations for surface electromyography: results of the SENIAM project. 2nd ed. Roessingh Research and Development

#### CONCENTRIC CONTRACTIONS ARE MORE CONDUCTIVE TO EXPLOSIVE TORQUE PRODUCTION THAN ECCENTRIC OR ISOMETRIC CONTRACTIONS

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**Introduction** The influence of contraction type (concentric, eccentric and isometric) on maximum strength (maximal voluntary torque, MVT) has been widely documented via the in vivo torque-angular velocity relationship (Rassier et al., 1999). However, due to methodological

limitations, the influence of contraction type on explosive strength (rate of torque development), and the human ability to utilise the available torque capacity of the muscle during explosive efforts has not been documented. This study assessed the influence of contraction type on explosive strength and the utilisation of the available torque capacity of skeletal muscle. Methods Fourteen male participants completed a series of explosive voluntary contractions of the knee extensors in four separate conditions on an isokinetic dynamometer: concentric (CON) and eccentric (ECC); and isometric at two knee angles (101°, ISO101; and 155°, ISO155). CON and ECC were performed at constant accelerations from stationary. In each condition explosive voluntary torque was measured at 25-ms intervals up to 150-ms from torque onset, and then normalised to the MVT specific to that joint angle and angular velocity. Explosive voluntary torque after 50-ms in each condition was also expressed as a percentage of torque generated after 50-ms during an electrically evoked octet (8 pulses at 300 Hz; a measure of the maximum explosive capacity of the muscle) in the same condition. These two procedures of normalising voluntary explosive torque controlled for the influence of joint angle and angular velocity on explosive torque production, and enabled us to quantify human ability to utilise the available torque capacity of the muscle. Agonist EMG normalised to Mmax was also recorded during the four conditions. Results CON explosive contractions were 60% more effective at utilising the available torque generating capacity (explosive torque normalised to MVT) than any other condition (Paired t-tests,  $P < 0.001$ ), after the initial 25-ms. The percentage of evoked torque expressed after 50-ms of the explosive voluntary contractions was also greater for CON (CON,  $76.6 \pm 16.6\%$ ; Paired t-tests,  $P < 0.001$ ), followed by ISO101 ( $46.4 \pm 14.2\%$ ), ISO155 ( $36.4 \pm 12.7\%$ ), and ECC, ( $23.1 \pm 8.7\%$ ). This suggests a higher volitional activation during CON that was confirmed by greater agonist EMG normalised to Mmax in CON (Paired t-tests,  $P = 0.032$ ). Conclusion These results provide novel evidence that human ability to utilise the available torque capacity of the muscle is highly dependent on the type of contraction. Specifically, concentric contractions seem to be considerably more conducive to explosive torque production due to a more effective neural strategy. References Rassier et al. (1999). J Appl Physiol, 86, 1445-1457.

## A NEW METHOD FOR MONITORING SKELETAL MUSCLE CONTRACTILE PROPERTIES

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Skeletal muscles enable efficient movement at varying intensities, duration and different movement patterns. Estimation of contractile properties of skeletal muscles has important influence on all activities regarding human motion, from daily work to physiotherapy and professional sport. The biomechanical and contractile properties of the skeletal muscles have been studied by various methods. The most direct approaches, where the actual muscle fiber type is estimated, require samples obtained by muscle biopsy and are therefore considered invasive (Dahmane & al. 2000). Other approaches include monitoring body movement velocity or movements of specific parts of the body with motion capture systems and force plates, tensiomyography and electromyography (EMG). The first two methods have several limitations, like high cost and lack of portability. The EMG is well established but the results indicate that the surface EMG amplitude cannot be used to predict either the level of muscle activation or the magnitude of muscle force when the muscle exhibits any fatigue (Dideriksen & al. 2010). The contractile properties of skeletal muscles cannot be measured selectively and non-invasively during movement using existing methods. Therefore a new measuring method and device, called the MC sensor (TMG-BMC Ltd.), was developed. The device consists of a sensor with sensor tip, a microprocessor and a supporting part, made of carbon fibre reinforced epoxy polymer, which binds together all of the device parts. Because of the small size and light weight ( $\leq 1g$ ) the MC sensor is suitable for continuous, unobtrusive monitoring of muscle contractile/biomechanical properties. During the measurement the sensor is fixed on the skin above the muscle while the sensor tip is shallowly deepened into the muscle. The measured muscle tension produces force  $F$  in the direction along the muscle surface. This force causes subcutaneous tissue and skin to press on the sensor tip. Vector sum of all forces produce force  $F_s$  in the direction along the sensor tip which is then measured with the force meter. In the simplified 2D model this force would be equal to:  $F_s = 2F \cos(\alpha)$  MC sensor enables muscle load assessment, resulting from muscle contraction or stretching. Preliminary study on m. biceps brachii in isometric conditions showed strong linear relationship between isometric force and MC signal. The aim of the present study was to monitor changes in muscle contractile properties during fatigue. For this we used MC sensor simultaneously with EMG attached to the m. vastus lateralis and medialis on the same leg during a one-leg squat. Dahmane R, Valenčič V, Knez N, Eržen I. (2000). Med. Biol. Eng. Comput., 38, 51-55. Dideriksen JL, Farine D, Enoka RM. (2010). Phil. Trans. R. Soc. A, 368, 2765-2781.

## CHANGES IN SURFACE EMG WITH DISCRETE WAVELET TRANSFORM FOLLOWING A WINGATE TEST

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Introduction Surface electromyography (sEMG) amplitude increases but the frequency of the signal decreases with fatigue. Fourier transform (FT) has been used to analyse sEMG frequency, but its mean frequency does not necessarily provide actual frequency changes. Discrete wavelet transform (DWT) is a novel method for time-frequency analysis of sEMG and is expected to provide greater sensitivity to changes in frequency than FT (1). A previous study (2) reported that the intensity of the 12-27 Hz wavelet domain increased after 50 maximal knee extensor concentric contractions. However, no previous studies have used DWT to investigate sEMG frequency spectrum changes following a Wingate test. Thus, this study examined the changes in frequency during maximal voluntary isometric contractions (MVC) of the knee extensors performed after supramaximal cycling using DWT. Methods Seventeen men ( $24.4 \pm 2.6$  y) performed 30-s maximal pedalling on a cycle ergometer with a load of 7.5% body mass, during which power output was recorded, and changes in peak power were calculated later. Before, and 1, 3, 6, 9, 12 and 15 min after the cycling, 3-s MVC of the non-dominant knee extensors was measured at 90°, and sEMG of the vastus lateralis was recorded. sEMG root mean square (RMS) was used for amplitude analysis and DWT decomposed the sEMG signal into 10 frequency domains between 0 and 500 Hz using a Daubechies mother. Blood lactate concentration was measured at the same time points as the MVC measures. Changes in the variables over time were analysed by a one-way repeated measures ANOVA, and significance was set at  $P < 0.05$ . Results Peak power output during the Wingate test was  $7.8 \pm 0.6$  W/kg and decreased  $33.2 \pm 8.8\%$  at the end. Blood lactate increased to  $11.5 \pm 1.1$  mmol/L at 1 min post-cycling and remained elevated for 15 min. MVC decreased from baseline between 3 and 15 min post-cycling. RMS increased  $34.4 \pm 8.3\%$  at 1 min post-cycling and remained elevated for 15 min. Intensity of all DWT frequency domains increased from baseline at all time points after cycling. The greatest increase was found for the 16-32 Hz domain than others with the greatest increase at 1 min post-exercise and gradual decreases thereafter. Discussion The increases in DWT intensity and RMS suggest greater muscle activity in the fatigued muscle. The greatest increases in DWT intensity in the 16-32 Hz domain in the present study are in line with the finding of the previous study (2). It is speculated that decreases in conduction velocity and increases in slow twitch fibre recruitment were associated with the frequency changes. References 1) Karlsson S et al. (1999) IEEE Trans Biomed Eng., 46, 670-84 2) So R et al. (2009) Med. Sci. Sports Exerc., 41, 788-96

## Oral presentations

### OP-BN12 Balance and Stability 2

#### ATTENTION AND BALANCE CONTROL IN SPORT: A STUDY BY ACCELEROMETRY

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STATE UNIVERSITY OF LONDRINA - PARANA, SPONSORED BY ARAUCARIA FOUNDATION

**ATTENTION AND BALANCE CONTROL IN SPORT: A STUDY BY ACCELEROMETRY** Oliveira, AR.1, Gallagher, JD.2, Oyen, AS.3 1: UEL/CNPq (Londrina, Brazil), 2: UP (Pittsburgh, USA), 3: PSU (State College, USA) **Introduction** This study proposed to determine the relationship between a motor skill postural and focal components (Frank & Earl, 1990) and moving balance. Increased motion and reduced smoothness of head and trunk in the medial-lateral plane might be related to decreased balance skills for children, especially after 7 years of age, a period where it is expected that they demonstrate an adult pattern of balance control strategies (Yack et al., 1992). The study investigated the influence of selective attention on the development of balance control. **Methods** The sample involved sixty female subjects (6-, 12-, and 19-years old). In each age group there were 10 gymnasts and 10 non gymnasts. The instruments were a scale with stadiometer, three tri-axial accelerometers (ADXL150/EM-3, 5g, Analog Devices, Norwood, MA) placed on head, hip and ankle, a footswitch, a line on the floor, a balance beam, and an AD computer. The tasks were: walk on a line on the floor (3.68 m long, 10.0 cm wide), over a white obstacle, walk across a balance beam, and over an obstacle. The dependent variables were Root Mean Square and Index of Smoothness of the head and trunk in three planes of movement: vertical, anterior-posterior, and medial-lateral,  $p < 0.05$ . Children were cued to look at the end of the line and beam in the experiment. **Results** Selective attention improved vertical head and trunk smoothness in the ML plane. The younger children group stabilized the trunk and head regardless of strategy use. The 12-year olds displayed smooth trunk motion without the use of a strategy and decreased smoothness with strategy. The adults demonstrated trunk stability regardless of strategy and deteriorated performance with strategy. When the selective attention strategy was used subjects differed in terms of head stabilization in space to improve their balance and the non gymnasts decreased their head motion but did not alter the trunk. **Discussion** The youngest group demonstrated a smoother trunk ML pattern when not using the strategy, independent of task conditions (obstacle absent and present). Otherwise, in the older groups (12- and 19-years old) the use of strategy made the difference and a smoother trunk in the ML plane was demonstrated in the experiment. The greatest difference was observed in the 12-years old group. Experience and selective attention strategy influenced the balance control across age and task complexity levels. **References** Frank JS, Earl M. (1990). Coordination of posture and movement. *Physical Therapy*, 70 (12), 855-863. Yack J, Shelden J, Schieb D. (1992). An investigation of accelerometry as a technique for balance assessment in children. In M. Woollacott & F. Horak (Eds.), *Posture and gait: Control mechanisms*, Vol. II (pp. 319-322). Portland, OR: University of Oregon Books.

#### NEUROMUSCULAR EFFICIENCY DURING SIT TO STAND MOVEMENT IN WOMEN WITH KNEE OSTEOARTHRITIS

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**Introduction** Knee osteoarthritis (OA) is associated with pain, quadriceps dysfunction, joint stiffness, instability and difficulties in performing daily activities. The purpose of this study was to investigate the neuromuscular efficiency of women with knee osteoarthritis when performing a sit to stand (STS) movement and during maximum strength efforts. **Method** Twelve women with unilateral knee OA (age  $60.33 \pm 6.66$  yrs, height  $1.61 \pm 0.05$  m, mass  $77.08 \pm 9.2$  kg) and eleven controls (age  $56.54 \pm 5.46$  yrs, height  $1.64 \pm 0.05$  m, mass  $77.36 \pm 13.34$  kg) participated in this study. Subjects performed a STS movement from a normal height chair while position of center of pressure and knee angular velocity were recorded. Furthermore, maximal isokinetic knee extension and flexion strength at  $60^\circ/\text{s}$ ,  $120^\circ/\text{s}$  and  $150^\circ/\text{s}$  was measured. Surface, electromyography (EMG) from the biceps femoris (BF), vastus lateralis (VL) and vastus medialis (VM) was recorded during all tests. Analysis of variance was used for the statistical analysis. **Results** During the STS test that women with knee OA demonstrated significantly lower knee angular velocity ( $44.49 \pm 9.61^\circ/\text{s}$  vs  $71.68 \pm 19.86^\circ/\text{s}$ ), a more posterior position of the center of pressure ( $39.20 \pm 7.02\%$  vs  $41.95 \pm 2.49\%$ ) and a higher antagonist BF activation ( $57.13 \pm 20.55\%$  vs  $32.01 \pm 19.5\%$ ) compared with typical women ( $p < 0.05$ ). Further, women with knee OA demonstrated a lower moment : EMG ratio than controls in extension, but not in flexion. **Discussion** The lower ability of women with OA to rise from a chair is mainly due to a lower knee extension capacity, which, coupled with a higher BF co-activation is indicative of a reduced neuromuscular efficiency than typical individuals.

#### MEASURING LOCAL DYNAMIC STABILITY OF ATHLETE IN AGILITY DRILL USING LYAPONOV EXPONENT

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**MEASURING LOCAL DYNAMIC STABILITY OF ATHLETE IN AGILITY DRILL USING LYAPONOV EXPONENT** Arshi AR.1, Mehdizadeh S.1, Komasi P.2, Shirzad E.2, Nabavi H.1 1: AUT (Tehran, Iran), 2: NOAI (Tehran, Iran) **Introduction** Local dynamic stability is defined as the ability of the system to recover its original state in movement after small perturbations (Gates et al., 2010). During the recent years, nonlinear dynamics has been implemented increasingly in studying facets of movement science such as fatigue and local dynamic stability (Sanjari et al., 2010; Gates et al., 2010). Agility is defined as the ability to change the body direction effectively while maintaining dynamic stability, coordination, speed (Vescovi, 2004). In the present study the local dynamic stability of the movement of the athlete performing an agility workout is measured using Largest Lyapunov Exponent (LLE). **Methods** An agility test designed during which participants completed two 180-degree and two 90-degree turns. Five semi-professional soccer players who had no previous injury experience participated in the experiment. 2D coordinates of the body center of mass (COM) were recorded at the sampling frequency of 300 Hz. Three two-dimensional and one three-dimensional state spaces are constructed. Two-dimensional state spaces are  $v_x$  vs.  $x$ ,  $v_y$  vs.  $y$  and  $v_r$  vs.  $r$  where  $v_x$ ,  $v_y$  and  $v_r$  are velocity in  $x$ ,  $y$  and tangential velocity, respectively. The three-dimensional state space is constructed by COM position ( $r$ ),  $v_r$  and  $a_r$  where  $a_r$  is COM acceleration. Local dynamic stability of the COM is measured in each state space using Largest Lyapunov Exponent (LLE) is used. LLE is defined as the exponential rate of divergence or convergence of the neighboring points of the system state space (Rosenstein et al, 1993). Greater amount of LLE indicates greater instability. **Results** Average LLEs of the five athletes in each state space are as follows: 1.5 for  $v_x$  vs.  $x$  state space, 2.25 for  $v_y$  vs.  $y$  state space, 0.12 for  $v_r$  vs.  $r$  state space and 0.0625 for  $a_r$  vs.  $r$ . **Discussion** The results show that definition and dimension of state space are important in quantifying local dynamic stability. It also can be seen from the results that although athlete COM in  $x$  and  $y$  directions has instability, the athlete in the direction of movement



is stable. Due to complex nature of body COM in agility drill and also due to the importance of stability in agility performance, LlyE as nonlinear measure of system stability is a useful tool to quantify athlete agility performance. References Gates DH, Dingwell JB (2010). J Biomech, 43, 913-919. Rosenstein MT, Collins JJ, DeLuca, CJ (1993). Physica D, 65,117-134. Sanjari MA, Arshi AR, Parnianpour M, Seyed-Mohseni S (2010). J Biomech Eng., 132,101002. Vescovi JD (2004). NSCA Hot Topic Series: Agility.

## DYNAMIC BALANCE CONTROL AND H-REFLEX SENSITIVITY DURING SLOW PERTURBATION IN YOUNG AND ELDERLY MALES

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**INTRODUCTION** High muscle force and especially rapid force production are related to balance control during balance perturbations (Piirainen et al. 2010). Age related decreases in force production have been shown to be caused by decreased muscle mass and lower activation efficiency from the central pathways. In addition, activation of the alpha-motoneuron pool, as revealed by H-reflex, may be modulated during dynamic tasks (Chalmers & Knutzen 2000). The purpose of the study was to evaluate if H-reflex sensitivity is affected by ageing and if it is related to dynamic balance control during balance perturbation. **METHODS** Totally 19 young (n=9, 27±3 years) and elderly (n=10, 68±3 years) males participated in this study. Dynamic balance control was measured using custom build balance measurement device with 7,5cm perturbation amplitude and with 0.3m/s<sup>2</sup>, 15cm/s in posterior directions in horizontal plane. COP displacement peak amplitudes and slopes were analysed from acceleration and deceleration phases of the perturbation. H/M20% was measured during 10ms, 30ms and 90ms after posterior direction perturbations. RMS EMG activity was measured from the soleus and medial gastrocnemius muscles and related to the maximal isometric RMS value. **RESULTS** In balance displacement, only significant difference between the age groups were observed in deceleration phase slope and peak amplitudes, which were 27.9% (p<.05) and 36.4% (p<.05) lower in young group, respectively. During balance perturbation, young group showed higher H/M20% ratio in all three time points, although only significant difference was observed 10ms after the perturbation (p<.05). All three H/M20% ratios correlated negatively (lowest r=-.775, p<.05-.01) with the deceleration phase slope in young, but not in elderly. Young had higher EMG activity in both acceleration (Sol 120.8% p<.001, MG 210.2% p<.01) and deceleration phases (Sol 178.9% p<.001, MG 323.4% p<.01). **DISCUSSION** Age related differences in dynamic balance control were seen during deceleration phase of the slow type balance perturbation. Deeper slope of the balance displacement curve in the deceleration phase and lower H-reflex sensitivity in the elderly might be connected to lower spinal level coordination. On the other hand, higher EMG activity and higher H-reflex responses in the young subjects may indicate more efficient Ia-afferent feedback and voluntary response. In addition, higher EMG activity in the acceleration phase in young could be an indication of higher stretch reflex response after the perturbation. **REFERENCES** 1.Piirainen JM, Avela J, Sippola N, Linnamo V. 2010. Eur J Sport Sci, 10(1): 69-79 2.Chalmers, Knutzen 2000. J Gerontol A Biol Sci Med Sci., 55(12):B570-9

## INFLUENCE OF AGE ON BALANCE TASKS

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**Influence of Age on Balance Tasks** Karen Roemer, Louisa D Raisbeck, Michigan Technological University **Introduction** 1.8 million falls occur within the elderly population that is directly related to instability. Postural instability has been linked to poor proprioception, vision, imbalance within the vestibular system, slow reaction time and decreased lower limb strength (Manfield & Maki, 2009). This study is focusing on the relationship between sway and lower limb strength in elderly. It is hypothesized that increased lower limb strength will enhance postural stability for dynamic balance tasks. **Methods** Ten subjects, aged 20 – 40 years (Y) (24.13±/- 4.24) and ten subjects, aged 60 -80 years (O) (66.5 ±/- 5.02) with no fall related injuries participated. To measure dynamic balance, subjects were asked to perform maximal number of lunges with each leg. An AMTI force plate was used to quantify the full body center of pressure (COP). Local sway area (LSA) of the front foot was measured using a TekScan pressure distribution mat. Dynamic strength (ANL) was determined using amplitude and number of the lunges (noL). ANL was normalized to step length and body height for each subject. Relative base of support (RBS) was calculated determining the LSA relative to the normalized base of support. Kinematics were quantified using a Vicon Motion Analysis System. **Results** Two sample t-tests were used to identify significant differences between Y and O. Y showed smaller ANL values(Y: 2.33±2.07cm/noL; O: 5.02±3.83cm/noL), decreased LSA (Y: 24.79±7.64cm<sup>2</sup>, O: 31.22±15.01 cm<sup>2</sup>), and increased normalized step length (SL) (Y: 0.4±0.03cm, O: 0.36±0.04cm) (p<0.05) for both the left and right lunges. O showed increased values for distance of COP to the front foot (FF) (Y: 0.65±0.1cm/SL, O: 0.73±0.08cm/SL) and RBS (Y: 61.43±19.25cm<sup>2</sup>, O: 102.47±65.48cm<sup>2</sup>) (p<0.05) for the right lunges only. **Discussion** Similar to previous studies, our results show that balance and strength decrease with age (Karamanidis et al 2008). Specific changes in the COP distance to the FF and RBS suggest that the older age group adjusts the COP to reduce the load on their left leg. Arampatzis et al 2011 found that dynamic stability and base of support is related to leg strength. Six out of ten elderly performed more right lunges suggesting a relationship between the location of COP and leg strength. Increasing the relative load on the right leg increases LSA and RBS and seems to increase the danger of falls while the right leg is in front. **Acknowledgement:** This investigation was funded by: Michigan Technological University Research Excellence Fund. Arampatzis, A., Peper, A., & Bierbaum, S. (2011). J Biom, 44, 52-58. Karamanidis, K., & Arampatzis, A. (2007). Eur J Appl Phys, 99, 73-85. Mansfield, A., & Maki, B. E. (2009). J Biom, 42, 1023-1031.

## MODULATION OF SPINAL IA AFFERENT INPUT DURING UPRIGHT STANDING IN VARIOUS BALANCE CONDITIONS FOR YOUNG AND ELDERLY ADULTS

BAUDRY, S., LECOEUVE, G., DUCHATEAU, J.

UNIVERSITE LIBRE DE BRUXELLES

**Modulation of spinal Ia afferent input during upright standing in various balance conditions for young and elderly adults** Baudry S, Lecoivre G, Duchateau J. Laboratory of Applied Biology, Université Libre de Bruxelles - Belgium **INTRODUCTION** Alterations in balance capacity with ageing have been associated with differences in the modulation of Ia afferent pathway from soleus muscle, as tested by the Hoffmann reflex (H-reflex)(Koejca et al. 1995). The H-reflex can be modulated presynaptically and such inhibitory mechanism seems to differ in young and old adults during upright standing (Earles et al. 2001). The purpose of this study is to determine if changing visual and proprioceptive information involved specific modulation of Ia presynaptic inhibition in young and old adults during upright standing. **METHODS** Seven young (21-35 yrs; 4 women) and eight older adults (67-88 yrs; 5 women) participated in this study. Surface electromyogram (EMG) was recorded from the soleus, gastrocnemii medialis and lateralis, and tibialis anterior during the four following balance

conditions: rigid surface/eyes open (REO); rigid surface/eyes closed (REC); foam surface/eyes open (FEO); foam surface/eyes closed (FEC). These tests were performed on a force platform that allows computing the center of pressure (COP). Maximal H-reflex (Hmax) and M-wave (Mmax) were obtained by stimulating the posterior tibial nerve at rest and during the four balance conditions. Submaximal H-reflexes were then conditioned by a single pulse delivered to the common peroneal nerve (conditioned H reflex). Modulation in presynaptic inhibition was inferred from the ratio of the conditioned H reflex and test H reflex (no conditioning stimulation). RESULTS The COP data indicate that postural stability decreases with age and balance complexity (age x balance condition,  $P < 0.05$ ). The Hmax/Mmax is reduced in old compared with young adults ( $P < 0.05$ ) and tends to differ across age and balance conditions ( $P = 0.06$ ). The conditioned H-reflex/test H-reflex decreased from rest to upright standing ( $P < 0.001$ ), and was greater in old compared with young adults ( $P < 0.05$ ). DISCUSSION These preliminary data confirm differences in the modulation of Ia afferents during balance conditions of various complexity (Koceja et al. 1995). Moreover, these results suggest that altering vision and proprioception induces greater increase in Ia presynaptic inhibition for old than young adults during upright standing. This may indicate that old adults manage balance complexity by limiting to a greater extent Ia afferent inputs onto motoneurons. ACKNOWLEDGEMENTS This work was supported by the Institute for Research and Innovation of Brussels, Grant # BB2B 2009-1-01 to S Baudry. REFERENCES Earles et al., Clin Neurophysiol 112: 1273-1279, 2001 Koceja et al., Electroenceph Clin Neurophysiol 97 : 387-393, 1995

## Oral presentations

### OP-BN06 Motor Learning 2

#### ANALYSIS OF THE PERFORMANCE IN THE FIRST TENNIS SERVE UNDER THE EFFECT OF AN INDUCED AERODYNAMIC FLOW (WIND)

MENDES, P.1, MENDES, R.2, MARTINS, F.3, FACAS VICENTE, M.A.4, COELHO-E-SILVA, M.J.1, FUENTES, J.P.5, DIAS, G.1, MENAYO, R.6

ESCOLA SUPERIOR DE EDUCAÇÃO DE COIMBRA

1: CIDAF (Coimbra – Portugal), 2: CIPER (Lisboa – Portugal), 3: IT (Covilhã – Portugal), 4: Department of Mathematics, Faculty of Sciences and Technology of the University of Coimbra and INESC-C, 5: FCD – UEX (Cáceres – Spain), 6: FCSAFD (Murcia – Spain). Introduction The present study provides an analysis of the tennis serve performed by 12 expert players when constrained with an induced streamlined flow (ISF) or “side wind” produced by an industrial ventilator. Methods The sample comprised 12 tennis players who were asked to perform 100 serves at the maximum speed and accuracy towards an intersection point between the central and the service lines (“T” point). In the practical procedure, an electronic variator of 11 positions, SEW Eurodrive, and a telescopic elevator, GUIL ELC – 506, were coupled to the industrial ventilator, METEC - HCT - 45 - 4T. Five practical conditions were previewed: without ISF; ISF1 (2,4m/s); ISF2 (4,3m/s); ISF3 (5,8m/s) and; Random ISF (random series of the 3 speed values used in this study). Human movement was recorded using two digital cameras to allow a 2D analysis and manual tracking based on Kwon software (version 3.16) to determine serve’s accuracy. The speed of the ball was assessed by radar, Stalker Pro Sport Results No significant differences in accuracy and precision between the different speeds of ISF were found. In addition, it was possible to identify meaningful statistical changes in speed for six of the 12 players. Concerning to the relation between the speed of the serve and the accuracy (measured by the radial and absolute errors), the results estimated negative correlations for the speed ISF1 (2,4m/s), ISF3 (5,8m/s) and for random ISF. Discussion Tennis experts’ serve accuracy and precision showed a substantial stability under the effect of ‘side wind’. Through the ellipses of error (in the least squares sense), we observe that tennis serve’s accuracy and precision is smaller in depth (anterior-posterior location) than in direction (lateral location). The results also supported the “Fitts Law”, that established an inverse relationship between increments in service velocity and decrements in the accuracy. Additional research is needed to provide the best learning design to combine a powerful serve with accuracy.

#### THE DEVELOPMENTAL ACTIVITIES OF ELITE INTERNATIONAL SOCCER PLAYERS AGED 16 YEARS

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Introduction The activities that expert athletes engage in during their development may follow either an early specialization or early diversification pathway (for a review, see Ford et al., in press). Early specialization involves high amounts of practice and competition in the primary sport from childhood onwards, whereas early diversification involves engagement in several sports in childhood with delayed specialization. We examined the developmental activities of elite soccer players from around the world to test whether their engagement followed one of these pathways. Methods Participants were elite 16 years of age soccer players at top league professional clubs or national academies in Brazil, England, France, and Mexico ( $n = 200$ ). They completed the Participation History Questionnaire (PHQ; Ford et al., 2010) under supervision. The PHQ recorded their developmental milestones (e.g., start age in soccer), hours in soccer-specific deliberate practice, deliberate play and competition, and number of other sports. Results Participants started playing soccer at 5 years of age. Between 6 and 12 years of age, they engaged in 171 hrs/yr of deliberate practice in soccer, 186 hrs/yr of deliberate play in soccer and 34 hrs/yr of soccer competition. Players participated in an average of 2 other sports, which indicates the extent of early diversification. Participants started playing at an elite soccer academy at 12 years of age. Between 13 and 15 years, they engaged in 411 hrs/yr of deliberate practice in soccer, 91 hrs/yr of deliberate play in soccer and 59 hrs/yr of soccer competition. Some between-country differences were found. For example, during childhood, Brazilian players engaged in futsal for 181 hrs/yr over four years alongside a high amount of deliberate play in soccer (224 hrs/yr) and a low amount of deliberate practice (124 hrs/yr) compared to players in the other countries. Discussion The developmental activities of elite soccer players aged 16 years generally did not follow the early diversification pathway. The number of other sports during childhood was very low. Elite soccer players aged 16 years tended to follow the early specialization pathway. However, some between-country exceptions to this rule were found. Implications for talent identification and development are discussed, including the hypothesis that it takes “10,000 hours of practice” to become an expert. References Ford PR, Hodges, NJ, Williams, AM (in press). In ‘Beyond ‘talent or practice?’: The multiple determinants of greatness’ (Ed. S Kaufman, DK Simonton). Oxford: Oxford University Press. Ford PR, Low J, McRobert, AP, Williams AM. (2010). J Sport Ex Psych, 32, 638-654.

## EFFECTS OF EXTERNAL AND INTERNAL FOCUS TRAINING ON FOOT-STRIKE PATTERNS IN RUNNING

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**Introduction** The provision of instructions is critical in the acquisition of skills; and, in the exploration of functional movement solutions. In the case of running, studies have shown that heel strike running pattern generates greater impact on the foot, which leads to injuries. Numerous studies have been undertaken to examine how injury can be prevented or alleviated. We postulate that alteration of foot-strike patterns, from rear foot to fore foot strike, could be a viable strategy to minimise injuries through the provision of different attentional instructions, namely, instruction with either external or internal focus. The objective of this study was to investigate the effectiveness of external or internal focus instructions on encouraging a change from a heel strike to a forefoot strike pattern. **Methods** Nine participants, aged 21-40 years old, were randomly assigned to either an internal focus group (n=4) or an external focus group (n=5). Participants underwent six training sessions with their respective instructional conditions over three weeks with 10 one-minute running trials per session during the intervention phase. 3D motion analysis system (MAC, USA), with 8 cameras was used to capture 21 reflective markers, which were placed at the lower extremities, during pre and post-test sessions. Kinematic calculations were performed through Visual 3D. **Results** Both groups showed a significant change in calcaneus displacement ( $p=0.001$ ) at initial contact (IC), which indicates the change from heel strike to fore-foot strike. However, external group displayed greater plantar flexion at IC compared to internal group. Cycle time ( $p=0.036$ ) and cycle length ( $p=0.024$ ) were significantly decreased for the external group. **Discussion** Internal and external focus of attention on the impact of skill acquisition have been investigated in different skill performances such as vertical jump (Wulf & Dufek, 2009) & standing broad jump (Chow et al, 2009), with beneficial effects observed for external focus of attention instructions. Similarly, external focused group in this study showed greater and functional changes in limb kinematics as compared to internal focused group. However, the effectiveness of both focus instructions could be task and individual dependent. Further empirical investigations should be undertaken across a variety of tasks as well as a function of learners' skill levels. **References** Chow, J. Y., Koh, M., & Davids, K. (2009). Effects of Focus of Attention on Performance, Kinematic and Kinetic Changes to Standing Broad Jump in Experienced Jumpers. The 12th ISSP World Congress of Sport Psychology. Wulf, G., & Dufek, J. S. (2009). Increased Jump Height with an External Focus Due to Enhanced Lower Extremity Joint Kinetics. *Journal of Motor Behavior*, 41(5), 401-409.

## THE INFLUENCE OF MOTOR SKILL ON DECISION MAKING ACROSS THE DEVELOPMENTAL SPECTRUM

BRUCE, L., FARROW, D., RAYNOR, A.

RMIT UNIVERSITY

A considerable body of knowledge has developed addressing the perceptual-cognitive and perceptual-motor skills which differentiate expert and novice sport performers, yet relatively little work has directly examined how these skills interact during the development of domain specific expertise (Starkes, Cullen, & MacMahon, 2004). Expert (19 international), developmental (20 Australian underage), and novice (19 social) netballers completed tests designed to evaluate three different components of domain-specific expertise: (i) motor skill-execution; (ii) perceptual-cognitive decision making; and (iii) perceptual-motor decision making. The perceptual-cognitive and perceptual-motor tests were designed such that the participant had two available passing options, however, tactically one option was considered to be a better choice due to the distance of the required pass and/or the position of the defensive players. Visual search measures were also recorded on the perceptual-cognitive task. A series of ANOVA's revealed that irrespective of skill level, when players were able to combine their decision with movement as in the perceptual-motor task, the decision they made (i.e., direction of the path) was more accurate than when they were required to provide only a simple verbal response as in the perceptual-cognitive task. However, when an execution component (i.e., team mate successfully catching the ball) was included in the response accuracy of the perceptual-motor task, the performance of the novice participants diminished relative to their performance on the perceptual-cognitive condition. Although an individual's motor skill was found to be related to the successful execution of their decision in a game situation, it was not found to limit the nature of the decision made by participants. Visual search mean values indicated that the novice participants spent more time viewing the short options and less time viewing the long option when compared to the expert and developmental athletes, however these differences fell short of the required level of statistical significance. As such, no evidence was found to support the supposition that lesser skilled participants bias their perceptual-cognitive decisions towards ones that are more aligned with their own personal motor ability. Results fail to comprehensively support the contemporary models (Starkes, et al., 2004) for the development of perceptual-cognitive and perceptual-motor skill in sport. Starkes, J. L., Cullen, J., & MacMahon, C. (2004). A life-span model of the acquisition and retention of expert perceptual-motor performance. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (pp. 259-281). London: Routledge.

## EFFECT OF ACHILLES TENDON VIBRATION DURING SUBMAXIMAL ISOMETRIC PLANTARFLEXION AND POSTURE

AMIRIDIS, I.G., SPILIOPOULOU, S., HATZITAKI, V., BALTZIS, P., KELLIS, E.

LAB OF NEUROMECHANICS

**Introduction** Tendon Vibration (TV) is known to modify proprioceptive input by eliciting a selective discharge of spindle group Ia afferents, which evokes an increase of the plantarflexors' tension, due to the tonic vibration reflex (Burke et al., 1976). Nevertheless, the vibration induced muscle tension regulation at the ankle joint cannot fully account for the posterior shift of the Centre of Pressure (CoP), favoring the hypothesis of task dependent processing of vibration based on the active state of the muscle and the degree of instability of a particular task. To further explore this hypothesis, we compared vibration induced responses of the ankle plantarflexors across different levels of submaximal force production and static postural tasks of increasing difficulty. **Methods** Twenty seven young women performed 3 isometric plantarflexions at 10, 20, 30 and 50% of MVC and 3 postural tasks of increasing difficulty (Normal Quiet Stance, Sharpened Tandem and the One Leg Stance) with a vibrator applied to the Achilles tendon (80Hz). Both isometric plantarflexion and postural tasks were performed under 5 successively presented experimental conditions, each lasting 10": i. vision, ii. no vision, iii. no vision – TV, iv. vision – TV and v. vision. Isometric plantarflexion moment, CoP displacement and EMG activity from Medial Gastrocnemius (MGAS), Tibialis Anterior (TA) and Soleus (SOL) were recorded. During posture, the fascicle's length and pennation angle of the MGAS was also determined by use of ultrasonography. **Results** An increase ( $P<0.01$ ) in isometric plantarflexion moment was observed during the TV application at all percentages, accompanied by a greater ( $P<0.01$ ) MGAS and SOL activation. No differences were observed in TA activity. During all postural tasks, the application of the TV resulted in a backward displacement of the CoP that was accompanied by an increase in EMG activity of MGAS, SOL and TA muscles. Moreover, an increase ( $P<0.05$ ) of the pennation angle of MGAS and decrease ( $P<0.05$ ) of the fascicle length

was observed during posture, confirming the contraction of the plantarflexors, during the TV application. Discussion A vibration induced excitatory Ia afferent input, resulting in an increase in EMG, was confirmed during both submaximal force production and postural performance. The tonic vibration reflex is clearly manifested during force and static balance tasks. It does not seem unreasonable to hypothesize that the amount of central drive to the ankle muscles, controlling both submaximal force production and postural sway, modulates the spindle's sensitivity to the vibration stimulus, possibly through the  $\gamma$  system. References Burke D, Hagbarth KE, Lofstedt L, Gunnar Wallin B (1976). *J Physiol*, 261, 695-711.

### QUIET EYE TRAINING IN A VISUO-MOTOR CONTROL TASK

CAUSER, J., HOLMES, P.S., WILLIAMS, A.M.

THE UNIVERSITY OF SYDNEY

QUIET EYE TRAINING IN A VISUO-MOTOR CONTROL TASK Causer, J. 1, Holmes, PS. 2, Williams, AM. 1,3 1: USYD (Sydney, Australia), 2: MMU (Cheshire, UK), 3: LJMU (Liverpool, UK) Introduction: Several researchers have reported the importance of maintaining a longer final fixation on the target (quiet eye period, QE) prior to performing an aiming task (Causer et al., 2010; Vickers, 1996). We present an innovative, perceptual training intervention intended to improve the efficiency of gaze behavior (i.e., QE) in shotgun shooting. Methods: A sample of 20 international-level, skeet shooters were assigned equally to one of two, matched-ability groups based on their pre-test shooting scores. A perceptual training group participated in a 4-step, pre-shot routine, alongside three video feedback sessions involving their own gaze behaviors and those of an expert model in an effort to influence positively QE behaviors. A control group received video feedback of performance, but without the addition of feedback on QE behaviours. Participants completed pre- and post-tests along with an 8-week training intervention. Eye movement and gun barrel kinematic data were collected during the pre- and post-tests. An ASL Mobile Eye system allowed point of gaze to be calculated in relation to the scene, while motion of the gun was evaluated using markers placed on the barrel which were captured by two stationary cameras. Results: The perceptual training group significantly increased its mean QE duration (397 v 423ms), employed an earlier onset of QE (257 v 244ms), and recorded higher shooting accuracy scores (62 v 70%) from pre- to post-test. Participants in the perceptual training group significantly reduced gun barrel displacement and absolute peak velocity on the post- compared to the pre-test, even though neither variable was overtly trained. A transfer test, based on performance during competition, indicated that perceptual training significantly improved shooting accuracy pre- to post-intervention. No pre- to post-test differences were observed for the control group on the measures reported. Conclusion: Significant improvements in visuo-motor control were reported after an 8-week intervention programme, as indexed by an earlier onset of QE, a prolonged QE duration and more economical gun barrel displacement and absolute peak velocity. These modifications led to increases in shooting accuracy pre- to post-test and in a measure of transfer involving a comparison of shooting scores in competitions pre- to post-intervention. Findings have implications for those examining the role of attention and gaze orientation in the organization of motor performance. In a more applied setting, the results identify a number of potential avenues for improving coaching strategies, including early gaze behavior training and video feedback to enhance performance. References: Causer J, Bennett SJ, Holmes PS, Janelle CM, Williams AM. (2010) *Med Sci Sport Exerc*, 42, 1599-1608. Vickers JN. (1996). *J Exp Psychol Hum Percept Perform*, 22, 342-354.

## Invited symposia

### IS-SH07 Novel Modalities for Increasing Adherence to PA in Children: Exergaming

#### NOVEL MODALITIES FOR INCREASING PHYSICAL ACTIVITY AND REDUCING SEDENTARY BEHAVIOUR IN CHILDREN: EXERGAMING

STRATTON, G.

LIVERPOOL JOHN MOORES UNIVERSITY

The genre of exergaming began in the 1980s. Dance Dance Revolution sold over three million copies and was probably the pioneer of exergaming. Over the past decade, a number of devices and games have used exergaming to much success: the Sony EyeToy camera has sold over ten million units while Nintendo's Wii Fit has sold in excess of 21 million copies. Recently the X-Box Kinect having shipped 10 million sensors and forecasts suggest that this game will possibly break all previous records. In the UK more than 80 per cent of nine to 19-year-olds own a games console and 70 per cent play computer games online. The research literature in the area is growing rapidly although there are few prospective interventions on the effect of exergaming on increasing physical activity and decreasing sedentary behaviour. This presentation will review current research on exergaming in children and young people Increasing physical activity (PA) and reducing the time spent sedentary can favourably impact health in youth. Active video games discourage sedentary behaviour by incorporating PA into video gaming, and have the potential for increasing opportunities for, and the promotion of, PA. The aims of this workshop will be a) review current research on exergaming b) compare adolescents' energy expenditure (EE) whilst playing sedentary and active video games; c) to examine methodological approaches to assessing physical activity and sedentary behaviour related to active video games; d) to compare the physiological cost and enjoyment of active video gaming, e) to evaluate the effects of active video gaming interventions on children's habitual PA and sedentary time, behaviour preferences, and, body composition. At present more complex interventions that consider the wide range of PA and sedentary behaviour opportunities available to young people in the home environment appear necessary to benefit PA and health. Further, the novelty effect observed for active video game use supports the call for the production of new active video games that can sustain their interest.

#### WII KINETC WITH PHYSICAL ACTIVITY – ACTIVE VIDEO GAME PLAY IN OBESE CHILDREN

MCMANUS, A.

UNIVERSITY OF HONG KONG

Introduction Exercise is routinely recommended to obese children and adolescents as a means of attenuating risk of later cardiovascular disease, improving glycaemic control and limiting excessive weight gain. The traditional exercise paradigm, that at least 20 minutes of moderate-to-vigorous activity at least 3 days a week, will counteract specific risk factors related to cardio-metabolic diseases has dominated child and adolescent exercise prescription. Yet interventions utilizing this exercise prescription have generally failed those who are overweight or obese (Lobstein et al., 2004) Recently interest has been re-focused toward the role low-intensity exercise plays in metabolic

health and although evidence in children is limited it would appear that low-intensity exercise results in greater levels of lipid oxidation in comparison to the more commonly prescribed moderate-to-vigorous exercise (Lazzer et al., 2007). Furthermore, a number of low-intensity home-based exercise options in the form of activity-enhanced video game play or exergames (e.g., Wii, XBOX Kinect) are now available and being promoted as alternative exercise modalities for young people, particularly the overweight and obese. While it is likely that these activity-enhanced video game options are more feasible and sustainable compared to traditional moderate-to-vigorous intensity exercise, it is important to establish the level of play necessary to attain metabolic and clinical benefit. It is also important to establish whether compensation occurs during exergame interventions i.e., a parallel reduction in energy expenditure elsewhere in the day to compensate for the increase in energy expenditure from the exergame. Methods Data from our work on the use of exergames with overweight and obese children will be shared. Attention will be given to energy expenditure levels, as well as lipid oxidation rates during exergame play. We will also discuss the problem of compensation and whether this occurs during low-intensity activity-enhanced video game play. Discussion A greater understanding of the metabolic benefits which low-intensity exergames may confer in obese children and adolescents is of major importance if these games are going to be used for the treatment of obesity. References Lobstein T, Baur L, Uauy R, for the IASO International Obesity Task Force (2004). *Obesity Rev*, 5(Suppl 1):4-85. Lazzer S, Busti C, Agosti F, De Col A, Pozzo R, Sartorio A (2007). *Clin Endocrinol*, 67:582-588.

## THE USE OF NEW TECHNOLOGIES TO IMPROVE HEALTH: EXERGAMING AND EXCESSIVE USE

HUSSAIN, Z.

UNIVERSITY OF DERBY

Physical inactivity among young and old people is a serious health problem and could lead to lifestyle related illnesses such as diabetes and cardiovascular disease. It has been suggested that video game playing, television viewing and computer use are contributory factors that encourage sedentary lifestyles in young people. Although video game playing has often received a lot of criticism, more recent forms of video gaming technology, called Exergaming, may help to increase physical activity. Exergaming has experienced an increase in popularity especially with the advent of the Nintendo Wii, Microsoft Kinect and the Sony PlayStation Move. Research investigating the effectiveness of Exergaming and the negative consequences of excessive video game playing will be reviewed.

## Invited symposia

### IS-BN06 Intrinsic high and low running capacity: Models for health and disease

#### TRANSCRIPTOME – PHENOTYPE ASSOCIATIONS IN HIGH AND LOW CAPACITY RUNNER RATS

KAINULAINEN, H.

UNIVERSITY OF JYVÄSKYLÄ

A strong statistical association exists between low aerobic exercise capacity and complex metabolic diseases. The difference in aerobic endurance capacity between individuals is the sum of inborn capacity and that acquired via lifestyle activity. Despite much study, however, the explicit genetic programs for neither the intrinsic nor acquired components of aerobic capacity have been defined. To probe the linkage between low aerobic capacity and diminished health status, we utilized rat models of low and high intrinsic aerobic endurance running capacity that differ also in the risk for metabolic syndrome. We investigated in skeletal muscle gene network-phenotype relationships that might connect aerobic endurance capacity with metabolic disease risk factors. The comparison was performed between 12 high capacity runners (HCRs) and 12 low capacity runners (LCRs) from generation 18 of selection that differed by 615% for maximal treadmill endurance running capacity. Gene set enrichment analysis (GSEA), a statistical technique that relies on the principle that genes act as groups in a coordinated manner and not in isolation, was used to identify the subsets of genes that are congruently regulated within a given gene set. Centroids (centroid is the mean expression of the coregulated genes within a subset) are known to correlate with various systemic metabolic and physiological factors and may therefore be used to probe for gene expression patterns that are causative of complex metabolic diseases. On average, LCRs were heavier and had increased blood glucose, insulin, and triglycerides compared with HCRs. HCRs were higher for resting metabolic rate, voluntary activity, serum high density lipoproteins, muscle capillarity, and mitochondrial area. Bioinformatic analysis of the skeletal muscle gene expression data revealed significant differential expression for 239 genes in gastrocnemius muscle that can underlie at least part of the phenotypic differences for low and high intrinsic aerobic endurance capacity. Seven mean mRNA expression centroids, including tricarboxylic acid cycle, oxidative phosphorylation, fatty acid metabolism, PPAR signaling, and STAT3 pathways correlated significantly with several exercise capacity and disease risk phenotypes such as voluntary activity, insulin sensitivity, blood triglycerides, and fatty acids. These expression-phenotype correlations, together with diminished skeletal muscle capillarity and mitochondrial area in LCR rats, support the general hypothesis that an inherited intrinsic aerobic capacity can mediate a difference between health and disease.

#### EXPERIMENTAL MODELS OF COMPLEX DISEASE: A THERMODYNAMIC STRATEGY

BRITTON, S.L., KOCH, L.G.

UNIVERSITY OF MICHIGAN

Symposium Title: Intrinsic high and low running capacity: Models for health and disease. Steven Britton: Experimental Models of Complex Disease: A Thermodynamic Strategy Heikki Kainulainen: Transcriptome – phenotype associations in high and low capacity runner rats Jatin Burniston: Muscle proteome changes associated with differences in whole-animal aerobic capacity Experimental Models of Complex Disease: A Thermodynamic Strategy Britton, Steven L. and Koch, Lauren Gerard Background The statistical linkage between low aerobic capacity and low health initiated the idea that artificial selection for low and high treadmill running capacity might yield models that differ for disease risks (ca. 1988). Yet, we knew of no direct fundamental mechanisms that explained the strong link between aerobic function with morbidity and mortality: this made initiating a large-scale selection paradigm based solely upon clinical association an insufficient path. Our search for a predictable hypothesis led us to these two tenets: a) the transfer of energy to mediate the motion of atoms and molecules into function was the central obligatory feature of evolution, and b) disease process must be tightly associated with the mechanism underlying evolution. Temporal evaluation of earth's geochemical and fossil records supports the notion that development of atmospheric oxygen was mechanistically essential for evolution from single to multicellular complexity (1). The coupling of Ilya

Prigogine's (2) ideas about "energy dissipative structures" as they operate through Peter Mitchell's (3) chemi-osmotic theory of ATP formation provide explanation for evolution of complex organisms that are far from thermodynamic equilibrium. Outcome of Artificial Selection These ideas formed a qualitative logic that much of complex disease arises from spatial and/or temporal dysregulation of oxygen and ATP metabolism. Upon this theoretical base we started two-way selective breeding to develop strains of rats that contrast for intrinsic (i.e., untrained) aerobic treadmill running capacity in 1996 (4). The founding population was 168 genetically heterogeneous rats of the N: NIH outcrossed stock. Now at 28 generations of selection, the low capacity runners (LCR) and high capacity runners (HCR) differ by over 500% for endurance running capacity. The LCR display cardiovascular risks, features of the metabolic syndrome, accelerated aging, and reduced longevity. The HCR are higher for VO<sub>2</sub>max, heart function, blood high density lipoproteins (5), and state 3 mitochondrial function in skeletal muscle. These rats represent a potentially useful model for understanding the networks connecting exercise endurance capacity and complex disease risks at all levels of biologic organization. 1. Falkowski et al. Science 309, 2202-2204, 2005. 2. Prigogine. Science 201, 777-785, 1978. 3. Mitchell. Nature 191, 144-8, 1961. 4. Koch and Britton. Physiological Genomics 5, 45-52, 2001. 5. Wisloff et al. Science 307, 418, 2005.

## MUSCLE PROTEOME CHANGES ASSOCIATED WITH DIFFERENCES IN WHOLE-ANIMAL AEROBIC CAPACITY.

BURNISTON, J.

LIVERPOOL JOHN MOORES UNIVERSITY

The proteome is the cell-specific protein complement of the genome and is what defines a cell and dictates its functional characteristics. High-capacity runner (HCR) and low-capacity runner (LCR) rats exhibit marked differences in functional capacity and susceptibility to disease that are likely to be underpinned by differences in their heart and skeletal muscle proteomes. Further to providing confirmation of mRNA findings, proteomic analysis offers the opportunity to discover site-specific post-translational modifications using an unbiased systems biology approach. Difference in-gel electrophoresis (DIGE) and sophisticated protein identification by tandem mass spectrometry (MS/MS) are important techniques in this endeavor. We have used these tools to construct detailed gel maps describing the abundance and different post-translational states of soluble muscle proteins. Image analysis of such maps can provide novel information regarding key features in cardiac and skeletal muscle that correlate with either enhanced whole-body aerobic capacity or susceptibility to cardiometabolic disease. The muscles analysed were from animals of generations 23 and 25 of selection. On average, the intrinsic running capacity of HCR was 5-fold greater than LCR. DIGE resolved almost 1000 gel spots in each striated muscle and the proteins within the majority of these spots were unambiguously identified by MS/MS analysis. Protein expression profiling detected 68 statistically significant ( $P < 0.05$ ; false discovery rate  $< 10\%$ , calculated using q-values) differences between HCR and LCR hearts. In skeletal muscle, 45 statistically significant differences were detected. The majority of differentially expressed proteins were associated with the Biological Processes category: generation of precursor metabolites and energy. In particular, each enzyme of the beta-oxidation pathway was modulated in the heart and differential expression of enzymes involved in branch-chain amino acid metabolism was a consistent feature in cardiac and skeletal muscle. These findings complement transcriptome data, but the majority of gene products were resolved as multiple isoelectric species. Thus, some of the differences in spot expression represent differences in post-translational modification not evident in microarray investigations. In particular we found novel modifications of metabolic enzymes and greater phosphorylation of molecular chaperones, including alpha B-crystallin and glucose-regulated protein 58 in LCR heart and skeletal muscle respectively. Our findings suggest selection on running capacity is associated with robust changes in energy metabolism and that the muscle proteome of LCR is exposed to greater oxidative stress.

## Invited symposia

### IS-PM09 Exercise and Energy Balance in Cancer Risk and Treatment

#### FIT OR FAT? EXERCISE AND ENERGY BALANCE IN CANCER RISK AND PROGNOSIS

ULRICH, C., STEINDORF, K.

GERMAN CANCER RESEARCH CENTER AND NATIONAL CENTER FOR TUMOR DISEASES (NCT) HEIDELBERG

Energy balance and its contributing factors (physical activity and body weight) are known to play a role in the primary prevention of cancer, but may also impact tertiary prevention, affecting the quality of life and prognosis of cancer patients. Low physical activity levels and overweight or obesity have been associated with increased risk of several types of cancer, particularly of the colorectum and postmenopausal breast (for physical activity) or the colorectum, postmenopausal breast, liver and esophagus (for obesity). Possible biologic mechanisms include influences on systemic inflammation, immune parameters, insulin-like growth factors, insulin resistance, steroid hormones, vitamin D status, and lipid metabolism. A novel possible mechanism linking energy balance to cancer risk includes effects on DNA repair capacity. Defects in DNA repair function foster carcinogenesis and intriguing preliminary evidence suggests that regular exercise results in an adaptive response of enhanced antioxidant defenses and perhaps DNA repair. Among cancer patients, initial clinical studies illustrate benefits of exercise training on quality of life or fatigue as well as fitness levels, strength and cachexia. Epidemiologic studies also suggest a positive influence of physical activity on prognosis, particularly for colorectal cancer patients. However, many questions remain regarding causality of the associations, interrelationships between exercise and body weight, and the most appropriate type and timing of exercise training for cancer patients to achieve the maximum benefit with minimal risks.

#### CANCER PREVENTION: THE EFFECT OF EXERCISE ON SEX HORMONES

CAMPBELL, K.L.

UNIVERSITY OF BRITISH COLUMBIA

Lower levels of physical activity and higher body weight and body fat are associated with an increased risk of postmenopausal breast cancer. One proposed mechanism for this association is through greater exposure to steroid hormones, particular estrogen. In postmenopausal women, the primary source of estrogen is conversion of steroid precursors into estrogen by adipose tissue. This presentation will: 1) provide an overview of cancer prevention intervention trials on sex hormones and 2) present findings from a recent diet and exercise intervention in postmenopausal women that collected subcutaneous adipose tissues samples and examined changes in adipose tissue gene expression.

**EXERCISE IN HEMATOPOIETIC STEM CELL TRANSPLANT PATIENTS – NEW STRATEGIES AND OUTCOMES**

WISKEMANN, J.1, JÄGER, D.2, BOHUS, M.3, NIES, R.1, HUBER, G.4, DREGER, P.5, ULRICH, C.M.1

1: NCT/DKFZ (HEIDELBERG, GERMANY), 2: NCT/UNIVERSITY CLINIC (HEIDELBERG, GERMANY), 3: CIMH (MANNHEIM, GERMANY), 4: ISSS (HEIDELBERG, GERMANY), 5: UNIVERSITY CLINIC (HEIDELBERG, GERMANY)

EXERCISE IN HEMATOPOIETIC STEM CELL TRANSPLANT PATIENTS – NEW STRATEGIES AND OUTCOMES Wiskemann, J.1, Jäger, D.2, Bohus, M.3, Nies, R.1, Huber, G.4, Dreger, P.5, Ulrich, C.M.1 1: NCT/DKFZ (Heidelberg, Germany), 2: NCT/University Clinic (Heidelberg, Germany), 3: CIMH (Mannheim, Germany), 4: ISSS (Heidelberg, Germany), 5: University Clinic (Heidelberg, Germany) Introduction Before, during and after allogeneic hematopoietic stem cell transplantation (allo-HSCT) patients experience considerable physical, psychological and psychosocial distress. Besides GvHD and infections, particularly reduced physical performance and functioning as well as high levels of fatigue affect patient's quality of life negatively (Kovalszki et al., 2008). In light of the increasing numbers of successfully treated patients the need is growing for evidence-based adjuvant therapy options, which reduce treatment-related side effects and consequently enhance the rehabilitation process. Physical exercise therapy constitutes a potentially promising intervention to support the stem cell transplantation process (Wiskemann et al., 2008). Methods In a multicenter RCT, founded by the German José Carreras Leukaemia Foundation, 112 patients were equally randomised to an exercise (EX) and a social contact group (Control). Exercisers trained in a home-based setting prior to hospital admission, during inpatient treatment and a 6-8 weeks period after discharge (partly self-administered with an intervention manual and DVD). Physical performance was assessed via 6-minute walk test and handheld dynamometry, fatigue via Multidimensional Fatigue Inventory (MFI) and QoL via EORTC-QLQ-C30. Overall distress was ascertained by the NCCN distress thermometer. Results EX showed significantly improvement in fatigue scores (up to 15% improvement in EX vs. up to 28% deterioration in Control; p-values <0.01-0.03), physical fitness/functioning (p-values 0.02-0.03) and global distress (p=0.03). All effects were at least detectable at one assessment time point after hospitalization or repeatedly. Physical fitness correlated significantly with all reported symptoms/variables. Discussion Our study demonstrates that a partly-supervised exercise intervention that is initiated prior to HSCT and continues post discharge significantly reduced cancer-related fatigue and improves the secondary outcome parameters physical capacity, functioning, anger/hostility, pain and global distress, which are the most common and impairing adverse effects of allo-HSCT beside GvHD. Because of its low personnel effort (only partly supervised training during and telephone calling before and after hospitalization) the here tested exercise intervention can be easily integrated into standard supportive medical care. References Kovalszki A, Schumaker GL, Klein A, Terrin N, White AC. (2008). Bone Marrow Transplant. 41(11):965-969. Wiskemann J, Huber G. (2008). Bone Marrow Transplant. 41(4):321-329.

**12:00 - 13:15****Plenary sessions****PS-PL03 NEW HORIZONS: For (Para)Olympism in 2012 and Beyond****THE FUTURE OF OLYMPISM**

PARRY, J.

CHARLES UNIVERSITY IN PRAGUE

I have previously tried to outline a philosophy of Olympism, including a theory of sport and physical education, that represents our common humanity at both the interpersonal and the political levels, and that seems to me to be the essence of the optimism and hope of this and other forms of humanism and internationalism. (Parry, 2006) This paper enquires into possible future directions for the Olympic Movement and its Games. Firstly, it will examine some of the external challenges to current conceptions and arrangements, such as the challenge of eastern thinkers to the cultural hegemony of the west and its pretensions to universality. Secondly, it will outline and examine some of the internal developments and emphases (i.e. within the IOC and the Olympic Movement), such as the focus culture and multi-culture, and on environmentalism. Thirdly, it will describe and discuss some recent developments and exemplars, including the introduction at the Youth Olympic Games of novel sport forms and events, and its emphasis on culture, education and festival. The paper will conclude with some thoughts as to likely future developments. Parry J, 2006, Sport and Olympism: Universals and Multiculturalism (Journal of the Philosophy of Sport, 33, pp. 188-204).

**PARA-OLYMPISM: SPORT AS PLAY VERSUS SPORT AS WORK**

NOAKES, T.

SPORTS SCIENCE INSTITUTE OF SOUTH AFRICA

I was 4 years old when Roger Bannister ran the mile in less than 4 minutes. Bannister trained for less than an hour a day and said that athletics could not be a real profession since it was not possible to train for more than 2-3 hours a day. So what did you do with the other 21 hours? Or with your life? I find modern international sport much less compelling than in the pre-professional era which perhaps ended with the 1968 Olympics. There athletes from East Germany competed for the first time as a country separate from (West) Germany. The success of East German (and Russian) athletes in Olympic competition added a new political edge to global sporting competition. No longer was sport purely about inter-individual competition. Instead sport became saddled with novel responsibilities that would change the focus of its top participants increasingly from players to workers. With the potential for a significant downside that becomes ever more apparent with each passing year as yet another global sporting icon falls prey to one or other misbehaviour. Most Para-Olympians at least in my country exist in the pre-professional era; they are overwhelming sports players not sports workers. The incentives to perform come wholly from within; the financial incentives to be successful are almost non-existent. Instead other forces must inspire their continuous search for sporting excellence. The existence of the Para-Olympic movement invites the interesting question: What is the cost of sports work? What happens to those who devote their childhood to the pursuit of sports work but who ultimately fail to join the ranks of those few icons who succeed. This question is especially relevant in the developing world from which I come. Professional sport in my country is simply unable to provide job security for anything more than a few hundred professional sportsmen and women at any time. Yet tens of thousand, perhaps more, live out their childhoods in dreams of becoming professional athletes only to discover too late the

extent of their and often their parent's and their nation's deception. As sports coaches, sports doctors and exercise scientists we play an important part in that deception. Our contribution is not neutral; we are part of the problem. In contrast many Para-Olympians are introduced to sport only after they experience a life-changing physical challenge for which the search for sporting perfection seems the ideal antidote. Para-Olympians have re-defined our understanding of what it is to be differently abled. Perhaps they can also help us better to understand which elements of competitive international sport need to be nurtured and conversely what we can be discarded if international sporting competition is to avoid the fate that befell the original Greek Olympic Games.

## 14:00 - 15:00

### Poster presentations

#### PP-TH01 Cycling Physiology

##### EFFECTS OF PACING STRATEGY ON PERFORMANCE AND ANAEROBIC ENERGY CONTRIBUTION DURING MAXIMAL PEDALING

KITADA, T., SASAKI, H., NAITO, H.

JUNTENDO UNIVERSITY, OSAKA INTERNATIONAL UNIVERSITY

**Introduction** During maximal exercise lasting for approximately 1 min, anaerobic energy supply accounts for 50-60% of the total energy supplies (Gastin, 2001). For a high intensity short exercise, the performance outcome largely depends on the pacing strategy, especially in the first half of the race (Saraslanidis et al., 2010), with several race paces being selected by different individuals. It is however not clear how varying paces in the first half of the race affects the contribution of anaerobic energy supply throughout the entire race. This study therefore aimed to investigate the influence of different pacing strategies on performance (total work per body mass) and anaerobic energy contribution during maximal 1-min pedaling. **Methods** Five 400-m runners (best 400-m record:  $60.2 \pm 1.0$  -s, age: 20-22 y-o, mass:  $52.1 \pm 3.3$  kg) volunteered for this study. Subjects were familiarized with the testing procedures of the bicycle exercise before the testing. During the test, subjects performed maximal bicycle pedaling on a cycle ergometer (load equivalent to 6% body mass, kp) for 1 min with similar racing strategies to their own 400-m race. In the following days on two occasions, the self-paced cadence in the first 30-s was increased (fast) or decreased (slow) by 5 % and the subjects pedaled again for 1-min for the best performance. The total work was calculated from the cadences and exercise load. Oxygen uptake and oxygen debt were obtained by collecting expired gas in Douglas bags at rest, during exercise and the recovery for each condition. Anaerobic energy contribution was determined by dividing the oxygen debt by the oxygen demand. **Results** Both the total work per body mass (self-paced:  $37.7 \pm 1.3$ , fast:  $35.6 \pm 0.6$ , slow:  $34.6 \pm 1.4$  kpm  $\cdot$  kg $^{-1}$ ,  $p = 0.001$ ) and anaerobic energy contribution (self-paced:  $73.5 \pm 3.7$ , fast:  $67.0 \pm 8.0$ , slow:  $66.8 \pm 5.4$  %,  $p = 0.029$ ) were greatest for the self-selected pace. The correlation between the total work and the 400-m record was relatively high ( $r = 0.813$ ), but was not statistically significant. **Conclusion** Changing the pace strategies in the first half of exercise affected the total work and anaerobic energy contribution, with the self-selected pace resulting in the greatest values. 400-m runners appear to have selected the optimum pace strategy already through their racing experience. **References** Gastin PB. Energy system interaction and relative contribution during maximal exercise. *Sports Med.* 2001, 31(10):725-41. Saraslanidis PJ, Panoutsakopoulos V, Tsalis GA, Kyprianou E. The effect of different first 200-m pacing strategies on blood lactate and biomechanical parameters of the 400-m sprint. *Eur J Appl Physiol.* 2010, DOI 10.1007/s00421-010-1772-4.

##### EFFECT OF LOW-INTENSITY CYCLING EXERCISE WITH SKIN COOLING ON INTRAMUSCULAR OXYGEN SATURATION AND GAS EXCHANGE RESPONSES

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**(Introduction)** Stimulation of the skin's cold receptors in working muscle changes the pattern of motor unit recruitment during sub maximal voluntary contraction. Our recent study has shown that low-intensity aerobic training with skin cooling increased muscle strength. The purpose of this study was to investigate the effect of skin cooling on muscle deoxygenation and cardio respiratory function during low intensity cycling exercise. **(Methods)** Seven healthy male (age:  $26.2 \pm 8.7$ yr,  $\text{VO}_{2\text{max}}$ :  $54.6 \pm 10.2$  ml/kg/min) participated in this study. All participants performed two cycling exercise trials corresponding to 80% anaerobic threshold (AT) intensity for 15 minutes with skin cooling and without skin cooling as a control. Pedal frequency was 60rpm. Maximum  $\text{VO}_2$  was measured on separate days and AT was determined by V-slope. Skin surface cooling was applied to the quadriceps femoris muscle by circulating water at 5 degrees through cooling pads (Japan Sigma Co.). The mean skin temperature was maintained at 25-26 degrees during exercise. Pulmonary gas exchange and ventilation were measured continuously using a gas analysis system, and beat to beat heart rate (HR) was recorded continuously by a three-lead electrocardiogram. Additionally, EMG activity and intramuscular oxygen saturation of the right vastus lateralis were measured. This muscle oxygenation status was monitored by near infrared spectroscopy (Omegawave, Tokyo Japan). **(Results & Discussion)** The EMG activity during exercise was significantly higher with skin cooling than the control. Additionally, the intramuscular oxygen saturation level during exercise with skin cooling was significantly lower than control. There were no significant differences in oxygen uptake and HR during exercise between skin cooling and the control. On the other hand, skin cooling increased  $\text{VCO}_2$  values and respiratory exchange ratio during exercise compared with control. Thus, skin cooling had a significant effect on the physiological responses, except for HR during low intensity endurance exercise. Moreover, this study demonstrated that skin cooling during aerobic exercise influences muscle activity and the intramuscular oxygen environment, both of which play an important role in exercise induced muscular hypertrophy.



## THE FOUR WEEKS AQUA CYCLING TRAINING FOR TRI-ATHLETES VS DETRAINING EFFECTS: STUDY OF THE CARDIO METABOLIC PARAMETERS.

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**Introduction** The effects of the Detraining on the cardio metabolic parameters are well known and, above all on athletes that practice sport characterized by a great volume of training, they result to be more determinants to the goals of the performance. Triathlon is a plural-sports characterized by manifold stimuli (run - bicycling - swimming), for which the preparation and the different distances of competition are united for the load of prevailing training in running and biking; nevertheless the tri-athletes has also a discreet aquatic motor abilities. This study was set to analyze if during a phase of rest the practice of a period of Aqua Cycling training following a short and intense protocol, could be an effective training of maintenance to make to practice to the Tri-athletes. **Methods** 9 male athletes at Italian national level, homogeneous for category according to the rule of the Italian Federation Triathlon (age  $39.2 \pm 13.2$  years, weight  $73.5 \pm 4.5$  kg, height  $178 \pm 9$  cm) agreed to participate in this investigation. In a first phase they were submitted to an incremental test to exhaustion with the use of the Hydro Bikes (Hydrosider Professional -Italy) with incremental RPM (frequencies of pedaled) every 2 min. During the test they wore a portable metabolic device (VO2000, MedicGraphics, USA) and data of maximal oxygen uptake ( $\text{Vo}_{2\text{max}}$ ), maximal heart rate ( $\text{HR}_{\text{max}}$ ) and anaerobic threshold (AT) were gathered. Subsequently they have participated in 10 sessions of Aqua Cycling (training: 30 min, freq.: 3 times week, duration: 4 weeks) following a protocol of training type Interval Training 4' : 3' x 4 (references 1 - 2). After such period and with the same materials and methods they have been repeated the incremental test to exhaustion. **Results** Statistic analysis revealed that the values of  $\text{Vo}_{2\text{max}}$ , HR and AT have not statistically had any meaningful increases but that the same are also maintained unchanged after the period of training effected with the Aqua Cycling. **Discussion** Results of the present study reveal that a protocol of training with Aqua Cycling of brief duration and high intensity can also oppose the detraining effects in athletes that usually practise great volumes of training. **References** Di Prampero, (1985) The human locomotion on earth, in water, in air. *edi-ermes*. 1- Impellizzeri F. Ms, Marcora S, Chestnut C, Reilly T, Stones To, Iaia F, Hooks it is, Physiological and Performance Effects of Generic vs Specific Aerobic Training in Soccer Players, *Int.J.Sports Med* 2006;27 (6):483-92 2-J.Helgerud et Colleagues, Aerobic High Intensity Intervals Improve  $\text{VO}_{2\text{max}}$  Blackberries Than Moderates Training - *Med Ski Sports Exerc*.2007; 39(4):665-71

## POWER PROFILES OF CIRCUIT RACES IN FEMALE COMPETITIVE CYCLISTS

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**Introduction** This study aims to characterise the demands and exercise intensity of women's criterium races, to reveal how the lengths of a circuit race track influence the power profile and to compare these results with demands of men's criterium races and women's road races. Previous studies investigated the exercise intensity via heart rate recordings. However, it is the mechanical power output, which reveals the most accurate information about exercise intensity. **Methods** SRM power output profiles (SRM, Jülich, D) were collected from 22 criterium races (mean  $\pm$  SD; distance:  $42.31 \pm 7.82$  km; duration:  $67:28 \pm 13:40$  min; number of laps:  $26 \pm 15$ ; distance of laps:  $3.08 \pm 3.10$  km; number of curves:  $100 \pm 62$ ) run by five female cyclists (mean  $\pm$  SD; age:  $29.0 \pm 5.1$  years; body mass:  $56.6 \pm 5.0$  kg; height:  $165.4 \pm 5.5$  cm; BMI:  $20.7 \pm 1.1$  kg/m<sup>2</sup>; race experience:  $5.2 \pm 6.1$  years). Power controls recorded power (W), cadence (rpm), distance (km), speed (km/h) and heart rate (bpm) with a recording interval of one second. **Results** The competitive female cyclists in this study performed an average power of  $194.50 \pm 18.52$  W ( $3.45 \pm 0.32$  W/kg). In 28.89 per cent of the race time the power ranges from 0 – 99 W ( $0 - 2$  W/kg; 31.11 %). In contrast to the relatively constant heart rate, the power, measured during the race, varied to a large extent. Mean values for the heart rate and cadence were  $182.11 \pm 7.00$  bpm and  $90.42 \pm 5.69$  rpm. A total and remarkably high number of 175.42 kicks and 175.15 breaks between pedalling was counted averagely during one race. Concomitantly, a significant correlation between the length of a circuit and the number of power peaks above 8 W/kg and 10 W/kg could be found. The data used in this study reveals that there are more peaks on a shorter circuit than on longer ones. During the race a significant decrease of the power can be observed. This means that power, which is performed at the beginning of a race, cannot be kept on the initial level during the whole race due to local muscle fatigue. **Discussion** In contrast to road races, which show rather constant exercise intensity for the cyclist, circuits can be characterised through the intermittent peaks of power. In comparison to the power profiles of men's criterium races, the relative power output is similar to the women's data ( $3.45 \pm 0.32$  for women and  $3.51 \pm 0.36$  for men). However, the longer distance and duration of the men's races might distort this comparison. In conclusion, the intermittent exercise intensity during the race implies that training focused on the anaerobic capacities, strength and the abilities to sprint can be beneficial for a successful performance in criterium races. **References** Ebert, T.; Martin, D.; Stephens, B.; Withers, R. (2006). Power output during a professional men's road-cycling tour. *Int J Sports Med* 1, (4): 324–335. Impellizzeri, F.; Ebert, T.; Sassi, A.; Menaspà, P.; Rampinini, E.; Martin, D. (2008). Level ground and uphill cycling ability in elite female mountain bikers and road cyclists. *Eur J Appl Physiol* 102, (3): 335–341.

## TIME TO EXHAUSTION AT MAXIMAL LACTATE STEADY STATE DURING CYCLING INTERMITTENT EXERCISE

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**Introduction** The maximal lactate steady state intensity ( $w\text{MLSS}$ ) is usually determined by continuous protocols of 30 min. However, the prescription of aerobic training in sports like cycling and swimming is also conducted intermittently. Thus, the aim of this study was to analyse the time to exhaustion (TTE) and physiological response at  $w\text{MLSS}$  determined by cycling intermittent exercise ( $w\text{MLSS}_{\text{int}}$ ). **Methods** Fourteen trained cyclists performed a maximal incremental test followed by 3-5 visits to measure the  $w\text{MLSS}_{\text{int}}$ . Later, the subjects performed a TTE test in intermittent protocol until exhaustion. The intermittent tests were performed with exercise/rest ratio of 5:1. Blood samples were collected at 110, 230 and 350 min to determine the  $w\text{MLSS}_{\text{int}}$ . The  $w\text{MLSS}$  was defined as the highest [La] that increased by no more than 1.0 mM during the end 20 min of net working time. Oxygen uptake ( $\text{VO}_2$ ) and pulmonary ventilation (VE) were measured breath-by-breath. Heart rate (HR) was recorded continuously.  $\text{VO}_2$ , VE and HR were analysed as percentage of TTE ( $\text{t}20\%$ ,  $\text{t}40\%$ ,  $\text{t}60\%$ ,  $\text{t}80\%$  and  $\text{t}100\%$ ). Blood lactate samples were analysed at min 110, 230, 350 ( $\text{t}_1$ ,  $\text{t}_2$ ,  $\text{t}_3$ , respectively) and at exhaustion ( $\text{t}_{\text{end}}$ ). One-way ANOVA with repeated measures was used ( $p < 0.05$ ). **Results** TTE at  $w\text{MLSS}_{\text{int}}$  was  $67.8 \pm 14.3$  min. Blood lactate at  $\text{t}_{\text{end}}$  ( $5.5 \pm 1.8$  mM) was significantly higher than  $\text{t}_1$ ,  $\text{t}_2$  and  $\text{t}_3$  ( $4.3 \pm 1.0$ ;  $4.8 \pm 1.1$ ; and  $4.9 \pm 1.2$  mM, respectively). VE increased over a time ( $89.6 \pm 12.6$  vs.  $113.3 \pm 23.4$  L•min;  $p < 0.05$ ). Also, HR increased over a time ( $166 \pm 8$  vs.  $179 \pm 7$  bpm;  $p < 0.05$ ). On the other hand,  $\text{VO}_2$  did not rise

significantly between  $\dot{V}O_2$  and  $\dot{V}O_{2\max}$  ( $50.1 \pm 7.3$  vs.  $50.6 \pm 7.7$  mL•kg<sup>-1</sup>•min<sup>-1</sup>). Discussion The TTE found at wMLSSint was supposedly higher than TTE found by Baron et al. (2008) and Fontana et al. (2009) during continuous protocol. The increase in HR and VE values between  $\dot{V}O_2$  and  $\dot{V}O_{2\max}$  are in agreement with Baron et al. (2008) and Lajoie et al. (2000). Furthermore, Baron et al. (2008) also found that  $\dot{V}O_2$  on TTE did not rise between  $\dot{V}O_2$  and  $\dot{V}O_{2\max}$ . In contrast, Lajoie et al. (2000) found that  $\dot{V}O_2$  increased over a time. We found a tendency of [La] accumulation after the 30th min of exercise. A supposed mechanism that could be highlighted to elucidate our finding is the greater recruitment of type II fibres after 30 min of exercise. References Baron B, Noakes TD, Deckerle J, Moullan F, Robin S, Matran R, Pelayo P. (2008). Br J Sports Med, 42, 528-533. Fontana P, Boutellier U, Knöpfli-Lenzin C. (2009). Eur J Appl Physiol, 107, 187-192. Lajoie C, Laurencelle L, Trudeau F. (2000). Can J Appl Physiol, 25, 250-261.

## 6-5 MAXIMAL CYCLING SPRINT TEST: THE PREDICTION OF OPTIMUM LOADING FOR MAXIMIZING MUSCLE POWER OUTPUT

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6-s MAXIMAL CYCLING SPRINT TEST: THE PREDICTION OF OPTIMUM LOADING FOR MAXIMIZING MUSCLE POWER OUTPUT Nedeljkovic, A.1, Pazin, N.1, Bozic, P.2, Berjan, B.2, Jaric, S.3 1: Faculty of Sport and Physical Education (Belgrade, Serbia), 2: Serbian Institute of Sport (Belgrade, Serbia), 3: University of Delaware (Newark, USA) Introduction 6-s maximal cycling sprint test has been widely used for the assessment of muscle power output (MPO). It has been generally presumed that there is an optimum external loading (Lopt) that allows for the muscular system to maximize MPO (Hill, 1938). In cycling task, Lopt has been shown to be within 5-10% of body weight (BW) for Wingate test (Dotan and Bar-Or, 1983) or 5-12% of BW for 6-s maximal cycling sprint test (Pazin et al., 2011). The aim of this study was to investigate the regression model that could predict Lopt. Since the higher relative loads could be more sensitive for the differences among MPO recorded in individuals with different training history (Pazin et al., 2011), we hypothesized that the relation between Lopt and MPO would be higher for higher relative loads. Methods Forty-one healthy male subjects with different training history were tested through the standard 6-s maximal cycling sprint test protocol on a mechanically braked cycle ergometer (834 E, Monark). Eight different loads relative to the subjects' body weight (i.e., 5-12% of BW) were applied. In order to determine Lopt, the obtained data were plotted for each individual subject and a second order polynomial regression was employed to assess the changes in MPO associated with changes in loading conditions (Pazin et al., 2011). Thereafter, the obtained Lopt were plotted against the recorded MPO normalized for BW (i.e., W/kg0.67). The calculated linear regression model and corresponding correlation coefficients were taken for further analysis. Results The applied second order polynomial regression revealed the average value of Lopt 8.9% of BW (range: 5.6-11.4%). The calculated linear regression models appear to be relatively stable across different loading conditions. The corresponding correlation coefficients (R<sup>2</sup>) were: 0.21, 0.20, 0.31, 0.34, 0.44, 0.58, 0.61 and 0.72, calculated for 5-12% of BW, respectively. Discussion The relatively stable outcomes of the conducted analysis suggest that the applied regression model could be considered as a valid method for the prediction of Lopt. The hypothesized higher correlation coefficients indicate increased significance of the prediction model when the higher relative loads are used (i.e., 12% of BW). The valid prediction of Lopt that maximize MPO could be of utmost importance for improvement of routine testing of neuromuscular system and its adaptations to training and rehabilitation procedures. References Hill AV. (1938). Proc R Soc Med, 126, 136-195. Dotan R, Bar-Or O. (1983). Eur J Appl Physiol Occup Physiol, 51, 409-417. Pazin N, Bozic P, Bobana B, Nedeljkovic A, Jaric S. (2011). Eur J Appl Physiol. Epub ahead of print.

## EFFECT OF VIRTUAL REALITY DURING INDOOR CYCLING ON TIME TRIAL PERFORMANCE

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Introduction Indoor cycle trainers have been developed that simulate 'real life' conditions by providing means for video feedback with synchronized power fluctuations. While they view digital video from the course, cycling speed of the video is controlled by power output, and realistic power fluctuations are simulated on ascents and descents. Studies have suggested enhanced training motivation through virtual reality cycling (1-2). It is unclear whether this leads to an increase in actual cycling performance. We hypothesized that virtual reality-enhanced indoor cycling would lead to a better performance on a 48 km time trial. Methods Seventeen male well-trained cyclists age 34(11); maximal power 350(58); maximal heart rate 190(9) were recruited for the study. Subjects cycled an incremental maximal exercise test, and thereafter the virtual reality cycling time trial (VRC), and the same time trial test without video (CON) (random order) on a Tacx Fortius Multiplayer cycletrainer (Tacx b.v., the Netherlands). Subjects cycled 48 km of the Pro Tour cycling classic 'Amstel Gold Race'. Measurements: power output, speed, cadence, time to completion, heart rate and Borg-score. After the study participants were asked whether they favored VRC, CON or neither condition. Participants had no feedback of any of these parameters during the investigation. Paired samples T-tests were used to assess significant differences between groups. Results Data are mean (SD). Time to completion was 90m24s (10m10s) vs. 89m54s (9m12s) in VRC vs. CON (NS). Heart rate was 156(8) vs. 156(9). There were no significant differences in any of the other performance parameters between the two conditions. Ratings of perceived exertion were identical with an average Borg-score of 14 (1) in both VRC and CON. All but one participant (94%) subjectively favored the VRC to CON time trial test. Discussion The current study demonstrated that virtual reality cycling does not elicit a performance increase during a time trial compared to a control time trial without video. Perceived exertion was also unaltered by video feedback. Participants may have been well able to maximize their motivation and performance level at a given distance and course irrespective of video feedback being present. Although we found no direct effect on cycling performance, VRC might promote training adherence and thus enhance performance in the long term, since participants favored the VRC to CON time trial test. References 1. Dagonneau V, Maiano C, Mercier C-S, Mestre DR. Virtual reality and physical activity: attentional and behavioral aspects. Int J Virt Real 2009;8(4):37-42. 2. Annesi JJ, Mazas J. Effects of virtual reality-enhanced exercise equipment on adherence and exercise-induced feeling states. Percept Mot Skills 1997;85(3 Pt 1):835-44.

## DIURNAL EVOLUTION OF CYCLING BIOMECHANICAL PARAMETERS DURING A 60-SECOND WINGATE TEST

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INSERM ERI 27

DIURNAL EVOLUTION OF CYCLING BIOMECHANICAL PARAMETERS DURING A 60-SECOND WINGATE TEST Gauthier, A., Lericollais, R., Bessot, N., Davenne, D., INSERM, ERI27, Caen, F-14000 France; Univ Caen, Caen, F-14000 France Introduction The power recorded during the Wingate test presents a circadian rhythm which can be partly explained by (i) the higher level of motivation (Racinais et al., 2005), (ii) the

higher rate of strength developed by the lower limb (Nicolas et al., 2005), (iii) the higher aerobic contribution to energy release (Souissi et al., 2007) and (iv) the higher body temperature (Souissi et al., 2007) in the evening than in the morning. However, the movement involved during a Wingate test is complex and requiring several muscular chains based on a free pedal rate. Consequently, we have hypothesized that the freedom and complexity of pedalling allow for adaptations in movement patterns at different time of day, in order to help to maintain higher performance in the evening. The aim of this study was to examine the evolution of biomechanical cycling parameters during a fatigue exercise at two times of day. Methods 20 active male subjects were asked to perform a 60-second Wingate test at 06:00 and 18:00 h. Two classical parameters of the Wingate test were analyzed: the Peak Power (PP) and the Mean Power over 60 s (MP60s). The evolution in 30 averaged power output values throughout the Wingate test was used to evaluate and describe the fatigue phenomenon. Kinematic variables were measured during 2 intervals Wingate test: I1 from the 5 to the 20th s and I2 from the 45 to the 60th s. The mobilization of ankle, knee and hip was characterized by studying 2 parameters: the mean angle and the range of motion (ROM). Results PP and MP60s were significantly higher at 18:00 than at 06:00 h. Power output value decrease revealed 2 distinct phases. From the 4 to 20th s, all power output values recorded at 18:00 h were higher than those values recorded at 06:00 h, while from the 22nd to the end these values were not significantly different. The ROM of the ankle angle recorded during I1 was significant lower at 18:00 h than at 06:00 h. The diurnal changes in ankle ROM showed correlation ( $r = -0.68$ ) with the diurnal fluctuation in power outputs. Discussion These results indicate a greater progression of fatigue in the evening than in the morning. In addition, the diurnal changes in power outputs can be mainly associated with modifications in cycling kinematic parameters. This phenomenon has a direct influence on performance and fatigue. These data lead us to believe that there could be diurnal adaptations in pedalling movement allowing an optimization in movement in the evening. References Nicolas A, Gauthier A, Bessot N, Moussay S, Davenne D. (2005). *Chronobiol Int*, 22, 997-1011. Racinais S, Connes P, Bishop D, Blanc S, Hue O. (2005). *Chronobiol Int*, 22, 1029-39. Souissi N, Bessot N, Chamari K, Gauthier A, Sesboüé B, Davenne D. (2007) *Chronobiol Int*, 24, 739-48.

### PHYSIOLOGICAL CHANGES CAUSED BY SMALL VARIATIONS IN SADDLE HEIGHT IN ELITE UNDER-23 PORTUGUESE CYCLISTS.

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**Introduction** The optimization of the relationship between the cyclist and the bike is important for performance maximization. There are only a few studies with elite cyclists, and the published studies used large changes of the saddle height. Thus, this study aimed to observe physiological variations with a sub-maximal laboratory test when vertical changes of the saddle position (DVS) occurs. **Methods** Ten cyclists, aged  $22.2 \pm 2.3$  years old, presented a body mass, stature, sitting height and skinfolds sum (triceps, subscapular, suprailiac, abdominal, anterior mid-thigh and medial calf) of  $67.1 \pm 5.8$  kg,  $172.3 \pm 7.5$  cm,  $90.8 \pm 3.2$  cm and  $47.3 \pm 2.08$  mm, respectively. Geometrical variables of the cyclists' bikes were also measured, and questionnaires about their athletic past and saddle positioning were given. A sub-maximal test with VO<sub>2</sub> and heart rate determination was performed in three saddle positions (reference position (REF), REF plus 2.5% of the DVS and REF minus 2.5% of the DVS). The drawing back of the saddle (RS) and the height between the handle-bar and the base of the saddle were held constant in all of the tests. The load and frequency on the pedal thrust used in the sub-maximal tests were individualized, corresponding to the anaerobic lactate threshold (LAL) values obtained from each cyclist in a previous direct maximum test. The sub-maximal tests of each saddle position were randomly done on the same day. The athletes pedalled for 11 min (8 with a load equal to their LAL), followed by an active and passive recovery of 5 and 15 min between each position. Capillary lactate analyses were performed before and after the tests. **Results** The symphysis pubis height (SP) correlated with the DVS ( $r=0.959$ ;  $p<0.01$ ) and with the height of the saddle (AS) ( $r=0.958$ ;  $p<0.01$ ). In spite of being able to observe an elevated correlation between the SP with the DVS and the AS, the adjustment of the saddle position for the cyclist by the mean of the SP or trochanteric height might lead to considerable differences in the adjustments (of the saddle position) when compared with the individual adjustment. **Discussion** Among the physiological variables measured in this study, VO<sub>2</sub> was the most sensitive to the variation of vertical saddle position, establishing a valid criterion for optimization. VO<sub>2</sub> was influenced by the variation of the saddle position, but the rising and lowering of its position had not just led to a single tendency concerning VO<sub>2</sub> variation. Our results concerning saddle position and VO<sub>2</sub> do not agree with other studies. Our work suggests that the best saddle position for competing cyclists is an individualized task and should be done with the direct measuring of physiological and biomechanical variables.

### EFFECT OF CADENCE ON BOTH CRITICAL POWER AND THE END POWER OF A 3-MIN ALL-OUT ISOKINETIC TEST

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**Introduction** The end power of a 3-min non-isokinetic all-out test (EP) has been suggested to represent the boundary between the severe and heavy intensity domains (Burnley et al., 2006). One piece of evidence was the non significant difference found between EP and the asymptote of the power – time relationship (Critical Power, CP; Vanhalato et al., 2007). If EP truly represents CP, a cadence-induced change in CP (Barker et al., 2006) should be mirrored by a change in EP. The present study aimed at testing the relationship between EP and CP at two different cadences (60 vs 100 rpm) with the 3-min all-out test performed in an isokinetic mode. **Methods** Nine habitually active subjects completed an exhaustive ramp test, two 3-min all-out isokinetic tests to establish EP (EP-60 and EP-100) and eight predicting exhaustive trials to establish CP (CP-60 and CP-100). CP was represented by the intercept of the P-1/time relationship ( $P = CP + W'/t$ ). All tests were performed on an electrically-braked cycle (Schoberer Rad Messtechnik with 8 strain gauges, SRM, Germany). **Results** The Maximal Minute Power at the end of the ramp test was  $315 \pm 55$  W. EP-60 ( $247 \pm 46$  W;  $P<0.01$ ) was systematically and significantly lower than CP-60 ( $228 \pm 47$  W). The two sets of data were significantly correlated ( $r=0.95$ ;  $P<0.01$ ). The bias  $\pm$  95% level of confidence were  $-18 \pm 26$  W with intra-individual differences ranging from  $-29$  to  $+2$  W. EP-100 ( $236 \pm 53$  W) was significantly lower than CP-100 ( $207 \pm 41$  W) with a significant correlation being the two sets of data ( $r=0.74$ ;  $P<0.05$ ). The bias  $\pm$  95% level of confidence were  $-30 \pm 69$  W with intra-individual differences ranging from  $-79$  to  $+13$  W. Mean CP-60 and CP-100 were not significantly different ( $P=0.06$ ) and were significantly correlated ( $r=0.76$ ;  $P<0.05$ ). Mean EP-60 and EP-100 were not significantly different ( $P=0.34$ ) and were significantly correlated ( $r=0.83$ ;  $P<0.05$ ). **Discussion** EP has previously been reported to be sensitive to training-induced changes in CP (Vanhalato et al., 2008). The physiological responses during constant-load exercise performed just above and below EP have been shown to characterise the severe and heavy intensity domains respectively (Burnley et al., 2006) leading the authors to conclude a 3-min all-out test provides a good estimation of CP (Vanhalato et al., 2007). In the present study, strong correlations were indeed found between the two sets of EP and CP values but with EP underestimating CP at both cadences ( $-9\%$  at 60 rpm and  $-15\%$  at 100 rpm). Interestingly, when a 3-min all-out test is performed in an isokinetic mode, EP does not correspond to CP. Therefore, an all-out test lasting 3 minutes should not be seen as an

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### EFFECT OF POLAR TRAINING LOAD-GUIDED VERSUS NON-GUIDED TRAINING IN CYCLISTS

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**Introduction** One possibility for finding the right balance between intensity and recovery is to calculate the impacts of different training sessions (1). In this study a new system based on the Training Load (TL) concept by Polar Electro Oy, Finland, was studied. TL aims to make different exercise sessions comparable in terms of adaptive or exhausting characteristics. Input information for TL are gender, weight, VO<sub>2</sub>max, HRmax, HRrest, lactate threshold (LT), and anaerobic threshold (IAT). This novel feature can be utilized by using PolarPersonal-Trainer.com service (PPT.com) and RS800CXBike Computer. The training software guides cyclists' training based on their individual Cumulative Training Load value (CTL) with a colour based system. **Methods** 22 competitive cyclists (11 males, 11 females) were randomised in a study group (PPT.com) and a control group (PPT) with 5 or 6 males and females in each group. The average VO<sub>2</sub>peak of PPT.com group was 58,3 ml/min/kg and VO<sub>2</sub>peak of PPT group was 60,3 ml/min/kg with an average training time of 15h/week. All subjects trained for 8 weeks, PPT.com group guided by the Polar RS800CXBike and PPT.com, PPT group without guiding. At the beginning and end of the study a standardized incremental exercise test (IET) was performed on a SRM-ergometer (Schoberer Rad Messtechnik, Jülich, Germany). Two subjects dropped out of the study due to illness. **Results** PPT.com group completed on average 49 training sessions with an average HR of 133 bpm and an average duration of 133 min. PPT group completed on average 55 training sessions with an average HR of 138 bpm and an average duration of 116 min. CTL was significantly lower in PPT.com group regarding the following parameters: CTL before ( $p=0,013$ ) and CTL after training ( $p=0,049$ ), CTL impact of all training sessions ( $p=0,048$ ). PPT.com group had significantly less too intense training sessions, according to CTL limits ( $p=0,038$ ). In PPT.com group power output increased on average 0,33 W/kg at IAT ( $p=0,0086$ ) and 0,15 W/kg at Pmax ( $p=0,039$ ). In PPT group power output increased on average 0,22 W/kg at IAT ( $p=0,011$ ) and 0,05 W/kg at Pmax ( $p=0,63$ ). **Discussion** PPT.com and PPT group had similar training time while PPT.com group had fewer but longer training sessions with lower training intensity. Training analysis in terms of CTL clearly documented the difference in training intensity. Nearly all calculated CTL markers showed significant differences between PPT.com and PPT groups. Pre and post IET predominantly showed significant improvements at both thresholds and Pmax in both groups, PPT.com group tending to get higher increases. PPT.com group achieved slightly higher increase of performance with similar training time at significantly lower average intensity. **References** 1 BANISTER E.W., MORTON R.H., FITZ-CLARKE J. (1992): Dose/Response Effects of Exercise Modeled from Training: Physical and Biochemical Measures. *Ann. Physiol. Anthropol.*, 11(3): 345-356.

### REST HRV FOR PROFESSIONAL CYCLISTS DURING 2010 TOUR OF SPAIN.

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CATHOLIC UNIVERSITY OF VALENCIA

**Introduction** Knowing the effect of effort during training or competition is one of the concerns of coaches and trainers. This information is important in all sports, but especially in cycling where the results depend directly on the physiological parameters (Faria, Parker et al. 2005). Thus in the Grand Tours of cycling, knowing the effort in each stage, through non-invasive means such as registration of heart rate variability (HRV) is a key element for the control of the athlete. Heart rate variability is related to the modulation of autonomic nervous system (sympathetic and parasympathetic) (Task Force 1996). In this study we try to find a relationship between effort on previous stage and HRV at rest day on early morning, for professional cyclists on Tour of Spain 2010. **Methods** 4 professional cyclists participated in the study (age:  $28 \pm 2.6$ ) during the Tour of Spain 2010. HRV records were taken at rest immediately after waking. Also monitored the heart rate of cyclists during the stages to establish the effort by trumps (Earnest, Jurca et al. 2004). It took a single case methodology for the study of data, for each rider. MANOVA was also carried out analysis and effect size to find intra-subject variables. **Results** We didn't find similar patterns on HRV variables evolution for any of our cyclists. Also we didn't find significant differences for any HRV variables (average RR, average HR, RMSSD, HF y LF) between mountain and plain stages for any subject, although we find significant differences on response to mountain stages for one subject (subject 1  $\eta^2=0,121$ ), possibly caused by cyclist specialization. The calculated effort by trumps was greater for all subjects in mountain stages ( $\eta^2 = 0.822$ ) as well as perceived exertion according to Borg scale ( $\eta^2 = 0.628$ ). **Discussion** HRV at rest may be a valid tool to detect fatigue states associated with different stages types. Due to our results we can't determine a causal relationship between the intensity of the stages and HRV response. We consider important a better quantify of cyclists efforts during the stages to more effectively discriminate different stages types. **References** Earnest, C. P., R. Jurca, et al. (2004). 'Relation between physical exertion and heart rate variability characteristics in professional cyclists during the Tour of Spain.' *British Journal of Sports Medicine* 38(5): 568-575. Faria, E. W., D. L. Parker, et al. (2005). 'The Science of Cycling: Physiology and Training - Part 1.' *Sports Medicine* 35(4): 285-312. Task Force (1996). 'Heart Rate Variability : Standards of Measurement, Physiological Interpretation, and Clinical Use.' *European Heart Journal* 17(3): 354-381.

## Poster presentations

### PP-SH14 Physical Education 2

#### SCHOOL PERCEPTION RELATED TO EXTRA-SCHOLAR PHYSICAL ACTIVITIES: A CASE STUDY AT ESCOLA PIA BALMES SCHOOL.

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UNIVERSITAT RAMON LLULL

School perception related to extra-scholar physical activities: a case study at Escola Pia Balmes School Marc Franco-Sola, MS1, 2; Enric Mª Sebastiani PhD1; Sara Figueras PhD1; Myriam Guerra PhD1 1 Universitat Ramon Llull (Barcelona, Spain); 2 Escola Pia Balmes (Barcelona, Spain) **INTRODUCTION** Extra-scholar sport activities, after SPM, are very popular in Spain, very motivating and can be used as an educa-

tional tool. As students get older, many of them hang off these activities. The purpose of this study was to identify the perceptions on extra-scholar sport of students 8 to 12 years old in a school of Barcelona (Spain) METHODS This is a case study focused at the Escola Pia Balmaes school in Barcelona. After an inform consent, 205 boys and girls, 8-12 years of ages, volunteered answering a questionnaire. The questionnaire included four main questions: quantity of sports practice, reasons of choosing the place where to train, motivations of the participants and the evaluations of the activities. SPSS (v.15.0.1) was used obtaining descriptives the statistic frequency to obtain their perception information. RESULTS Results showed that students have a positive perception on the sport they train. They enjoy playing and learning new aspects of the sport, and they feel happy when playing. They prefer to practice sport where they feel next to their friends, so there is an important social component of this practice. The practice diminishes as they become older (86% of sports practice at 8 years and 76% of practice at 12 years old). DISCUSSION and CONCLUSIONS Students enjoy with extra-scholar sport, but the practice diminishes when they get older. As there is a positive perception and a social component, it is important to consider, when organizing these educational programs, the social aspect just to motivate and hang them on to continue training. During these age stages, from the schools where the activities are organized, it is important to consider not only the technical learning and the competition results, but also the educative and social point of view. REFERENCES - Blázquez, D. (1995) . La iniciación deportiva y el deporte escolar. Barcelona: INDE. - Coller, X. (2000) . Estudio de casos. Madrid: Centro de Investigaciones Sociológicas. - Piéron, Delfosse, Lendent i Cloes (2001) Las percepciones al final de la sesión de educación física. IV Congreso internacional sobre enseñanza de la educación física y el deporte escolar. Santander (Spain): ADEF Cantabria. - Vila, I. (1998). L'ús del temps de la població infantil i juvenil: els hàbits esportius. Invited symposia in the Congress of Physical Education and sport's school of Barcelona, on 21th may 1998.

## THE STATE AND STATUS OF PHYSICAL EDUCATION IN SELECTED SCHOOLS IN FOUR SOUTH AFRICAN PROVINCES: A SURVEY

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The state and status of Physical Education in selected schools in four South African provinces: a survey Karel J. van Deventer (Department of Sport Science, Stellenbosch University, Stellenbosch, Republic of South Africa) Introduction Democracy in South Africa (SA) brought about a new education system that implied a radical paradigm shift for Physical Education (PE). Curriculum 2005 reduced PE from an alone-standing subject to a learning outcome of Life Orientation (LO). The main aim of the study was to determine the perspectives of LO teachers regarding the implementation thereof with specific reference to the Learning Outcome, PE in selected primary and secondary schools in the Eastern Cape (EC), Free State (FS) and North West (NW) Provinces. Methods Quantitative data was captured by a self-designed questionnaire that was tested in a pilot study and adapted according to the problems identified. The questionnaire was also used in a study conducted in Western Cape (WC) Province in 2007. The survey schools (N=300) (primary n=150 and secondary n=150) were randomly selected in the EC, FS and the NW Province. Results The 2007 study in the WC had the same intention as the current study, which was to determine the progress of the implementation of LO. It was found among other things that 60% of the LO teachers were not qualified in PE (Van Deventer & Van Niekerk, 2008). Compared to the WC study, the current study found that 50% of the LO teachers were not qualified in PE. In Grades R-3, 54% of the LO teachers were not qualified in PE and in Grades 10 to 12, 42% were not qualified to teach PE. Discussion Although most of the time set aside for LO should be allocated to PE, it is not sufficient according to international standards, which stipulate daily PE lessons. According to the European Parliament, schools should provide for at least three PE lessons per week (Seghers et al., 2009). This situation is further complicated by LO teachers not qualified in PE, who either ignore the learning outcome or learners perform a once off activity to have marks available. Learners' right to participate in a fully-fledged PE programme will realise when schools have qualified PE teachers and when PE has the status of an alone-standing subject (Seghers et al., 2009). However, not much has changed regarding the unfairness of equal education opportunities in unequal settings in SA (Jansen, 1999); Botha, 2002; Fiske & Ladd, 2004; Prinsloo, 2007). References Botha RJ. (2002). International J for Leadership in Education, 5(4), 361-371. Fiske EB, Ladd H. (2004). Equity. Education reform in post-apartheid South Africa. Washington, WA: Brookings Institution Press. Jansen JD. (1999). Current Issues in Comparative Education, 1(2), 42-47. Prinsloo E. (2007). SA J of Education, 27(1), 155-170. Seghers J, De Martelaer K, Cardon, G. (2009). PE and Sport Pedagogy, 14(4), 407-420. Van Deventer KJ, Van Niekerk E. (2008). Unpublished research report. Stellenbosch University.

## SCHOOL SPORT FOR BOYS: THE CRADLE OF SPORTSMANSHIP?

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\*ORTHOSPORTS. +UNIVERSITAT INTERNACIONAL DE CATALUNYA. # ESCUELA DEPORTIVA BRAFA

Introduction In its Olympic charter, the IOC defines its role as 'To encourage and support the promotion of ethics in sport as well as education of youth through sport and to dedicate its efforts to ensuring that, in sport, the spirit of fair play prevails and violence is banned (Olympic charter 1 September 2004, p.10). The education of youth through sport is a worthwhile ideal, but it is difficult to identify content, values, means and methodology to carry it out. The spirit of fair play is closely related to the idea of sportsmanship or sportpersonship. The Multidimensional Sportpersonship Orientations Scale (MSOS) (Vallerand et al, 1997) has been validated as an objective measurement of sportpersonship. From an educational point of view it incorporates notions of patience, respect for others, courage, cooperation, commitment and sacrifice. Strategies to develop sportpersonship can be assessed and compared, as a first step to validate the role of sport in the education of youth and development of character (Nucci & Narváez (2008). Handbook of Moral and Character Education. NY, Rutledge). Brafa is an extracurricular sports school in a migrant district in Barcelona, Spain. For the last 30 years it has developed SportsMagister, a values education programme through sport for boys between the ages of 4 and 13. Children play either football or basketball. Every week they train twice (outside school hours) and play competition games on weekends. The SportsMagister programme is implemented by the coaches within training sessions. It is supportive and intends to assist parents in the education of their children. The outline of the Sports Magister Programme, its background and methodology will be outlined. Methods A random cohort of 100 boys (ages 14-17) from Brafa undertook the MSOS assessment questionnaire, and compared to an equivalent cohort (n=100) of boys from other clubs in the same competitions and to a control group (n=100) of boys who did not practice organised sports or competitions. Results The primary outcome is the assessment and comparison of the levels of sportpersonship achieved in each of the three groups, the null hypothesis being that the students from BRAFA achieve higher levels of sportsmanship. The secondary outcome is the relationship of these results with family structure and relationships, family income and education levels of the parents, assessed by regression analysis of the data obtained. Discussion The results suggest that the Sports Magister Programme can be a good model to teach educational and personal values through sport and achieve good levels of sportsmanship and contribution to society, thus validating the IOC charter. References Vallerand RJ, Briere NM, Blanchard C & Provencher P (1997). Development and validation of the Multidimensional Sportper-

sonship Orientations Scale. Journal of Sport and Exercise Psychology, 19. 197-206 Nuci LP, Narvaez D (2008) Handbook on Moral and Character Education. NY, Rutledge .

### CHILDREN AND ADOLESCENTS PERCEPTION ABOUT PE CLASSES IN ELEMENTARY AND HIGH-SCHOOLS OF TIRANA

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Abstract CHILDREN AND ADOLESCENTS PERCEPTION ABOUT PE CLASSES IN ELEMENTARY AND HIGH-SCHOOLS OF TIRANA. Shyti, A. Asc. Pr. PhD; Pano, G. Msc; Gugalli, G. Msc (2010) Tirana Sports University, Introduction Understanding attitudes towards sport and PE, especially in children and adolescents, is becoming increasingly important. Early learning experiences are recognized as being crucial to continuing involvement in physical activity (Kirk, 2005). Bailey (2005) has argued that 'much more empirical research is necessary if the benefits of sporting participation for young people and society are to become much more than a theoretical aspiration'. The aim of this study was to examine the perception that children and adolescents of elementary and high-schools of Tirana have about PE classes, in the context of the general program of the school. Methods 12.338 children, 10-14 years old and 7512 adolescents, 15-18 years old, were asked through a questionnaire: • Write the 3 most important classes for you. • Write the 3 most amusing classes for you. • If the school will be open in your leisure time, which are the 3 most interesting activities that you will prefer to do? Results Question 1 results show that PE is part of the 3 most important classes for 6.2% of the elementary and 2.1% for high-school. Question 2 results show that 38% of the children and 21.2% of the adolescents considered PE classes as amusing. Question 3 results show that 54.9 % of the children and 40. 2% of the adolescents preferred sport among their leisure time activities. Discussion There is a very low percentage for PE as "important" among the classes in the school programs, reflecting the traditional tendency of considering education in school based only on theoretical classes. Surprisingly, PE in school is considered "amusing" only from a relatively low percentage of participants, for both 10-14 and 15-18 years old. And in adolescents the evaluation of PE in school as "amusing" is less evident than in children. The positive perception of the PE in school tends to decrease from elementary to high school despite the general interest, showed by the participants, for PA in general and sport in particular as an activity to follow in free time. References Bailey, R. (2005) Evaluating the relationship between physical education, sport and social inclusion Educational Review 57 (1) (pp.71-90) Duncan, M. J. Al-Nakeeb, Y., Nevill, A. and Jones, M. (2004) Body image and physical activity in British secondary school children European Physical Education Review 10 (3) (pp. 243-260) Garrett, R. (2004) Negotiating a physical identity: girls, bodies and physical education. Sport, Education and Society 9 (2) (pp. 223-237). Kirk, D. (2005) Physical education, youth sport and lifelong participation: the importance of early learning experiences European Physical Education Review 11 (3) (pp. 239-255).

### SPORT ACTIVITIES OF LATVIA BASIC AND SECONDARY SCHOOL STUDENTS

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Introduction In order to stay healthy regular physical activities and healthy lifestyle are of great significance. Young people who participate in regular sport activities are less corpulent and they have rare problems with excess weight. Their muscular strength develops and sustains, metabolism improves, as well as their behaviour changes and less often they suffer from depression (Malina, 2005). The aim of the work was to compare sport activities of different age Latvian basic and secondary school students. Methods The questionnaire of Riga basic school 6th and 8th grade students and secondary school 10th and 12th grade students about their sport activities and interest about sports was carried out. 310 students were questionnaire. Results The results of investigation showed that sport activities of basic school students are higher than secondary school students. The highest level of sport activities have 6th grade students but the lowest level of sport activities have 12th grade students. The majority of students have positive attitude to sports. 6th grade students miss less sport lessons than 8th grade students and secondary school students. 26% of 6th grade students, 22% of 8th grades students, 19% of 10th grade students and 12% of 12th grade students go into separate branches of sports. Most of all students (among boys as well as girls) train into basketball. The most popular branches of sports among boys are sport games (basketball, football and hockey). Rather many boys go into various branches of wrestling. Among girls popular are basketball, volleyball, swimming and sport dances. For many basic school students sport is the main hobby. The main reason that doesn't allow students to go in for sports more than they do it is a lack of time. At the same time there are students who have other interests which are not connected with sports. The main motivation for majority of basic school students to go in for sports is to improve their physical condition or they enjoy physical activities. The main motivation for majority of secondary school students to go in for sports is to improve their health level. Discussion It is necessary to increase the level of sport activities (especially for secondary school students). Physical condition program should be emphasized more on the aerobic activities such as cross-country running, swimming, skiing but not only teaching the skills used in team sports such as basketball etc. To promote student's motivation of healthy lifestyle the qualitative physical education process, taking into account student's current needs, is necessary. References 1. Malina R. M. Health, Fitness and Behavioral Outcomes Associated with Physical Activity in Youth // In: 9th International Scientific Conference "Sport Kinetics 2005", Book of Abstracts – Rimini, Italy, 2005 - p. 27.

### THE IMPACT OF A HYBRID SPORT EDUCATION-INVASION GAMES COMPETENCE MODEL SOCCER UNIT ON DEFENSIVE DECISION MAKING AND SKILL EXECUTION ACCORDING TO STUDENTS' SKILL LEVEL

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*FADEUP*

THE IMPACT OF A HYBRID SPORT EDUCATION-INVASION GAMES COMPETENCE MODEL SOCCER UNIT ON DEFENSIVE DECISION MAKING AND SKILL EXECUTION ACCORDING TO STUDENTS' SKILL LEVEL Santos, D., Farias, C., Araújo, R., Mesquita, I. Centre of Research, Education, Innovation and Intervention in Sport, CIFI2D, FADEUP, Porto, Portugal Introduction The coalition of SE and TGFU has been efficient in promoting students' performance improvements (2). Given that the Invasion Games Competence Model (IGCM) takes also into account the strategic specificity of invasion games, the purpose of this study was to examine the impact of the application of a hybrid SE-IGCM unit on students' improvements in defensive decision making (DM) and skill execution (SE) during a soccer season. Method A class of fifth-grade (17 girls and 9 boys) from a Portuguese elementary school participated in a 22-lesson season of soccer following a hybrid SE-IGCM unit. One Pre-test (PTT) and two post-tests (PTT1, PTT2) measured the defensive decision making and skill execution using the instrument developed by Blomqvist et al. (1). Results From PTT to PTT1 all students improved in guard/mark (DM); students of high skill improved in movements as required by the flow of the game (DM); medium skill students improved in duel (SE). From PTT to PTT2 all students improved in

movements as required by the flow of the game (DM); students of medium and high skill improved in guard/mark (DM); students of low skill improved in duel (SE). From PTT1 to PTT 2, students of medium skill improved in movements as required by the flow of the game (DM). No differences were found between groups at PTT, PTT1, or PTT2. Discussion The program had a positive impact on the defensive performance of all students. The specific structure of the unit may account for most of these improvements (4) as it encouraged largely the systemization of defensive positioning and the defensive skill execution. The lower entry scores of low skill students may have given them more scope for improvements; the higher skill students (medium and high level) showed less improvement as probably they already were in transition to a more competitive and strategically more complex form of defensive behavior (3). References (1) Blomqvist, M., Vääntinen, T. & Luhtanen, P. (2005). Assessment of secondary school students' decision-making and game—play ability in soccer. *Physical Education and Sport Pedagogy*, Vol. 10, n.º 2, 107-119. (2) Hastie, P., & Curtner-Smith, M. (2006). Influence of a hybrid Sport Education - Teaching Games for Understanding unit on one teacher and his students. *Physical Education and Sport Pedagogy*, 11(1), 1-27. (3) Musch, E., Mertens, B., Timmers, E., Mertens, T., Graça, A., Taborsky, F., Remy, C., De Clercq D., Multaël, M. & Vonderlynnck, V. (2002). An innovative didactical invasion games model to teach basketball and handball, presented on cd. Paper presented at the 7th Annual Congress of the European College of Sport Science, Athens, Greece.

### EFFECT OF PHYSICAL EDUCATION CLASS ON BEHAVIORAL CHANGE OF NON-ACTIVE UNIVERSITY STUDENTS.

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The purpose of this study was to evaluate the influence of certain physical education class on behavioral change of exercise and nutrition of non-active university students. Seven male and sixteen female students (age;  $19 \pm 1$  ys, height;  $164 \pm 9$  cm, weight;  $53.4 \pm 9.3$  kg, BMI  $19.9 \pm 2.7$ ) who attended the class were recruited as participants. The class was conducted once a week for thirteen weeks including 30-min lectures and 60-min exercises; stretch, stabilizer ball, dumbbell, walking and Ba Duan Jin. Three evaluation scales were used in both first and last week of the class: mean energy expenditure using 3-axes activity monitor (Tanita AM-120, Japan), mean nutrition intakes using 3-day food records (Meiji Seika Kaisha, Japan) and behavior of exercise and nutrition by the questionnaires. There was no significant change in body size and nutrition intakes compared among two periods. The mean energy expenditure of last week was significantly higher than that of first week. ( $p=0.007$ ). The behavioral skills was also significantly higher in last week. The results of this study suggested the possibility that this type of physical education class enhanced the readiness for exercise behavior and activity level of non-active university students.

### PRACTICAL KNOWLEDGE AND PHYSICAL EDUCATION: A CONCEPTUAL ANALYSIS AND A REVIEW OF THE LITERATURE

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1: SOGN OG FJORDANE UNIVERSITY COLLEGE & 2: NORWEGIAN SCHOOL OF SPORT SCIENCES

Introduction It is an old debate about knowledge which says that we need a differentiated understanding of it (Ryle 1949). All knowledge cannot be reduced to theoretical or propositional knowledge, that is, to justified true beliefs. There is also practical knowledge which enables one to move around in the world and to act in complex situations. Whereas theoretical knowledge is associated with the intellect, has high status and interested philosophers the most, practical knowledge is usually associated with the body, has lower status and is of interest to anyone engaged in the performance of skill. The purpose of this paper was to study the concept of practical knowledge in the context of physical education by reviewing literature on the subject. Method A combination of conceptual analysis and a review of literature were conducted. The databases ERIC, ISI Web of Science and SportDiscus were searched for the combination of key words 'physical education' and 'practical knowledge'. Inclusion criteria were: a) Journal article or book chapter; b) Physical education or education of physical education teachers as contexts; c) Available in English. Results The study showed that the use of "practical knowledge" in the context of physical education is many-sided and not clearly delineated. Authors often contrasted the concept to theoretical knowledge with the risk of creating a strong dichotomy and thus not illuminating properly how deeply intertwined theory and practice are to teaching and learning situations in physical education. Practical knowledge was mainly related (i) to the performance of motor skills. But the concept was also used (ii) to account for the skill of teaching others, and (iii) to the skill of learning others to teach. Discussion Even though it is interesting to discuss how skilled or competent one needs to be in performing a motor skill in order to teach well, the discussion circulates around the second and third point above. These two points are discussed in relation to work in sport pedagogy (Tinning 2010), that is, the practical work of teaching on the one hand and the learning experiences and meanings emerging on the side of the participant on the other hand. Hence, by using the concept of practical knowledge as an entrance to work in sport pedagogy, one can illuminate the intentions and learning experiences of both teachers and participants in sport pedagogical settings. References Ryle, G. (1949). The concept of mind. Penguin Books. Tinning, R. (2010). Pedagogy and human movement. Theory, practice, research. London: Routledge.

### LEARNING FROM THE EXPERTS: EXPLORING PLAYGROUND EXPERIENCE AND ACTIVITIES USING A WRITE AND DRAW TECHNIQUE

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Introduction Research exploring the role of playtime (or recess) during the school day has offered findings with regard to children's social, cognitive, emotional and creative development together with impact on physical activity levels. Understanding and exploring the playtime experience is important yet qualitative studies have generally involved small samples of older primary school children. Research amongst those in the early years of compulsory education is deemed problematic requiring a more developmentally appropriate and creative methodology such as 'write and draw'. The aim of this study was to use a write and draw technique to examine both younger and older primary school children's views, experiences and perceptions of playtime. Methodology 299 children aged 7-11 years from 4 primary schools participated with their respective schools enlisted into the Liverpool Sporting Playgrounds Project (Ridgers et al., 2010). Children were grouped into Years 3 & 4 and 5 & 6. The write and draw instructions asked children to think about 'what I like about playtime' and 'what I dislike about playtime'. A large box titled 'what playtime means to me' offered the child an opportunity to draw, write or present a combination of these in order to answer the question. Pen profiles were used to analyse the data to provide a composite of key themes deduced via an efficient process which offers examples of verbatim data as opposed to more comprehensive (in number) and truncated (due to space) offerings within content analysis (Ridgers et al, 2012). Results Results indicated 'likes' were focused on play,

positive social interaction and games across both age groups but an increasing dominance of games in older age group together an appreciation for being outdoors was also found. Dislikes focused on dysfunctional interactions linked with bullying (physical & verbal), membership, equipment for games/activities and conflict for playground space. Discussion Football was a dominant feature across both cohorts and 'likes/dislikes' in respect of causing conflict and dominating the physically active games undertaken. Data support the importance of playtime for the development of skills such as conflict management, social skills and contributing to physical activity engagement thus contradicting suggestions within the literature to remove/reduce playtime in the face of behavioural issues. Ridgers, N.D., Fairclough, S.J. & Stratton, G. (2010). 12-month effects of a playground intervention on children's morning and lunchtime recess physical activity levels. *Journal of Physical Activity and Health*, 7, 167-175. Ridgers, N.D., Knowles, Z & Sayers, J. (2012). Play in the Natural Environment: A Child-Focused Evaluation of Forest School. *Children's Geographies*.

## RESEARCH INTO THE PROCESS OF PRACTICAL KNOWLEDGE ACQUIREMENT IN PE TEACHERS

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**Introduction** The aim of this research is to discern the practical knowledge behind "the energetic lesson," from among all practical knowledge held by physical education teachers used in their decision-making and actions. Physical education does not involve learning theory from any particular textbook, or learning using workbooks, so it relies heavily on the practical knowledge of the teacher (Elbaz: 2000). The educational effectiveness of physical education is also enhanced by "energetic lessons" in which students learn independently. In this research, we investigated the practical knowledge of three physical education teachers who guarantee "energetic lessons," by studying their past lives. **Methods** Subjects: A proficient physical education teacher (35 years teaching experience), average teacher (15 years teaching experience), new teacher (1 year of teaching experience). Lesson Studied: A high school soccer lesson. **Methods:** 1) Videotaping of the lessons given by the three teachers. 2) Retrospective interviews of the three teachers while showing videotapes of their own lessons. 3) Interviewing students on their impressions of the three teachers and what they learned. **Results** 1) The systems of practical knowledge and knowledge acquirement of the proficient and average teachers were simple, like those of the new teacher, when they too were not very experienced. Their philosophical knowledge was that of an understanding of "the response relationship between the teacher and students." Methodical knowledge included those of "student management" and "unilateral guidance provided by the teacher." 2) As teachers grew from being average teachers to proficient teachers, they underwent changes to acquire complex systems of practical knowledge. Their philosophical knowledge was that of ways to "promote student independence," and understanding that "as students grow they will engage more independently in the lessons." Methodical knowledge included ways to "ask questions and provide guidance within the context of the students' overall understanding," "provide assistance in guiding them to promote their growth," "promote their growth through asking questions," "evaluate their growth" and "evaluate their efforts during lessons other than those leading to growth." **Conclusion** The research clarified the system of practical knowledge behind "the energetic lesson" used by proficient teachers, which until now had been vague. As teachers become increasingly proficient, their philosophical knowledge and methodical knowledge grow in variety and complexity. They also change to a system of supporting the independent learning of students. **References** Elbaz, F.(2000)The teacher's "practical knowledge": Report of a case study, *Curriculum Inquiry*, 11(1), pp.43-71. Yasuyuki N.,(2008)Research Respecting Situational Cognition on The Part of Sports Instructors, *Educational Technology Research*, 31, 133-142.

## THE WEEKLY HOURS OF PHYSICAL EDUCATION LESSONS IN HUNGARIAN PUBLIC EDUCATION: A STUDY FROM EUROPEAN PERSPECTIVES

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According to some specialty writers (Báthory, 2003) teaching time assigned to subjects is not, or only in a very small degree influences students performance. The number of the physical education lesson problem in public education is a constant issue in Hungary among the curriculum theory professionals and the physical education teachers in more specific terms: the question of the "physical education lesson every day". It is a question whether the time frame that is what the current physical education curriculum documents provide meets the requirements of more diverse goals and tasks of the physical education or not. „The PE is a unique domain that has a direct influence on students' physical development and which provides the opportunity for learning motor activities of place and position accompanied by development of gross muscle groups. In addition to improving motor skills and abilities, physical education undertakes the role of: creating a balance between a healthy body and mind, promoting a healthy lifestyle, combating harmful addictions and against substance abuse, forming proper hygienic and sexual habits, fostering recreation and/or rehabilitation" (Hamar et al., 2006). The alteration of the Public Education Act in 2003 declares unambiguously that it stands up for the "physical education lesson every day". However in our view, the everyday (compulsory) physical education class, and daily physical activity and exercise are not the same. To confirm the mentioned statement through the analysis of Hungarian and European curricula answers were looking for that what number of hours of physical education can be found in the curricula of some European countries. The current time frame for physical education in Hungary is more or less compared to other European curricula? As a result of our analysis it is concluded that the minimum and maximum curricular time frame of the physical education classes -expressed in minutes per week- shows significant differences among the 27 EU member states (Hardman, 2007). In Hungary this data is 90 minimum/minute and 225 maximum/minute. In the Hungarian public education the percentage of the physical education classes in the 12-14 year age group falls behind the countries in Europe. To confirm these, there are some data: Austria 11%, Portugal 10%, Netherlands 9%, Finland 8%, while Hungary is 6% (source: Education at a Glance, 2000). These data speak for themselves, but it is also known that the available number of hours doesn't guarantee the effective teaching and learning. The number of physical education classes can be raised as high as enough if these are not matched by a generous teacher, a certified professional work and love of children.

## ORGANIZATION OF THE SCHOLAR SCHOOL IN THE EDUCATION CENTERS ACCORDING TO THE ENTITIES

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**Introduction** The scholar school in Spain is developed in a diversify way and with heterogeneous structure within the regions and the towns. The consequence of this reality produces that each scholar center organize the scholar school in a different way according to the



importance that they give to the sport. In that way, we analyze the organization taking into account the entities involved in the scholar school centers in Madrid. The main target is to define the improvement lines. Methods We have used a quantitative methodology of descriptive cut. For this target the sectional survey through personal interview have been applied to people who is working teaching scholar school in Primary Centers of Madrid (300 teachers). To catch the relevant information for the study we have used a structured interview (González y Campos, 2010). Results The main activity for teachers is to work for private sector companies (33,6%), then in sports association and sports clubs (24%) and finally in educational centers (20,6%). Furthermore, there are a lot of entities that arrange the out of school sport activities. In the first place we find the AMPAS (38,3%) and the educational centers (38,3%) and then the town council (19%). Discussion We agree with Augustin (2003) when he suggests that the scholar school teachers work for different entities. This is because the educational centers prefer to contract private companies for this item. Furthermore, we have found several companies that organize and promote out of school sport activities. The percentages of use of this external companies are different from other studies (Campos, 2010). Due to this big diversity of management it is necessary to create a clear organization structure (De la Iglesia (2004). References Augustin, J.P. (2003). *Le sport et ses métiers – nouvelles pratiques et enjeux d’une professionnalisation*. Paris, La Découverte. Campos, A. (2010). *Dirección de recursos humanos en las organizaciones de la actividad física y del deporte*. Síntesis, Madrid. De la Iglesia, G. (2004). *Régimen jurídico del deporte en edad escolar*. Barcelona, Bosch. González, M.D, Campos, A. (2010). Teachers’s Methodology of Scholar School Accordinc to his Inicial Qualification. *Journal of Phychodidactics*, 15(1), 101-120.

## REGULATION DOCUMENT STUDY ON ITALIAN PRESCHOOL

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Introduction In recent years Italian pre-school, called commonly pre-primary, infant, kindergarten or childhood and the pupils go between 2 years old to 5, has been updated the ministerial documents relating to the educational contents and activities. At the same time, last discoveries about the neurophysiology of the brain changed the scientific bases on which are based psychological and pedagogic paradigms on educational theories. These theories are the basis on body learning according to motor control theory such as closed loop system (Adams 1975), open loop system (Schmidt 1985) and motor imagery (Rizzolatti 2006, Iacoboni 2008). The aim is to identify, into the regulation documents regarding the educational activity, aspects of psychology and pedagogy in the field of body and movement Method Research is integrated by two approaches: Theoretical and argumentative one on scientific paradigms regarding the motor control system theory and the related body learning in the early years of life and, the second one, historical and documentary approach on regulation documents relating to the contents and the teaching activities Result It does not carry out any aspects of education and didactics that can be connected to psychological and pedagogic aspects according to the new scientific and neurological theories. All regulation documents do not provide any reference to recent discoveries related to motor theory relating the body learning Conclusion It may be useful to update the regulation documents. It needs to deep properly the study and then to deliver the results to the governmental experts for the necessary updates to fill up the vacuum of the contents, didactics and teaching method for the particular field of body learning. Furthermore, the body and its movement field must help the educational science in an holistic vision of development References Latash M., (2008) *Neurophysiological Basis of Movement*, Human Kinetics, Champaign IL USA Schmidt, R., A., Wrisberg, G., A., (2008) *Motor Learning and Performance*, Human Kinetics, Champaign IL, USA Iacoboni M., (2008) *Mirroring People*. The new science of how we connect with others, Farrar Straus & Girox, L.A. USA Rizzolatti, G., (2006) *So quel che fai. Il cervello che agisce e i neuroni specchio*. Raffaello Cortina Editore, Milano, Italia Decree of Republic President (2009) no. 89 20/03, Revision of the educational organization regulated directions for the first cycle of the school, Rome, Italy Ministerial Decree (2007) 31/07, The Guidelines for the curriculum of the pre-school, Rome, Italy Legislative Decree (2004) no. 59 19/02 National Guideline for the Programs of studies of the first cycle of education attachment A Rome, Italy Figel, J. (2009) *Early Childhood Education and Care in Europe: Tackling Social and Cultural Inequalities* EACEA P9 Eurydice Ministerial Decree (1991) 03 06 Guidelines for the educational preschool activity

## Poster presentations

### PP-SH15 Sport Statistics: Performance Analysis

#### T-PATTERN DETECTION ANALYSIS: DEFENSIVE PROCESS IN FOOTBALL

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It is acknowledged that the defensive process has an important role in a football team success; however, there is a discrepancy in the scientific literature on defensive process when compared with the offensive process. The observation of sports performances has focused on the frequency of occurrence as its performance index, still is debatable whether the frequency data alone allow to successfully distinguish effective performances and less effective performances, therefore observational studies should expand their indices of performance further than the frequency (Borrie et al, 2002). The detection of play patterns is one tendency to be followed, being emphasized the potential of THEME software in detecting temporal patterns of behaviour (James, 2006). To analyse and characterise the defensive process of successful teams were the main purposes of this study. The study observational design was multidimensional, nomothetic and sequential. The behaviour was coded through an “ad hoc” observational instrument combining field formats and categorical systems. Values above 0.9 for all criteria were achieved in this instrument reliability analysis, calculated through inter and intraobserver agreement. Three games of the Italian national team winner of the World Cup 2006 and 3 of the Spanish national team winner of the EURO 2008 were registered using Thème Coder software. For t- patterns detection we used THEME 5.0, ( $p < .005$ ). The results show that top-level teams have made a total of 459 defensive processes during the six observed games, making an average of 76.5 in each game. 11080 t-patterns were detected, corresponding to 3419 different t-patterns, ranging from a minimum of one level to a maximum of nine levels and two to 16 events. We conclude that the scoreline and the game time influenced the characteristics of the detected t-patterns, while the numerical relationship between teams did not influence the characteristics of the detected t-patterns. References Borrie, A., Jonsson, G.K., & Magnusson, M.S. (2002). *Journal of Sports Sciences*, 20, 845-852. James, N. (2006). *International Journal of Performance Analysis in Sport*, 6, 2, 67-81.

## VELOCITY AND ACCELERATION DIFFERENCES BETWEEN BALL-CARRIER AND TACKLER, AND ITS RELATIONSHIP TO POSITION AND TACKLE OUTCOME

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UNIVERSITY OF CAPE TOWN

Background: The tackle event in rugby union, at all levels of play (amateur to professional, juniors to seniors) places both ball-carrier (BC) and tackler (T) at high risk of injury compared to any other facet of play. The velocity at which the BC and T enter tackle (and the velocity difference between the two) is regarded as a risk factor for injury. For this reason, a better understanding of the dynamics of the tackle is warranted. Aim: The aim of this study was to determine the velocity and acceleration differences between BC and T, and relate these differences to i) position of BC and T and ii) tackle outcome. Methods: Ten Front-on and 10 side-on tackle situations in the 2010 Super 14 (S14), Varsity Cup (VC), and Currie Cup Under 19 (U19) matches were coded for. Thereafter, using a novel video analysis system, the BC and T were tracked for 0.5 seconds (s) before contact in each tackle situation. The displacement covered over this period, by the BC and T, were subsequently measured. Accordingly, velocity (m/s) and acceleration (m/s<sup>2</sup>) were calculated for the BC and T. For each tackle, position of BC and T (back or forward), and tackle outcome (ball-carrier or tackler and; territory change – much/very much, fair amount, little/no change) was recorded. Results: During the front on tackle, backs, whether as a BC or T had a higher velocity difference than forwards at all levels of play. During the side-on tackle however, forwards had a higher velocity difference as a BC. During the front-on tackle, a velocity deficit does not necessarily mean an unsuccessful outcome, whether as BC or T. Interestingly, during the side-on tackle the ball-carrier in all probability had a successful outcome at all levels of play. Acceleration differences between BC and T for backs and forwards were seemingly similar for both front-on and side-on tackles. In front-on tackles, BCs with a higher acceleration than Ts were more likely to succeed in the tackle than Ts with a higher acceleration. For side-on tackles, the outcome of the tackle favoured the BC regardless of acceleration differences. Conclusion: BCs seemingly have an advantage during the tackle situation, especially during side-on tackle situations. During front-on tackles, BCs usually make their intentions clear in terms of running line or passing the ball; therefore tacklers have more time to properly prepare for the imminent contact. In contrast, during side-on tackles, BCs are typically running at angles or executing a set-play making it hard for the T to commit. This delay results in Ts executing the tackle at a late stage, often when the BC is already beside him.

## ANALYSIS OF MIDDLE-BLOCKER ANTICIPATORY BEHAVIOUR RESPECT SETTING ACTIONS IN HIGH-LEVEL VOLLEYBALL. A PRELIMINARY STUDY IN A SPANISH TOURNAMENT.

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Introduction The anticipation of middle-blockers to assist the right and left blockers in the net game is an important and hidden skill in high-level volleyball (Liviotti et al, 2007). The setter try to fool the middle-blocker to avoid double and triple blocks while the blockers try to guess the direction of the setter passing. The aim of the present study was to analyze the temporal behaviour of the volleyball high-level middle-blockers and the opponent setters to get advantage in blocking. Anticipated responses were established when blocker movements start before 0.15 sec. after the setter ball contact (Broker & Crawley, 2001). Methods 300 actions were analyzed from a randomized sample of the 2009 Spanish Cup male tournament, held in Almería (Spain). A high-speed video camera (300 Hz) was used to record the rallies of 7 matches between the 8 best teams of the season. Frame by frame analysis was carried out to determine temporal intervals between middle-blocker and setter actions. We analysed the association between temporal behaviours and blocking efficacy (chi-square) considering other independent variables. Results The middle-blocker play 27% of attacks in first tempo (M= 0.403 sec, SD=0.083) and 66% second tempo (M= 1.052 sec, SD=0.178). Middle-blockers develop anticipated responses over 60,94% of the actions analyzed. When blocker's response overpass the temporal threshold (0.15 sec), the percentage of negative blocks increased ( $\chi^2=4.87$ ;  $p<.05$ ). When the middle-blocker time response was categorized into 6 intervals of 0.1 sec. before and after setting, we observed averages close to 50% of positive blocks in the category just prior and after the setter ball contact. Discussion The middle-blocker needs to anticipate his response around 60% of situations because the players in this level of performance play 27% of attacks in first tempo and 66% in second tempo. Considering timing of the conscious intention to move (Matsuhashi & Hallett, 2008) and the spatial conditions in volleyball blocking, middle-blockers develop anticipatory strategies to respond in front of these temporal demands. We also detected a marked trend to increase time response of blockers in first tempo situations (M= 0.158 sec, SD=0.021) respect the second and third tempo (M= 0.056 sec, SD=0.008). These data confirm the necessity to improve perceptual and specific motor skills to perform in blocking (Ker, 1990). References Broker J.P., Crawley J.D. (2001). XIX Biomechanics Symposia- San Francisco (USA). Conference Proceedings, p323-327. Ker, W. (1990) Volleyball Monthly, 9, 36-37. Liviotti, G. Lobietti, R., Fantozzi, S., Merni, F. (2007). X International Scientific Conference in Sport Kinetics. Belgrade (Serbia). Book of abstracts, p44. Matsuhashi, M., Hallett, M. (2008). Eur J Neurol, 28, 234–235.

## DEVELOPMENT AND VALIDATION OF A NOTATIONAL SYSTEM TO STUDY THE DEFENSIVE PROCESS IN FOOTBALL

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It is acknowledged that the defensive process has an important role in a football team success (Carmichael & Thomas, 2008; Bosca, Liern, Martínez & Sala, 2009); however, there is a discrepancy in the scientific literature on defensive process when compared with the offensive process. The detection of invariant behaviour is one relevant methodological process to football analysis, pointing out the Theme software possibilities to recognize temporal patterns of invariant behaviour, even though this is a recent procedure in the scientific literature (James, 2006). Therefore, the main purposes of this study were the development and validation of an "ad hoc" observational instrument, which will allow the defensive process of successful teams to be analyzed through t-pattern analysis. The methodology of instrument conception consisted in deductive-inductive procedures with special reference to the literature review, the consulting of a panel of experts consisting of coaches (UEFA level IV) and researchers to find out what performance indicators should be included in the instrument and content validation. The 'ad hoc' observational instrument (ObsPD) was created combining field formats and categorical systems, formed by five vertebrate criteria and the respective observed behaviours for each of these criteria (Martins, 2010). The instrument reliability was calculated by the intra and inter observer concordance, calculated through Cohen's K (using SDIS-GSEG software) and showed reliability levels higher than 0.9 for all criteria (Martins, 2010) and a K value greater than 0.75 is considered excellent (Bakeman & Gottman, 1997). The instrument reliability results ensure that subsequent studies using the ObsPD are based on data obtained from a

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### **NOTATIONAL ANALYSIS OF TACTICS USED BY CANOE POLO NATIONAL TEAMS DURING THE EUROPEAN AND WORLD CHAMPIONSHIPS SEMIFINAL AND FINAL MATCHES, FROM 2006 TILL TODAY**

VASTOLA, R., SIBILIO, M., DI TORE, S., SGAMBELLURI, R.

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**Introduction** The tactic preparation of athletes depends on the learning level of drills (actions and methods on how to fulfill the tactics), tactical projects (attack, counter-attack, zone defense and pressing) and technical / tactical trainings (individual and team) of sports tactics. Platonov stated "... the structure of tactical preparation depends on strategic aims that determine main directions of sports competitions...". Canoe polo is a game with different tactical projects where we can simply identify two macro-areas: the pressing and the zone game. The current preparation of canoe polo national teams and clubs is not supported by sufficient information to ensure a rational training planning. **Aim** The purpose of the research is to quantify the average time per match where the teams play the pressing and the zone systems, and to highlight any tactical elements that can determine the choice between the two game strategies. **Methodology** This type of research is observational and has used a video analysis, realized by "Dartfish", by scanning semifinals and finals World and European Championships matches, from 2006 till today, with the aim of recording the average game time when the teams apply the pressing or zone game system, and other tactical elements that can determine the choice between the two game strategies. **Results** The research shows that the 70% of game time is used by the teams applying the zone system. The tactics predilection toward this type of solution probably cause the least energy expenditure and a lower percentage of losing the match, except for the male Dutch team, where in international events, won more medals than any other national teams by mainly use the pressing system. **Conclusions** Analysis of matches has shown that the pressing system is used primarily at the end of the second half of the match by the team at a disadvantage. Issue of further researches can be the evaluation of the energy expenditure in the pressing game and the correlation of this strategy in relation to the match results.

### **A COMPARISON OF THE DISTANCE FROM THE GOAL LINE TO THE LESS ADVANCED OUTFIELD PLAYER BETWEEN FIVE SPANISH FIRST DIVISION SOCCER TEAMS**

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**Introduction** An outcome like the distance from the goal line to the less advanced outfield player can be used to describe a team's pattern of play (Carling et al., 2005). Teams using an offensive style may play closer to the opposing goal whereas those using a more defensive style may play closer to their own goal. Therefore, the aim of this study was to analyse differences in this tactical variable between four soccer teams. **Methods** A multiple-camera player tracking system (AMISCO Pro, Sport-Universal Process, Nice, France) was used to record the existing distance from the goal line to the less advanced outfield player of the analysed team (metres). A total of 25 matches, 5 per team, of the First Spanish Division were analysed. The matches were recorded and digitalized and the player's position and movements were registered with a frequency of twenty-five records per second (see Zubillaga et al., 2007). A total of 17546 data were collected. **Results** A one-way ANOVA revealed that the distance from the goal line to the less advanced outfield player was smaller in team 1 ( $28.50 \pm 12.89$ ) than teams 2 ( $30.40 \pm 12.93$ ), 3 ( $29.72 \pm 12.98$ ), 4 ( $29.72 \pm 12.75$ ) and 5 ( $29.65 \pm 12.53$ ) ( $P < 0.001$ ). Also this distance was greater in team 2 than teams 3, 4 and 5 ( $P < 0.05$ ). **Discussion** The distance from the goal line to the less advanced outfield player was found as a tactical variable able to discriminate between teams. These different distances from outfield players to their own goal may be a consequence of teams' defensive or offensive minded styles of play. Future studies could analyse whether playing closer or farther away from the own goal is related to a good or bad team performance. **References** Carling C, Williams AM, Reilly T. (2005). The Handbook of Soccer Match Analysis, 3. Routledge, London. Zubillaga A, Gorospe G, Hernandez A, Blanco A. (2007). J Sports Sci Med, suppl.10. 20.

### **EFFECTS OF SCORE-LINE ON TEAM STRATEGIES BEFORE AND AFTER GOAL SCORING IN ELITE SOCCER**

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**INTRODUCTION** Given that soccer is dominated by strategic factors it is reasonable to suggest that performance demands vary according to the status of the score-line. The aim of this study was to investigate differences in team strategies in an elite soccer team in the 5 minutes before a goal was scored and the 5 minutes after by analysing technical, tactical and physical performances. **METHODS** In total 100 goals scored in 50 matches of the Spanish Soccer League were analyzed using a multiple-camera system (AMISCO Pro, Nice, France). Data were collected for score line status of the match, % possession, zone of play (defensive 1/3, middle 1/3, attacking 1/3), distance covered, time spent in five different categories and the frequency and outcome of six technical indicators. Data were analyzed using an independent t-test and a linear regression. **RESULTS** Distances covered at submaximal or maximal intensities ( $>19.1$ ) and time spent in the attacking zone were higher in the 5 minutes before scoring a goal than for the overall half of the match in which the goal was scored. Moreover, there were differences in the frequency and outcome of the technical indicators. **DISCUSSION** Several studies (i.e. O'Donoghue and Tenga, 2001; Lago et al, 2010) have investigated the effect of score-line on aspects of soccer performance by comparing play in the whole time where the score was level with play where a team was winning or losing. However, it has been suggested (Carling et al, 2005) that overall changes in behaviour could be analysed in more detailed if the game was split into 5 minutes segments. According to other studies (i.e. Redwood-Brown, 2008) the current study has revealed differences in team strategies and performance profiles before and after goals are scored when compared to the average for the half of the match in which the goal was scored. The results emphasize the importance of accounting for match status during the assessment of tactical, technical and physical aspects of soccer performances. **REFERENCES** Carling C, Williams AM, Reilly, T. (2005) The handbook of soccer match analysis: a systematic approach to improving performances. Routledge: London. Lago C, Casais, L, Dominguez E, Sampaio, J. (2010) The effects of situational variables on distance covered at various speeds in elite soccer. Eur J Sport Sci. 10, 103-109. O'Donoghue P, Tenga, A. (2001) The effect of score-line on work rate in elite

soccer. J Sport Sci, 19, 25-26 Redwood-Brown, A. (2008) Passing patterns before and after goal scoring in FA Premier League Soccer, Int J Perf An Sport, 8, 172-182.

### **MATCH ANALYSIS OF TACTICS USED BY CANOE POLO NATIONAL TEAMS DURING THE EUROPEAN AND WORLD CHAMPIONSHIPS SEMIFINAL AND FINAL MATCHES, FROM 2006 TILL TODAY**

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**Introduction** The tactic preparation of athletes depends on the learning level of drills (actions and methods on how to fulfill the tactics), tactical projects (attack, counter-attack, zone defense and pressing) and technical / tactical trainings (individual and team) of sports tactics. Platonov stated "... the structure of tactical preparation depends on strategic aims that determine main directions of sports competitions...". Canoe polo is a game with different tactical projects where we can simply identify two macro-areas: the pressing and the zone game. The current preparation of canoe polo national teams and clubs is not supported by sufficient information to ensure a rational training planning. **Aim** The purpose of the research is to quantify the average time per match where the teams play the pressing and the zone systems, and to highlight any tactical elements that can determine the choice between the two game strategies. **Methodology** This type of research is observational and has used a video analysis, realized by "Dartfish", by scanning semifinals and finals World and European Championships matches, from 2006 till today, with the aim of recording the average game time when the teams apply the pressing or zone game system, and other tactical elements that can determine the choice between the two game strategies. **Results** The research shows that the 70% of game time is used by the teams applying the zone system. The tactics predilection toward this type of solution probably cause the least energy expenditure and a lower percentage of losing the match, except for the male Dutch team, where in international events, won more medals than any other national teams by mainly use the pressing system. **Conclusions** Analysis of matches has shown that the pressing system is used primarily at the end of the second half of the match by the team at a disadvantage. **Issue of furthered researches** can be the evaluation of the energy expenditure in the pressing game and the correlation of this strategy in relation to the match results. **Fitts, P.M.(1964)** Perceptual-motor skill learning, in A.W. Melton. Categories of Human Learning. New York. Accademic Press. **Gentile A.M, Higgins, J.R., Miller E.A. e Rosen, B.M.(1975).** The structure of motor tasks. *Mouvment*.7;pp.11-18 **Hughes M., Franks I. (2004)** Notational Analysis of Sport Systems for Better Coaching and Performance in Sport, 2nd Edition. Routledge **Mateev, L.P(1983).** Fundamentals of sport training. *Fis.Mosca* **Platonov, V. N. (2004).** The system of athlete preparation in the Olympic sports. General theory and its practical application. Kyiv: Olimpiyskaya Literatura. (Russian).

### **ANALYSIS AND PREDICTION OF TRAINING EFFECTS WITH ARTIFICIAL NEURAL NETWORKS**

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**ANALYSIS AND PREDICTION OF TRAINING EFFECTS WITH ARTIFICIAL NEURAL NETS** Haar, B.1, Alt, W.1 1: inspo (Stuttgart, Germany) **Introduction** Mathematical models attempt to describe and predict the effects of exercise on performance (Banister et al., 1975; Perl et al., 2001). Considerable weaknesses of these modelling approaches are inherent simplifications that question their capability for performance prediction. These simplifications include the prerequisite to aggregate training strain into a single variable and are not in accordance to the complex training process. Artificial neural networks (ANN) are non-linear, multivariate statistical data models to describe and predict complex input and output relationships. Therefore, it is the aim of this study to prove the concept of analysing and predicting training effects with ANN. **Methods** Three well-trained triathletes participated in this study (2 male, 1 female, mean VO<sub>2</sub>max = 3,77 l/min). Training loads were recorded daily by collecting training duration and heart rate in four categories (running, cycling, swimming and strength training) over a three months period. The effects of stress and recovery were also considered. For this purpose psychological assessment was done by means of RESTQ-Sport (Kellmann & Kallus, 2000). VO<sub>2</sub>max was measured as performance output every third day. Exercise testing was conducted as a ramp test on a cycling ergometer and measuring expired gases. A back propagation net was trained for each athlete. Sequenced values of the performance time series were used as autoregressive input to predict performance. Training loads and psychological variables were used as exogenous input data. The ANN output was VO<sub>2</sub>max. **Results** A very good model adaption was achieved for all three athletes (mean  $r=0.94 \pm 0.01$ ;  $P<0.001$ ). Model prediction over a 12 day period was still acceptable. The average Mean-Absolute-Error (MAE) was  $0.18 \pm 0.10$  l/min. **Discussion** Analysis and prediction of training effects with ANN seems to be a quite powerful method. The multivariate model can take multi-faceted factors that affect performance development into account. This means a step in increasing the model complexity that should lead to a better model behaviour. **References** Banister EW, Calvert TW, Savage MV, Bach A (1975). *Austr J Sports Med*, 7, 170-176. Kellmann M, Kallus KW (2000). Swets Test Services. Perl J, Dausher P, Hawlitzky (2001). *Int J Comp Sci Sport*, 1, 56-57.

### **A METHOD FOR CALCULATING PROBABILITIES IN BALLGAMES ACCORDING TO SCORES DURING THE MATCHES USING A SPREADSHEET**

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**Introduction** The probabilities such as winning probability in ballgames according to scores have not been easy to calculate. In general, the calculation needs an assistance of computer and a special knowledge of computer programming. In this paper, we propose a simple method for calculating the probability of ballgames reaching scores of  $i-j$  and the probability of winning from scores of  $i-j$  under  $n$ -point-up scoring system such as tennis, using a spreadsheet which makes it possible to obtain these probabilities without any special knowledge of computer programming. Here, we also propose a method for calculating the probability of reaching situations where a team leads by  $d$  points and the probability of winning the match when the team leads by  $d$  points, in terms of games continuously played such as soccer. **Method** We used mathematical formulations which represent the progress of the score under  $n$ -point-up scoring system (e.g. Sadovskis, 1993; Schutz, 1970). We also used formulations which expresses the progress of the scores in a game which is played continuously in a limited time. (e.g. Hirotsu and Wright, 2002). We demonstrate how to calculate these probabilities using a spreadsheet. In practice, these probabilities are obtained basically just by 'copy' and 'paste' procedures after inputting the formulation into cells. **Results** We applied this method to tennis, table tennis, badminton and volleyball, which are played under  $n$ -point-up scoring system. We also applied it to soccer, handball, basketball and rugby, which are played continuously in a limited time. For example, in terms of tennis, just by setting the probability to get a point by a server as 0.6 in a cell, we can obtain the probability to get a game as 0.736 by the proce-

dures on a spreadsheet. By formulating the hierarchy of the point system, we can also easily calculate the probabilities of winning a set or a match. Discussion As an application of this method, we calculated the winning probability and the number of plays in a volleyball game, not only under the rally-point system, but also under the side-out system. Using this method, we easily got the duration of the game for both systems. For example, assuming that one series of plays starting off with a service takes 0.4 minutes and the probability for each team to get a point from its service is 0.3, the duration of the game is  $74 \pm 9$  minutes under the rally-point system and  $129 \pm 39$  minutes under the side-out system. Further, also as an extension of this method, we can calculate at anytime in the course of the match the probability of winning a match, just by inputting 1 into a cell. The optimal timing of tactical changes is also calculated in a spreadsheet, under the formulation shown in Hirotsu and Wright (2002). References Hirotsu, N. and Wright, M. (2002) Journal of the Operational Research Society, 53, 88-96. Sadovskii, L.E. and Sadovskii, A.L. (1993). Mathematics and sports, Mathematical World Vol. 3, Providence, RI, American Mathematical Society. Schutz, R.W. (1970) Research Quarterly, 41, 553-561.

## A STRUCTURAL MODEL OF THE MATCH DYNAMICS IN INVASION TEAM GAMES

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Introduction The dynamics of the match in invasion team games (ITG) defines a complex context with two adversary teams imposing several constraints to each other for obtaining the ball possession and score. However, a better comprehension of the ITG opposition still requires a model that describes the match cooperation/opposition processes, its regulatory parameters (e.g. team's strategy) and its integration with other competition processes (e.g. training) (Lebed, 2007). Thus, our aim is to present an ITG model with its parameters and regulatory processes. Methods The ITGs were modeled as dynamical systems regulated by control fluxes and data fluxes in accordance with the control-system integration principles of the control theory (Shinners, 1998). In our multi-level model a subsequent layer describe the most relevant processes of the previous layer. The model was logically tested with applications to different sports. Simulation procedures are being organized. Results The dynamical structure of the match was satisfactorily modeled in six hierarchical layers: 1) Competition: its processes, feedback mechanisms and three main interfaces: a) team's strategy-training, b) team's strategy-match, c) match-match analysis; 2) Match: two teams, with respective strategies, preparing to confront each other. Controllers from both teams are the first two processes of the control and data fluxes and its outputs are integrated to produce the final adjustments for the confront occurrence; 3) Controller: controller structures of both teams compute the fluxes provided by the match and a new strategy sub-set is generated. The new strategy generates data specification for all players' action; 4) Match navigation: player's action (navigation) based on controllers' specifications; 5) Match planner: adaptation of the team's strategy to the individual plan of each player describing procedures for synchronizing their actions; 6) Epicenter: actions of players directly involved with the ball. Discussion The model of the match presented integrates extrinsic control (team's strategy operated by the technical commission), the intrinsic control defined by the players' individual decisions and the coordination between both for the collective action. Hence, the model shades some light into the comprehension of the behavior's regulations in the match opposition. Moreover, provides support for a more structured match analysis and contributes for defining more precise training focuses by the coaches. References Lebed, F. European Journal of Sport Science, v. 7, n. 1, pp. 55-62, 2007. Shinners, S.M. Modern control system theory and design. John Wiley & Sons Inc., 1998. FAPESP: 08/10810-1

## ANALYSIS OF PLAYER WORKLOADS FOR DEFENSIVE OUTLETS AT THE CHAMPION'S TROPHY INTERNATIONAL FIELD HOCKEY TOURNAMENT.

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Introduction For team invasion sports, adopting a strategy that requires the opposition to work relatively harder will generally be advantageous. However, it is often difficult to quantitatively measure team or player performances with sufficient accuracy to make meaningful comparisons. Although it is now common-place to use a variety of methods for tracking players during field sports (e.g. GPS, RF tracking), non-invasive methods based on video recordings have a number of advantages; in particular the possibility of simultaneously tracking all players on both teams. In this study we utilised an automated video-tracking methodology to estimate relative positional workloads for teams involved in the "Champions Trophy" hockey tournament, held in Australia in 2009. This data was then analysed using the concept of Specific Power to obtain an accurate surrogate for player and team workloads. Competing teams represented the top six field hockey nations globally. Methods A total of 18 matches were played, from which 42 defensive outlet plays were chosen for detailed examination. Output from a group of five cameras, each with a partial field of view of the game, was synthesised into a single whole-field view from which (x,y) information was obtained on a frame by frame basis (25 Hz). From these derived coordinates the player velocity could be obtained for each player on the field. Plotting the maximum speed sustained against its duration produces a characteristic speed-duration curve for each position. This methodology was used to examine the relative workloads of the teams (attacking and defending) under each of two defensive strategies. One was defined as a "fall back" strategy, in which defending players, having lost possession, fall back into their own half; whereas the second strategy (defined as a "press") represented the strategy of immediately challenging the (now) attacking team in their own half, with the objective of creating an attacking error, reversing the original turnover. Results In overall terms, the attacking/out letting team generally works at higher speeds than the defending team, regardless of the defensive strategy. But, imposing a press on the out-letting team does further increase the speed exhibited by players on most lines in the out-letting team, excluding deep defenders. Discussion There is a moderate increase in speed required of the defending team during a press, and the duration of those efforts is also longer in a press. The increase in work rate suffered by the pressing team is largely borne by the defensive lines, but this is equal to the additional load on the attacking AMF and strikers. Notwithstanding the additional work cost to the defending team, the average duration of the defensive outlets is more than twice as long for a fall away as for a press: any decision about relative workloads on players should take this into account. Also, there is a clear outcome benefit to the defending team in pressing.

## OLYMPIC WINNING PERFORMANCES IN ATHLETICS AND SWIMMING: A COMPREHENSIVE ANALYSIS

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OLYMPIC WINNING PERFORMANCES IN ATHLETICS AND SWIMMING: A COMPREHENSIVE ANALYSIS Stefani, R.T., CSULB (Long Beach, California, USA), Stefani@csulb.edu Introduction Athletics and swimming comprise over 25% of the 300 medal events in the 2012 London Olympics. The percent improvement per Olympiad (%/O) was calculated in those sports for all comparable winning performances of the

modern Games. Charts and photographs are used throughout to enhance the presentation. Overall and Individual Results For athletics events, the average %I/O was 0.7% for running, 1.5% for jumping and 2.9% for throwing. The average for swimming was 1.9%. The best individual %I/O were 6.2% in running by Lasse Viren (FIN, 1972, 5 k), 10.3% in jumping by Bob Beamon (USA, 1968, long jump, still the Olympic record), 17.4% in throwing by Gisela Mauermayer (GER, 1936, women's discus) and 10.2% in swimming by Andrew "Boy" Charlton (AUS, 1924, 1500 m). Comparing 2004 winners with those of 1924, Justin Gatlin would be 7.1% faster than Harold Abrahams at 100 m, Jeremy Wariner would be 7.6% faster than Eric Liddell at 400m, Stefano Maldini would be 19% faster than Albin Stenroos at the marathon and Grant Hackett would be 27% faster, lapping Boy Charlton 4 times in the 1500m swim. Results by Olympics For athletics, the highest %I/O was in 1900 (10.9%). Values peaked before WWI, dropped after that war, rebounded in 1924, peaked before WW2, dropped after that war, rebounded in 1952, remained high through the Cold War, dropped in 1980 and 1984 due to boycotting and then rebounded in 1988 when Ben Johnson of Canada was disqualified for doping in the men's 100 m run. Following a crackdown on performance enhancing drugs, 2/3 of the 1988 winners would still have won in 2000 and 1/2 would still have won in 2008. %I/O rebounded to 0.65% in 2004 and 0.34% in 2008. In swimming, %I/O values remained high through two world wars from 1912 through 1976. Values declined due to boycotting in 1980 and 1984, rebounded in 1988 and dropped in 1992 and 1996 as doping controls were enhanced. The values of 1.3% in 2000 and 1.8% in 2008 are unusual only as compared to the last eight Games but were commonplace before then. The importance of swim suits is overstated in that drag is measured passively as compared to suits not used in competition. Results by Gender In athletics, as opportunities and training methods began to catch up to those of men, women improved about 1% more than men from 1900 to 1988. After 1988, women improved a bit less than men, equalizing %I/O for both genders at 1.3% for all events. Similarly in swimming, women improved 0.6% more than men per Olympiad from 1912 to 1976, after which improvement was at the same rate as for men. Both genders have improved at about 1.9% for all events. Estimated Great Britain Medal Count in 2012 In the last 12 fully attended Games, the host nation earned 13 more medal at home than four years before. Great Britain should thus win 47 + 13 or 60 medals at London in 2012.

## Poster presentations

### PP-BN08 Motor Learning 2

#### THE EMPLOYMENT OF ALTERNATING INTERMITTENT VISION DURING GOAL-DIRECTED AIMING

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THE EMPLOYMENT OF ALTERNATING INTERMITTENT VISION DURING GOAL-DIRECTED AIMING Hansen, S.1, Hallam, M.2, Bennett, S.J.2, 1: Nipissing University (Canada), 2: LJMU (United Kingdom) Introduction Humans are capable of integrating alternating monocular visual samples to gain information needed for complex tasks such as one-handed ball catching (Olivier et al, 2000). However, deterioration in performance occurs when an inter-ocular delay is added between monocular visual samples (Bennett et al, 2000). Studies investigating reach-to-grasp tasks have also revealed that humans have difficulty integrating alternating monocular visual samples when there is an inter-ocular delay (Hansen et al, 2011; Wilson et al, 2008), resulting in a lengthened movement time and larger grip apertures to compensate for a reduced binocular percept. The current experiment was designed to further examine the apparent inability to integrate alternating monocular samples by using a manual aiming task that did not require control of a grip aperture, but still required a precise action. Methods Participants aimed at targets of three distances (250, 300 or 350mm). Liquid crystal goggles were used to provide the binocular, monocular, or three alternating monocular vision conditions. In the alternating conditions, 25ms monocular samples were provided to the right and left eye without a delay (0 ms), or with a delay of 25 or 50ms. Participants completed 150 randomly ordered trials, 10 in each of 15 conditions. A 2D digitizing tablet recorded the movements. Results An inter-ocular delay of 25 or 50ms resulted in longer movement time ( $F(4,44)=25.23$ ;  $p<0.001$ ) and time to reach peak velocity ( $F(4,44)=23.30$ ;  $p<0.001$ ) than those observed in the other conditions. Although there were main effects of target distance for constant error, there were no main effects or interactions involving vision condition. However, analysis of peak velocity revealed a significant interaction of vision condition and target ( $F(8,88)=3.44$ ;  $p<0.002$ ). Participants produced a lower peak velocity and failed to scale their velocity to the target distance when there was an inter-ocular delay. Discussion As expected, aiming accuracy was not influenced by visual condition. This required participants to compensate for the disrupted binocular percept in alternating monocular conditions by reducing limb velocity and consequently increasing the time to complete the action. The current results parallel studies of alternating monocular vision and grasping (Hansen et al., 2011; Wilson et al., 2008) and thus support the notion that humans are intolerant to alternating monocular vision with an inter-ocular delay. References Bennett, S.J, Rioja N, Ashford D, Coull J, & Elliott D. (2006). *J Mot Behav*, 38, 439-450. Hansen S, Hayes S, & Bennett S.J. (2010). *Neurosci Lett*, 487, 17-21. Olivier I, Weeks DJ, Lyons JL, Ricker K, & Elliott D. (1998). *J Mot Behav*, 30, 343-351. Wilson K, Pearson P, Matheson H, & Marotta J. (2008). *Exp Brain Res*, 189, 91-98.

#### COMPARISON OF THE EFFECTS OF SELF-CONTROL AND INSTRUCTOR-CONTROL FEEDBACKS ON PERFORMANCE AND FORCE-PRODUCTION TASK LEARNING AFTER GOOD, POOR, AND GOOD-POOR ATTEMPTS

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Introduction Improved performance have been shown if the subjects receive feedback both for good and poor attempts; by this feedback subjects will be both encouraged and informed about their errors (Chivacowsky 2002). Considering self control feedback (Janella 1997) and previous research in regard to positive and negative feedbacks (Chivacowsky2002), this study is aimed to compare the effects of self-control and instructor-control feedbacks on performance and force-production task learning after good, poor, and good- poor attempts. Methods 60 subjects were randomly divided into four groups: self-control feedback, instructor-control feedback after good, poor, and good-poor trials groups. Acquisition phase include 6 series of 12 attempts. All participant produced 10 kg force in acquisition phase. They couldn't see the result. After 24 hours, subjects performed a retention and transfer tests without feedback. To analyze data, Factorial analysis of variance with repeated measure was used. Results In the acquisition phase significant improvements occurred in the performance of the four groups. However, there was no significant difference between the groups. Performance of the self-control feedback group after good, poor, and good-poor attempts was significantly improved in comparison with instructor-control feedback group. No significant difference was observed between instructor- control groups. Discussion It seems that each of instructor-control conditions has its own specific benefits on learning, and this lead to the similar learning. Chivacowsky, S., & Wulf, G. (2002). Self-controlled feedback:

Does it enhance learning because performers get feedback when they need it? *Research Quarterly for Exercise and Sport*, 73, 408-415.

Janelle, C.M., Barbara, D.A., Frehlich, S.G., Tennant, L.K., & Gaurough, J.H. (1997). Maximizing performance effectiveness through video-tape replay and a self-controlled learning environment. *Research Quarterly for Exercise & Sport*, 68, 269-279.

### INCREASING CONTEXTUAL INTERFERENCE EFFECT ON GOLF PUTTING TASK

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Mendes, R.I, Dias, G. 2 1: ESE-IPC (Coimbra, Portugal), 2: FCDEF-UC (Coimbra) Introduction Porter and Magill (2005, 2010) advocate that can be beneficial to promote a gradual increase of Contextual Interference (CI) in acquisition in order to achieve positive effects on learning, especially in retention and transfer. The purpose of this study was to investigate the increasing CI effect on learning a golf putting task. Methods Forty inexperienced golfers undergraduate students (19,7±1.9 years old) were randomly assigned to one of four groups: blocked, serial, random and increasing CI practice schedules. They putted 126 trails in acquisition (3 distances to hole: 2, 2.75 and 3.5 meters) in a artificial indoor golf carpet, 30 trials in a random order in retention test and, in the transfer test 20 trials: T1 - 10 at 2.5 meters and 10 to T2 - 2.5 meters with 10 degrees of deviation (angle) from the starting point towards the hole. Absolute error (AE) a variable error (VE) were analysed using separate analyses of variances for acquisition (4 practice conditions x 9 blocks of trials) with repeated measures on the last factor and One-Way ANOVAs for retention and transfer tests. The Tukey HSD test was applied to the Post hoc analysis of data. Results It's observed in AE and VE a superiority of performance of increasing CI group on transfer test. However weren't significant differences between the four conditions in the transfer distance test,  $F(3,44)=0.535$ ,  $p=0.66$  and transfer angle test,  $F(3,44)=1.225$ ,  $p=0.31$ . Discussion Mendes & al. (2008) found better results on learning by effect of increase CI on a putt task. The effect of increasing CI was not found in this experiment. According to Guadagnoli and Lee (2004) several factors may constrain the effect of CI in ecological and field tasks as, for instance, the organization and amount of practice or the specificity and task complexity. It's necessary investigate the effects of these variables with the increasing CI practice References Guadagnoli MA, Lee TD (2004). Challenge point: a framework for conceptualizing the effects of various practice conditions in motor learning. *J Mot Behav.*, 36, 2, 212-224. Mendes R, Martins R, Dias G (2008). Effects of a contextual interference continuum on golf putting task. In: J Cabri, F Alves, D Araújo, J Barreiros, J Diniz, A Veloso (Eds.). Book of abstracts, A-490, 13Th Annual Congress of the European College of Sport Sci. Portugal. Porter JM, Magill RA (2005). Practicing along the contextual interference continuum increases performance of a golf putting task, *J Sport Exercise Psy*, 27, 124. Porter JM, Magill RA (2010). Systematically increasing contextual interference is beneficial for learning sport skills, *J Sports Sci*, 14, 1-9.

### GOLF PUTTING: PROCEDURES AND DATA ANALYSIS

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GOLF PUTTING: PROCEDURES AND DATA ANALYSIS Mendes, R.I, Dias, G.2, Couceiro MS.3, Luz JM.3, Figueiredo CM.3 1: ESE-IPC and CIPER (Coimbra and Lisboa, Portugal), 2: FCDEF-UC (Coimbra), 3: ISE-IPC (Coimbra) Introduction The coordination and control in the practice of golf putting is an individual process that is different for each subject depending on their profile and characteristics (Pelz, 2000; Hume et al. 2005). Like other motor skills, the intra and inter-individual performance resulting from the execution of this movement is a "fingerprint" (i.e., "signature") that is unique to each individual (Davids et al., 2008). The aim of this study was to present the experimental design and methodological aspects in the analysis of the effects of variability in golf putting performance of novice golf players. Methods Three male subjects, all right-handed and without previous experience related to the practice of Golf, performed three putts to 2m, 3m and 4m. The ball's trajectory and the putter movement were automatically analyzed based on visual detection and parameter estimation, using the Matlab software to determine the amplitude, velocity and acceleration of the putting execution, based on the respective video recordings. Results The results show that putter's trajectory during the movement is similar to a sinusoidal function. When a player has a radial error different than zero, the tendency is to raise the amplitude in position, velocity and acceleration of the putter in the second trial, in order to correct that error. Anyway, exceptions to this situation occur, when the subject can reduce or even eliminate the radial error in the second attempt, tends to maintain or raise the amplitude in position, velocity and acceleration of the putter. The available data confirm that golf's putting is a complex movement and differently executed from subject to subject. Discussion The intra-and inter-individual feature that results from putting represent a "fingerprint" that is unique to each individual. Experimental results clearly show, when considering different trials of every player, that each of them has a typical and distinct game style, a "fingerprint" (i.e., signature), confirming conclusions from studies mentioned in the introduction (c.f., Pelz, 2000). It becomes imperative that this movement is analyzed not only from the quantitative point of view, from the perspective of quantifying the error, but also from a qualitative point of view that focuses on the measures of the process variables, i.e., the closest approach of dynamic (c.f., Davids et al., 2008). References Davids K, Button C, Bennett S (2008). Dynamics of skill acquisition – A constraints-led approach, Human Kinetics. Pelz D (2000). Putting Bible: The complete guide to mastering the green. Publication Doubleday, New York. Hume PA, Keogh J, Reid D (2005). The role of biomechanics in maximising distance and accuracy of golf shots. *Sports Med*, 35, 5, 429-49.

### THROWING VARIABILITY AND ACCURACY UNDER INSTABILITY CONDITIONS IN YOUNG TEAM-HANDBALL PLAYERS.

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Introduction Precision and ball speed at throwing are two very important conditions in team-handball, but this task is carried out into a wide variability depending on the way the thrower assembles the arm. Previous studies analyzed relationship between precision and ball speed (van der Tillaar & Ettema 2006). Different task constraints have been studied in relation to speed and accuracy of human movement (Davids, Bennet and Newell, 2006). The aim of this study was to analyze the effect of unstable conditions at throwing and its relation to movement variability. METHOD Twenty-five young handball players performed thirty-two throws on the floor and on unstable surface (Bosu). Kinematic variables from hands, arm and hip were collected (Polhemus Liberty 240Hz update rate), ball speed (RS3600) and accuracy were recorded to determine performance. Correlation analysis was carried out to analyze the relationship between kinematics, movement variability and performance. Repeated measure ANOVA was carried out to compare unstable conditions effects. RESULTS Data did not offer concordance between ball speed and precision of throwing. Significant relations were found between hand rotation degree ( $p<0.50$ ), hip ( $p<0.01$ ) and amplitude of movement ( $p<0.01$ ) with quantity of error. Also relations were found between amplitude of movement and ball speed ( $p<0.01$ ) and variability of the ball speed as well as variability of the range of movement with

quantity of error. Unstable conditions did not affect ball speed and precision of throws. **DISCUSSION** As in this research, previous studies have not found the ball speed-precision trade-off in handball players (van der Tillaar & Ettema, 2006 and Párraga, Sánchez & Oña, 2001). Despite the fact variability is an inherent feature in human movements, and there is not a unique way to perform a throw, we have found some kinematic profiles related to better performance. Lower hip rotation and shorter movement amplitude correlated to higher ball speed and accuracy and lower variability at ball speed. Handball players exhibited higher variability under unstable conditions but it did not affect to performance. As conclusion, accuracy is not related to ball speed, variability is not clearly related to performance and shorter movements are faster and more accurate in handball throws. **REFERENCES.** Davids, K., Bennett, S. & Newell, K.M. (2006). Movement System Variability. Champaign, Illinois. Human Kinetics Párraga, J., Sánchez, A., y Oña, A. (2001). Ball speed and accuracy of the handball jump throw as parameters of performance. *Apunts: Educación Física y Deportes*, 66, 44-51. Van der Tillaar, R. and Ettema, G. (2006). A comparison between novices and experts of the velocity-accuracy trade-off in overarm throwing. *Perceptual Motor Skills*, 103, 503-14.

## **ASOCIATION BETWEEN MOTOR COORDINATION AND ACADEMIC ACHIEVEMENT IN PORTUGUESE ELEMENTARY SCHOOL CHILDREN**

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**Introduction** Several studies have addressed the relations between physical activity (PA), fitness and academic achievement (AA), however, no investigation has linked motor coordination (MC) and AA. We aimed to evaluate the relationship between MC and AA in a sample of Portuguese children aged 9-12 years. **Methods** This is a 2009/2010 school-based study with 596 urban children from the north of Portugal. AA was assessed using the Portuguese Language and Mathematics National Exams. MC was evaluated with the Körperkoordination Test für Kinder(1). Cardiorespiratory fitness was predicted by a maximal multistage 20m shuttle-run test of the Fitnessgram Test Battery(2). Body weight and height were measured following standard procedures. Socioeconomic status was based on annual family income. Logistic Regression was used to analyze the influence of MC on AA. Results 51.6% of the sample exhibited MC disorders or MC insufficiency and none of the participants showed very good MC. In both genders, children with insufficient MC or MC disorders exhibited a lower probability of having high AA, compared with those with normal or good MC ( $p < 0.05$  for trend for both) after adjusting for cardiorespiratory fitness, body mass index and socioeconomic status. **Discussion** Children of both genders with lower MC had lower odds of having high AA, after adjusting for potential confounding factors. Our results highlight the need of providing children opportunities to engage in structured and unstructured PA that requires different motor skills since MC in childhood may support AA. **References** 1.Schilling F. Körperkoordination Test für Kinder, KTK. Beltz Test GmbH. Weinheim.1974. 2. Welk GJ, Meredith MD, editors. Fitnessgram / Activitygram Reference Guide. 3 ed. Dallas, TX: The Cooper Institute; 2008.

## **DIFFERENT LEVELS OF VARIABILITY VERSUS SPECIFICITY OF PRACTICE APPLIED TO INCREASE THE PERFORMANCE UNDER STATICS TASK CONSTRAINTS.**

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**Introduction** Variability has usually been considered as an index of error, however, actually some studies have shown that motor variability allows exploring the environment and it can be useful for learning (Riley y Turkey, 2002; Davids et al., 2003). Therefore, increased variability during motor learning could be considered for a more adequately exploring behavior and increase task effectiveness (Davids, et al. 2003). This study examines the effect of different levels of variability of practice on a closed motor skill. **Methods** Thirty nine participants (18 male, 21 female) took part in this study. The participants were asked to perform series of throwing a ball with the right hand to a target located at 1.65 meters distance in front of them. After an initial test of eighty throws, the participants were divided in five groups. Four levels of variability of practice were applied to four groups along eight sessions (one per day) of 160 throws each of them. One control group did not practice. A final test and three retention tests (4 days, 2 weeks and 4 weeks) were carried out for the five groups. Kinematic variables were collected by Polhemus Liberty sensors attached to performing arm and hip (240Hz). Ball bounces were video recorded to calculate radial error. A repeated measures ANOVA was conducted to estimate the effects of training on accuracy. Result Repeated measures ANOVA showed significant differences for the radial error ( $F(4,24) = 20.86$ ;  $p < 0.001$ ;  $\eta^2 = 0.47$ ) and the standard deviation of radial error ( $F(4,24) = 21.21$ ;  $p < 0.001$ ;  $\eta^2 = 0.47$ ). No significant differences were obtained for group interaction. Nevertheless, all intervention groups improved (r1) their performance according the following ranking: level 1 ( $-3.34 \pm 2.56$ ), level 3 ( $-2.43 \pm 3.05$ ), level 2 ( $-1.89 \pm 2.38$ ) and consistency ( $-1.51 \pm 2.03$ ). At the post- and retention test, a Scheffé pos-hoc analysis showed significant differences between control group and variability level 2 group ( $p < 0.05$ ). Significant differences were also obtained between control and level 2 of variability groups in the SD radial error ( $p < 0.05$ ) in the post-test. **Discussion** Practice increased accuracy. Low-impact variability of practice (group 2) showed higher improvement in throwing accuracy. The higher level of variability of practice (group 4) did not increased performance variability in final test or in retention tests. The results suggest the effective use of variability to enhance the performance under static task constraints. **References** Riley MA, Turvey MT. (2002). *Journal of Motor Behavior*, 34: 99-125. Davids K, Glazier P, Araujo D, and Bartlett, R. (2003) *Sports Medicine*; 33: 245-60.

## **THE INFLUENCE OF TIME-SCALE CHANGES IN BASKETBALL FREE-THROW ON ACTION ANTICIPATION**

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[Introduction] Recent neurophysiological studies have reported the presence of a human motor mirror system providing feedback of movement simulation to the observer (Cross et al., 2006). In addition, at the psychophysical level, elite basketball players predicted the basket shot's fate by reading the body kinematics (Aglioti et al., 2008). However, the influence of changes in the variable of the time factor of an observed movement on such stimulation has not been clarified. Therefore, this study aimed to examine the influence of time-scale changes in movement during a basketball free-throw on action anticipation, and differences in eye position, involved in these changes, by simultaneously conducting eye-tracking measurement. [Methods] Six male basketball team members ("players"), aged  $21.8 \pm 0.4$ , and 6 males without experience of playing basketball ("watchers"), aged  $22.3 \pm 2.3$ , were studied. Images of 10 successful and 10 unsuccessful throws, giving a total of 20 free-throws, recorded from shooting to the peak of the throw, were randomly presented to subjects at 3



different speeds (slow, normal, and fast). The mean rates of correct predictions of the results were calculated by group. Eye position during observation was measured using an eye tracking system to examine rates of fixation within 3 regions (lower and upper body, and ball-tracking) of the image. [Results] The correct prediction rate was significantly higher in the players than in the watchers when watching the images at normal speed ( $p < 0.01$ ). Analysis of the simultaneously recorded eye position data revealed that the players' fixation rate was highest in the lower body region, followed, in this order, by the upper and ball-tracking regions. In contrast, the watchers' eye position was not observed in the lower body region, and their fixation rate was higher in the ball-tracking than in the upper body region. When watching the images at slow and fast speeds, a similar tendency in the fixation rate was observed in both groups, although the players' correct prediction rates significantly decreased ( $p < 0.01$ ). [Discussion] When watching the images at normal speed, the players' correct prediction rate was significantly higher as a result of their eye position being focused on the lower body region. The factors essential for mental imagery which is a process contributing to the prediction of throw results are involved in this region. The players' correct prediction rates varying among different speeds despite their similar eye position suggest that the variable of the time factor may be associated with mental imagery. Based on these results, it may be concluded that the speed of a movement, similar to that necessary for the observer to actually execute it, facilitates mental imagery and anticipation of the outcome. [References] Cross S, Hamilton F, Grafton T. (2006). *Neuroimage*, 31, 1257-1267. Aglioti S, Cesari P, Romani M, Urgesi C. (2008). *Nature Neuroscience*, 11, 1109-1116.

### **EFFECT OF COMBINING HIGH FREQUENCY OF KNOWLEDGE OF PERFORMANCE WITH SELF ESTIMATION OF ERROR IN THE LEARNING OF BASKETBALL SHOOTING BY CHILDREN**

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**Introduction** The present study aimed at assessing the effect of combining high frequency of knowledge of performance (KP) with self estimation of error in the learning of basketball shooting in children. **Methods** Participated of the study 40 males and females in the age range of 10-12 years. They were assigned to the following experimental groups: error estimation associated with KP in all trials (EST100-KP100), no error estimation associated with KP in all trials (EST0-KP100), error estimation in all trials associated with KP in 33% of the trials (EST100-KP33), and no error estimation associated with KP in 33% of the trials (EST0-KP33). During task acquisition, the children executed 50 trials from a single position. Performance in the shooting was filmed and evaluated offline for the periods before, immediately after and one day following the practice trials. Performance was evaluated on the basis of qualitative analysis of movement pattern. **Results** Results showed that all groups improved performance with practice, but no between-group difference was detected in the immediate posttest. In retention we found that high frequency of error estimation associated with high frequency of KP led to the best results of learning, with EST100-KP100 group achieving significantly higher scores in comparison with the EST0-KP100 and EST100-KP33 groups. **Discussion** These results indicate that self evaluation by children associated with abundant extrinsic information about their errors potentialize the beneficial effect of KP without creating dependence on that information in the learning of complex motor patterns by children, as those characteristic of sport actions.

### **SIGNIFICANCE OF SKIN CONDUCTANCE RESPONSES REVEALED BY GO/NO GO MOTOR TASK.**

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**Introduction:** Skin conductance response (SCR), a non-invasive method that measures the activity of sweat glands enhanced by sympathetic nerves, has been regarded as an excellent reflector of sympathetic nerve activity<sup>1)2)</sup>, although the neurogram, an invasive method, is regarded as the conclusive method to study the activity of autonomic nervous system. Somato-autonomic linkage has been discussed in peripheral circulation during exercise. It has been postulated that central motor command of the muscular system must have an effect on sympathetic nerve activity in sustained isometric force exertion<sup>3)4)5)6)7)</sup>. To investigate the intrinsic quality of the central command on the autonomic nervous system, a GO/No GO ballistic force task was adopted in this study. The GO/No GO motor task was chosen to provide a means for judging whether a descending neural volley is constructed only by neural components for a motor plan, or also by components for motor output. **Introduction** of the ballistic contraction to the study of autonomic activities during movement could provide a means to argue for the dependence of cortical command in collateral nervous functions, since it would put away the feedback component in related neural circuits. **Methods:** Twelve volunteers participated in this study. They sat on a stable chair and performed isometric hand grip force as fast as possible as a GO/No GO RT task. Force targets were set at three grades (10, 30, 50 %MVC) displayed on a monitor screen. SCRs were recorded from the contra-lateral index finger. **Results & Discussion:** SCR changes appeared in both GO trials and No GO trials. However, when changing the SCR amplitudes of GO trials, exerting force conditions were far higher than those of No GO trials. Furthermore, SCR amplitudes of GO trials increased depending on force amplitude exerted. Different SCR responses between trial conditions and force—dependent SCR change were observed. The results suggest that cortical motor programs including the plan and the neural output must have effects on sympathetic nerve activity as the central command. **References:** 1) Tranel, D. and Damasio, H. (1994). *Psychophysiology* 31: 427-438. 2) Dawson, M.E. et al. (2000). *Electrodermal System*. In *Handbook of Psychophysiology*, ed. Cacioppo, J.T. et al. 200-223, Cambridge Univ. Press. 3) Victor, R.G. et al. (1989). *Circ Res.* 65; 468-476. 4) Victor, R.G. et al. (1995). *Circ Res.* 76; 127-131. 5) Vissing, S.F. et al. (1991). *Circ Res.* 69; 228-238. 6) Seals, D.R. (1993). *J. Physiol.* 462; 147-159. 7) Vissing, R.G. & Hjortso E.M. (1996). *J. Physiol.* 492; 931-939.

### **A STUDY OF INTEGRATION OF VISUAL, AUDITORY AND SOMATOSENSORY INFORMATION USING A HAPTIC DEVICE**

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**Introduction** We use categories of sensory information in order to process external information. There are many studies investigating sensory interactions, but the haptic effects on other senses have not been sufficiently studied. The aim of this study was to measure how the brain integrates visual, auditory and tactile information using a haptic device. **Methods** We used a behavioral task based on the observation that when two identical visual objects move toward each other, they overlap and then continue their original motion (Bushara et al., 2003). Haptic, auditory or haptic and auditory stimulation was presented at various times relative to visual objects overlapped (100-, 200-, 300-, 400-ms before, after, or at the same time as visual objects overlapped). Subjects may perceive the objects as either bypassing each other or colliding and reversing their motion direction. We worked out the colliding rates of subjects for each presented time and for each presented sense type. **Results** The colliding rates when haptic stimulation was presented were higher than when auditory stimu-

lation was presented. However, the colliding rates when haptic and auditory stimulation was presented were the highest in other senses. Moreover, the rates were the highest when stimulation presented at around the time when two identical visual objects overlapped. Moreover, the rates were higher when stimulation was presented before they overlapped than when stimulation was presented after they had overlapped. Discussion Our results showed that timing of the stimulus presentation and type of stimulus presentation are important factors for interaction between different senses. References Bushara K, Hanakawa T, Immisch I, Toma K, Kansaku K, Hallett M. (2003). *Nature neuroscience*, 6(2), 190-195.

## Poster presentations

### PP-BN09 Coaching: Monitoring and Preparation for Sport

#### THE CENTRALIZED PREPARATION OF BRAZILIAN WOMEN ARTISTIC GYMNASTICS TEAM

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**Introduction** Over two Olympic cycles, 2001-2004 and 2005-2008, the Brazilian Women Artistic Gymnastics (WAG) team obtained the best results in its history. This success was attributed to the infrastructure of the Centre of Excellence (located in Curitiba), the implementation of centralized training program (SMOLEUSKIY; GAVERDOUSKIY, 1996) and the leadership of a renowned foreigner coach. However, we found out several problems caused by this model imported from the Sovietic Union (ARKAEV; SUCHILIN, 2004), as it was not adapted to the Brazilian AG context. Therefore, the aim of this field study was to discuss the centralized preparation of Brazilian WAG team. **Methods** We interviewed 34 WAG coaches who are coaching at the competitive level in 29 institutions in Brazil and have been competing nationally and some internationally. For data treatment we used the Content Analysis (BARDIN, 2008). **Results and discussion** The positive aspects of the program are mainly related to the physical infrastructure of the Centre of Excellence, human resources available to the gymnasts, and the financial support. Despite the aforementioned positive aspects, the negative ones seem to have more significance due to the greater number of categories and unity of analysis (BARDIN, 2008). The coaches said that there was a lack of recognition and depreciation of the Brazilian coaches. Another problem was the departure of the best gymnasts from their institutions to the Centre of Excellence. This aspect discouraged the clubs to invest in AG and, therefore, was prejudicial to the other gymnasts, coaches and AG in general. The coaches also said that the gymnasts who were not selected or successful in joining the centralized training program felt discouraged, without motivation and goals in the sport and dropped out. All these negative aspects weakened the process of development of the future generations of gymnasts in the country. **Conclusion** Besides the negative aspects, we believe that the implementation of the centralized preparation of the team was a significant experience for all involved with AG. From this initiative and its outcomes and impacts, it is important to reflect and rethink the format and concepts that led to this program. Undoubtedly the centralized preparation of the team showed its effectiveness through the improvement of competitive results. On the other hand, it revealed several problems that need to be improved to better contribute to an equitable growth and development of WAG in Brazil. **References** ARKAEV, L.; SUCHILIN, N. (2004) *Gymnastics: how to create champions*. Oxford: Meyer & Meyer Sport. BARDIN, L. (2008) *Análise de conteúdo*. Lisboa: Edições 70. SMOLEUSKIY, V.; GAVERDOUSKIY, I. (1996) *Tratado geral de ginástica artística deportiva*. Barcelona: Paidotribo.

#### PREPARING AN EXPEDITION - PERFORMING IN DUSTY ENVIRONMENTS

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**INTRODUCTION** When preparing and organizing an expedition it is important to understand how the performance of the participants will be influenced by the conditions in which they will have to act and take decisions. We continue here the studies we made (Fernando et al., 2010) with cold and mud and how this conditions influence decisions, even very simple decisions. To easier compare the results we keep, as possible, the same methodology. Dust is present in lot of sport environments, mainly in Open Spaces Sports and in Environments Adaptation Sports, and even, Sometimes in collective Outdoors Sports. **METHODS** To a sample of 15 people aging between 21 and 27 years, we presented on a paper a test of 60 arithmetical operations (additions, subtractions, divisions and multiplications), with numbers equal or inferior to 5, distributed randomly. They should perform these arithmetical operations with two sorts of objectives: 1- first of all to make no mistakes; 2 - to do it as quickly as possible. The sample was divided in two groups of 7 and 8, randomly. One group, group A, answered to the test, always the same test, first comfortably sitting at a table, indoors, and then after having been exposed to win and dust for 5 minutes, in a temperature of about 22 degrees C, in a "tunnel of dust". The other group, group B, did the same thing but in reverse order. So, after to do the first test, they had an hour for a hot shower and then answered to the same test in the same comfortable situation indoors. Everybody was using practice suits and when exposed to dust were wearing protection glasses. We've measured the time of each participant and the total of errors committed by all the members of each group. **RESULTS** Group A - the average of the time in adverse conditions was 23% higher than indoors in comfortable conditions. Distribution results had a much wider distribution in the outdoors situation. While in indoors conditions there where practically no errors (less than 3.5% of the total), in adverse conditions there where 15% of errors. Group B - the average of the time in adverse conditions was 25% higher than indoors in comfortable conditions. Distribution results had a much wider distribution in the outdoors situation. While in indoors conditions there where practically no errors (less than 2% of the total), in adverse conditions there where 20% of errors. **DISCUSSION** Performance was influenced by dust in the clothes and over the body so we must know what to expect and the influence it can have in the activities. This knowledge is an essential instrument to organize and plan an expedition. **REFERENCES** Fernando, C., Vicente, A., Lopes, H. & Almada, F. (2010). 15th ECSS, 473-474.

#### PREPARING AN EXPEDITION - PERFORMING IN A WARM AND SWEATING ENVIRONMENT

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**INTRODUCTION** To prepare and organize an expedition, for instance in the mountain or at the sea, it is important to understand how the performance of the participants will be influenced by the weather conditions in which they have to act and take decisions. It is not only the physiological reaction that we have to understand, it's also important to know how much conditions will influence decisions, even very simple decisions. With this study we complement similar works in cold, muddy and dusty conditions (Fernando et al., 2010). So we

keep the methodology used as similar as possible in order to enable comparing data and results. **METHODS** To a sample of 18 people aging between 18 and 25 years, we presented, on a paper, a test of 60 arithmetical operations (additions, subtractions, divisions and multiplications), with numbers equal or inferior to 5, distributed randomly. They should perform these arithmetical operations with to sorts of objectives: 1- first of all to make no mistakes; 2 – to do it as quickly as possible. The sample was divided in two groups of 9, randomly. One group, group A, answered to the test, always the same test, first comfortably sitting at a table, indoors, and then, after a light 15 minutes walk with temperatures of about 27 degrees C, outdoors and wearing heavy winter clothes. The other group, group B, did the same thing but in reverse order. So, after the walk (that they did together with group A), they had an hour for a shower and then answered to the same test in the same comfortable situation indoors. We've measured the time of each participant and the total of errors committed by all the members of each group. **RESULTS** Group A - the average of the time in adverse conditions was 19% higher than indoors in comfortable conditions. Distribution results had a much wider distribution in the outdoors situation. While in indoors conditions there were practically no errors (less than 1% of the total), in adverse conditions there were 14% of errors. Group B - the average of the time in adverse conditions was 24% higher than indoors in comfortable conditions. Distribution results had a much wider distribution in the outdoors situation. While in indoors conditions there were practically no errors (less than 1% of the total), in adverse conditions there were 12% of errors. **DISCUSSION** When practicing for an expedition people must consider not only the performances that must be useful during the raid, but also should take in account the conditions that can occur and the difficulties that will result from them. Even a heavy sweat in a walk as short as 15 minutes can have influence in the way people answers to a very easy test, altering the performance. **REFERENCES** Fernando, C., Vicente, A., Lopes, H. & Almada, F. (2010). 15th ECSS, 473-474.

## PREPARING AN EXPEDITION - PERFORMING IN A MUDDY ENVIRONMENT

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**INTRODUCTION** We've studied and presented last year in this Congress how cold and rain could retard decisions, even very simple decisions, and how important it was to know the importance it can have in it's preparation (Fernando et al., 2010). It is important to understand how the performance of the participants will be influenced by mud and how it can change the way they take decisions, by being unpleasant (or pleasant). Mud is present in situations of outdoors collective sports (for instance football), in open spaces sports (like walking raids, etc.) and in environments adaptation sports (as rappelling, etc.). Developing this kind of studies will allow us, in the future, to compared the influences of different sorts of conditions in the practice and in the performance in those types of sports. We will follow a similar methodology in all these studies to keep it easier to compare the results. **METHODS** To a sample of 12 people aging between 15 and 23 years, we've presented on a paper a test of 60 arithmetical operations (additions, subtractions, divisions and multiplications), with numbers equal or inferior to 5, randomly distributed. They should perform these arithmetical operations with two sorts of objectives: 1- first of all to make no mistakes; 2 – to do it as quickly as possible. The sample was divided in two groups of 6 randomly. One group, group A, answered to the test, always the same test, first comfortably sitting at a table, indoors, and then, after playing for five minutes in a muddy pool, in an environment temperature of about 25 degrees C, outdoors. To answer to the test, people came out from the pool and could use towels to clean the hands. The other group, group B, did the same thing but in the reverse order. So, after being in the mud pool and doing the first test, they had half an hour for a hot shower and then answered to the same test in the same comfortable situation indoors. Everybody was using practice suits. We controlled the time of each participant and the total of errors committed by all the members of each group. **RESULTS** Group A - the time average in adverse conditions was 45% higher than indoors in comfortable conditions. Distribution results had a much wider distribution in the outdoors situation. While in indoors conditions there were practically no errors (less than 1% of the total), in adverse conditions there were 17% of errors. Group B - the time average in adverse conditions was 34% higher than indoors in comfortable conditions. Distribution results had a much wider distribution in the outdoors situation. While in indoors conditions there were practically no errors (less than 1% of the total), in adverse conditions there were 25% of errors. **DISCUSSION** We found a similar conclusion to the previous study, however in more profound degree. It is essential to take into account the conditions that can occur and the difficulties that result from them. **REFERENCES** Fernando, C., Vicente, A., Lopes, H. & Almada, F. (2010). 15th ECSS, 168.

## OPTIMIZATION TECHNICAL TRAINING LEVEL JUNIOR TEAMS

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**Introduction** In the game of handball technique is currently the base, which constantly develops and improves the game, being more dynamic factor in raising the level of handball at increasingly high all over the world. There handball teams and players that do not possess the perfect elements and techniques required by the motor structure of the game, absolutely necessary for achieving victory and sporting performance. **Methods** The research was conducted during a competitive year (2009/2010) to a group of junior level II (15-17 years) of a school sports club. At the beginning and end of components research group under study have passed a series of control samples for testing the level of technical skill, the results and differences are interpreted in terms of statistics. Between the two tests was driven by a series of specific exercises to improve technical training. **Results** Samples of control subjects and the results passed the two tests were: the wall passes: initial testing  $23,43 \pm 2,24$ , variability coefficient 9,58%; final test  $27,86 \pm 2,03$ , variability coefficient 7,30%,  $p < 0,05$ ; specific test: initial testing  $47,85 \pm 2,91$ , variability coefficient 6,08%; final test  $42,88 \pm 2,62$ , variability coefficient 6,12%,  $p < 0,05$ ; dribbling 20 m: initial testing  $13,28 \pm 0,98$ , variability coefficient 7,35%; final test  $11,45 \pm 0,93$ , variability coefficient 8,08%,  $p < 0,05$ ; in slalom dribbling: initial testing  $16,01 \pm 0,99$ , variability coefficient 6,17%; final test  $13,96 \pm 0,96$ , variability coefficient 6,6%,  $p < 0,05$ ; small marathon: initial testing  $65,03 \pm 2,26$ , variability coefficient 3,48%; final test  $60,77 \pm 2,22$ , variability coefficient 3,66%,  $p < 0,05$ . Record the differences statistically significant ( $p < 0,05$ ) in all samples between initial testing and final inspection. **Conclusions** Technology is driving that shapes the structure of the game of handball, and the effectiveness is directly proportional to the performance capability of each team (player) in the party. The proposed program for improving the efficiency of technical training was expected from the results in both control samples and the method of the tactical action game. **Reference** Dupont G., Bosquet L., (2007), *Méthodologie de l'entraînement*, Ellipses edition, Paris Mihaila I., Popescu C., (2009), *Handbal indrumar practico-metodic*, Ed. Universitatii din Pitesti Torres Martin c., Iniesta Molina J., A., (2009), *La formacion del educador deportivo en balonmano*, Editorial Deportiva Wanceulen, Sevilla Trosse H., D., (2004), *Balonmano*, Editorial hispano Europea, Barcelona

## PREPARATION OF YOUNG SPORTSMEN TO THE PROFESSIONAL CAREER.

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PREPARATION OF YOUNG SPORTSMEN TO THE PROFESSIONAL CAREER. Likhachev O. 1; Fomin S. 2; Fomin A. 1. 1: Smolensk State Academy of Physical Culture, Sports and Tourism (Smolensk, Russia); 2: Russian State University of Physical Culture, Sports and Tourism (Moscow, Russia). Introduction. Nowadays, at the stage of economic and political changes in Russia, aggressive professionalization and commercialization of sport games is being observed. This is not just national, Russian phenomenon. There are similar tendencies in sport development in other countries. Professional sportsmen admittance to amateur sports last stronghold – participation in Olympic Games – is the basic stimulus of movement in this direction. Methods. The aim of the work is: the search of reserves and conditions which are necessary for successful preparation of qualified young sportsmen for professional basketball. For this purpose we used questionnaires, study of scientific and methodological works, periodicals and documents. 168 basketball players at the age of 17-20 and 57 coaches working with young sportsmen in different teams, which were in the first and top professional leagues of Russia basketball championship took part in questionnaires. Discussion. As a result of questionnaire it turned out that according to trainers they can't succeed in achieving the responsible attitude of young sportsmen to the training without any assistance as they haven't formed the responsible attitude to their sportive career yet. As a result while transforming from junior to adult teams we have big unjustified losses of talented sportsmen who weren't taught to work without any assistance. At the same time there aren't any special interseason training camps in Russia yet. Analogical results were obtained as a result of the questionnaire of young basketball players and the trainers of the student teams (the participants of the student league of Russia). According to them most of the students aren't ready to tough competition for the place in the team. After holidays the sportsmen practically aren't ready for the season, they have extra mass of the body, they practically lost the acquired level of technical and physical form during the last season. Results. The increased level of sport results in world sports, the wide professionalization of basketball and other sport games led to the necessity of specialized training of young sportsmen in the interseason period. At the same time the formation of the motives of the active preparation of young sportsmen without any assistance in the inter-season period acquires the paramount importance.

## APPLICATION OF CIRCULATING WATER CHANNEL FOR MONITORING AND EVALUATING PADDLING SKILL IN ELITE JAPANESE KAYAK ATHLETES

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APPLICATION OF CIRCULATING WATER CHANNEL (CWC) FOR MONITORING AND EVALUATING PADDLING SKILL IN ELITE JAPANESE KAYAK ATHLETES FUNATO, K.1 and MATSUO, A.2 1:Laboratory for Human Movement Sciences, Nippon Sport Science University (Tokyo, Japan) , 2 Japan Institute of Sports Sciences (Tokyo, Japan) Introduction In order to improve athletic performance of kayak paddling, circulating water channel (CWC) has newly constructed in Japan Institute of Sports Sciences (JISS). This study was designed to develop new training methods using CWC with monitoring mechanical variables such as propulsion force and rolling angle as well as comparing the physiological responses. Methods A rowing tank equipped with CWC was newly developed for both research and training of canoeing and rowing. Length, width and depth of the open channel in CWC were 10.0m, 2.5m and 0.6m, respectively. (respective size of the rowing tank were; length: 22.1m, width: 8.1m and height: 5.0m). Functional performance of the CWC were as follows; maximum velocity of the flow: 5.5m/s, uniformity of the flow:  $\sim \pm 5\%$  and maximum wave height:  $\sim 50\text{mm}$ . Bow of kayak boat was attached to the supporting guide system which measures propulsion force ( $F_y$ ) caused by paddling as well as rolling angle of the boat ( $\theta_r$ ). Subjects were national elite canoeing athletes (5males and 2 females, aged from 21-27). They performed interval training in the flow as to maintain the position of the boat at the water velocity of 3.5 to 5.5m/s. During interval paddling trials, simultaneous HR and  $\text{VO}_2$  were measured by K4b2 system (Cosmed, Italy). Results and Discussion Using newly developed system, definite boat propulsion force as well as three different angles (pitch, yaw and roll) were able to obtain and these parameters were useful information for monitoring kayak paddling skill. Relationship between rolling angle ( $\theta_r$ ) and propulsion force  $F_y$  (vertical axis) was obtained for different levels of Japanese kayak paddlers. National elite athletes were superior in  $F_y$  magnitude and  $\theta_r$  balance than these from collegiate athletes. Different instantaneous  $\theta_r$  (horizontal axis) and  $F_y$  (vertical axis) relations were characterized among athletic level, which the highest performer indicated clear eight figured shape in  $\theta_r - F_y$  curve. Conclusions Paddling skill for accelerating the kayak boat more effectively can be evaluated from the relationship between rolling angle and propulsion force. Circulating water channel simulation system for kayak paddling is useful for improving the athletic performance of the athletes.

## THE EFFECT OF DIFFERENT REST INTERVAL LENGTHS ON THE SUSTAINABILITY OF REPETITIONS DURING RESISTANCE TRAINING FOR LOWER LIMB

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Introduction There is a lack of research that investigate the relationship between rest interval length and the sustainability of repetitions when training with loads designed to develop muscular endurance for similar muscle groups. So this study aimed to compare the effect of 3 different rest interval lengths (1-min (RIL1), 2-min (RIL2), or 3-minute (RIL3)) on the sustainability of repetitions (knee extension, leg curl, seated leg press, and squat) over 5 consecutive sets performed with a 15 repetition maximum (RM)- load. Methods Fourteen experienced, resistance-trained males volunteered to participate in the study (age,  $25.6 \pm 4.1$  yr; weight,  $78.8 \pm 7.1$  kg). All subjects were tested weekly over a period of 4 weeks. During the 1st testing session, 15 repetition maximum (RM)- load for 4 lower limb exercises performed in a set manner were determined for each subject. During the next 3 testing sessions, 5 consecutive sets of the exercises were performed to voluntary exhaustion. The 3 testing sessions differed only in the length of rest interval between sets and exercises RIL1, RIL2, or RIL3 with a random order to testing sessions. Results - For all exercises, results demonstrate significantly decline in repetitions completed between the first set and each subsequent set thereafter ( $P=0.000$ ). - Between RIL1 and RIL2 condition a significant differences in the ability to sustain repetitions occurred for leg press and squat ( $P=0.013$ ,  $0.024$ ) respectively. Whereas differences were not significant for leg curl and knee extension ( $P=0.461$ ,  $0.055$ ) respectively. - Between RIL1 and RIL3 condition a significant differences in the ability to sustain repetitions occurred for all exercises ( $P<0.05$ ). - Between RIL2 and RIL3 condition a significant differences in the ability to sustain repetitions occurred for knee extension, leg press, and squat ( $P=0.019$ ,  $0.023$ , and  $0.031$ ) respectively. Whereas differences were not significant for leg curl ( $P=0.297$ ). Discussion This study has shown that the repetitions has decline between the first set and each subsequent set there-

after, irrespective of the rest condition. This result suggest that when training for similar muscle groups (lower limb); the rest interval length must be long enough ( $\geq 3$  minute) to sustain a high number of repetitions over consecutive sets, or decrease the intensity to sustain repetitions. References Fleck S.J., and W.J. Kraemer. Designing Resistance Training Programs. Champaign, IL: Human Kinetics, 1987. Willardson, J.M., and L.N. Burkett. The effect of rest interval length on bench press performance with heavy versus light loads. J. Strength Condi. Res. 20:396–399. 2006.

### THE RELATIONSHIPS BETWEEN PHYSICAL STRENGTH AND ANTHROPOMETRIC FACTOR IN THE PERIOD OF THIRTY YEARS

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Introduction Since 1975 we have executed the test to the new students and second grade students in Hokusei University. The physical strength of students has changed awfully during thirty years. The physical strength of students ought to relate to the rest of life. The purpose of this study is to reveal the way to solve the health problem in students. Methodology We have executed the test as seven items: These items are back strength, grip strength, side step, step test, forward flexion, trunk extension and vertical jump. The body height and weight as anthropometric factors have been measured for comparing the physical strength. The tests and measurement have executed at every April of the new school year. Results The body height in Japanese students has increased and reached plateau at 1995. On the other hand some items that are muscle strength and endurance capacity have decreased after the body height has reached the plateau. The flexibility also has decreased continuously. The muscle strength has reduced in particular. Discussion The health and ability of current students ought to strongly relate to the rest of their life. Therefore, the reduction of the physical strength in young adult is the main subject that has to be solved by the physical education. The reduction of muscle strength could be solved by physical education program in particular. It is important to increase the chance of physical activity in Japanese young adults.

### ESTIMATION AND VALIDITY VERIFICATION OF 1-RM ON BENCH PRESS, BACK SQUAT, LEG CURL AND LEG EXTENSION FROM 7-10RM, BASIC FITNESS AND ANTHROPOMETRIC VARIABLES FOR KOREAN ADULT MALE

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Introduction 1-RM is most useful item for strength training, so many equation for 1-RM were reported. Estimation of 1-RM were vary according to training level, age, anthropometric variables, and human race, etc. The purpose of this study were to develop and verify 1-RM prediction equation of leg curl and leg extension from anthropometric variables and 7-10RM. Methods Trained adult males of development group and verification group were measured 1-RM, anthropometric variables, and 7-10 RM(Barchle et al., 2000). This study was summarized and modified Lee et al.(2009), and Lee(2006). Results, Discussion As a results of regression analysis, The equation of bench press was  $y = -1245.954 + 1.092 * \text{right grip strength} + 0.331 * \text{standing long jump} + 2.858 * \text{circumference of upper arm}$  ( $p < .01$ ). The equation of back squat was  $y = -166.046 + 6.289 * \text{circumference of upper arm} + 0.410 * \text{standing long jump} - 0.340 * \text{circumference of chest}$  ( $p < .01$ ). The 7-10RM equation of LC was  $y = 29.946 + 0.821 * 7\text{-}10\text{RM}(\text{kg})$  ( $p < .01$ ), the equation of anthropometric variables was  $y = -48.838 + 2.428 * \text{thigh girth}(\text{cm})$  ( $p < .01$ ). The 7-10RM equation of LE was  $y = 4.275 + 1.255 * 7\text{-}10\text{RM}(\text{kg})$  ( $p < .01$ ), the equation of anthropometric variables was  $y = -4.411 * \text{weight}(\text{kg})$  ( $p < .05$ ). As a results of verification, there were no significant difference between measured 1-RM and predicted 1-RM for bench press and back squat. The equation of bench press and back squat were a little overestimate 1-RM. Both LC and LE, there were no significant difference, and high correlation between measured 1-RM and estimated 1-RM from 7-10 RM. The equation of 7-10 RM equation has a good validity, but the equation of anthropometric variables has a limitation to apply. Conclusion It was concluded that the satisfied 1-RM equation of bench press and back squat were made by anthropometric and basic fitness variables only for trained adult males. And both LC and LE, the satisfied 1-RM equation were made from submaximal strength(7-10 RM), except anthropometric variables. for trained Korean adult males. References Barchle TR, Earle RW (2000). Essentials of strength training and conditioning. 2nd Ed., Champaign, IL. Human Kinetics. Lee BK, Lee DK (2009). Estimation of 1-RM on Leg Extension and Leg Curl from Submaximal Strength and Anthropometric Variables for Adult Male, Kinesiology, 11(3), 21-30. Lee BK (2006). Development and verification 1-RM prediction equation of bench press, back squat and dead lift by anthropometric and basic fitness variables for adult males, Korea Sports Research, 17(6), 275-285.

### THE BODY- MIND IMPACT OF SINGLE 30-MINUTE DUNKING FEET, NECK, SHOULDER AND FEET MASSAGE

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Introduction In Traditional Chinese Medicine (TCM), meridian point massage is a popular form of therapy island wide in Taiwan. The aim of this study was to investigate the emotional, physical, and mental impact of 30 minutes of feet dunking, neck and shoulder as well as foot massage. Methods Fourteen subjects participated in this study, in the relative humidity 36-37%, at room temperature 26 °C, after the dunking feet and neck massage for 10 minutes, with twenty minutes of feet massage. The impacts evaluated by using Positive and Negative Affect Scales (PANAS), Profile of Mood State Scale (POMS) and Foot Massage-Induced Feeling Inventory (FMFI). All of the data were showed with Mean  $\pm$  SD, and analyzed with Windows Excel 2007 software package for Paired t-test and the significance level was .05. Results The negative affect domain of PANAS has a significant difference before and after massage from score of  $15.6 \pm 6.8$  decreasing to  $11.7 \pm 2.5$ . There were no significant differences before and after massage treatment, except the dimension scores of self-respect and vitality, the other dimensions showed significant difference in fatigue, nervousness, confusion, anger and depression of POMS. It increased the scores of activity recovery domain and decreased the scores of physical exhaustion of FMFI. Discussion Based on the results shown above, the neck, shoulder and feet massage has a significant impact for personal body-mind reflection due to evaluated by the scientific survey scoring. Owing to the negative affect score decreasing in PANAS, and reducing score of fatigue, nervous, confusion, anger and depression in POMS, and increasing the scores of activity recovery domain and decreasing scores in the physical exhaustion of FMFI, the conclusions of this study are that dunking feet, neck, shoulder and feet massage is conducive to reducing physical fatigue and exhaustion effects, but within a short period (30 minutes) can't immediately affect the positive emotional state. Future research is obviously required, but this is an exciting first step. We are hopeful that future research will provide more detailed results which may differentiate views from on another. Such as, subjects participated in this study by 30 minutes a day, lasting for 3 months. Then we can

inspect the impacts between initial and three months later. References Cheng J C M, Ting W C, Chang K M. (2011). Program of ICHPER.SD Asia Congress 2011, 128, Taipei, Taiwan.

## Poster presentations

### PP-BN10 Biomechanics: Balance and Coordination

#### RELIABILITY OF STATIC AND DYNAMIC BALANCE TESTS IN HEALTHY YOUNG ADULTS WITH A NEW METHOD OF ANALYSIS

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The assessment of balance is rather complex, since balance depends of the integration and coordination of many function. At present, most of the test proposed to assess static and dynamic balance show low reliability due to very high individual variation. Thus, new procedures and method of analysis should be developed to assess balance more reliably. Therefore the aim of this study was to design a new balance test-battery to assessed static and dynamic balance with high reliability. Methods. Twenty-three physical education students (mean  $\pm$  SD) age:  $23 \pm 3$  years, body mass:  $69 \pm 8$  kg were tested in two different days, two-week apart. Each testing day the subjects performed to trials of six different test consisting on: 1) One-leg standing on the jumping leg (JL; main propelling leg when jumping) with eyes open; 2) One-leg standing with the contralateral leg and eyes open; 3) One-leg standing on JL with eyes closed; 4) One-leg standing with the contralateral leg and eyes closed; 5) One-leg standing on jumping leg while executing a precision task with the dominant arm extended, consisting on taping on numbers marked on table 1 meter away in front of the subject in a standardized order; and 6) the same protocol of test 5, but standing on the contralateral leg. Each trial lasted 30 seconds and was performed on a Force Platform Kistler. Each day the same test was repeated twice, separated by a 30 min rest period. The mean and the best of the two trial performed each day was taken as representative for further analysis. Measurements. The reliability of each test was assessed calculating the ICC between the mean of testing day 1 and the mean of testing day 2 for the "Mean result" analysis. The best of testing day 1 and the best of testing day 2 were selected for the "Best result" analysis. The following variables were calculated: a) root-mean-square (RMS) medio-lateral (ML) velocity of the CP; b) root-mean-square (RMS) antero-posterior (AP) velocity of the CP; c) Mean CP speed; d) Sway Area; e) Mean Peaks; f) mean distance; g) Mean frequency ML; h) 95% Power frequency ML; i) Mean frequency AP; j) 95% Power frequency AP. Results. The ICCs for inter-item reliability of the CP-SPEED showed fair to excellent reliability for "Mean result" analysis (ICCs between 0.66 and 0.95) and excellent for "Best result" analysis (ICCs between 0.87 and 0.97). Only in test number 4, the reproducibility of the CP-SPEED was low. The rest of the parameters showed good to excellent reliability. Differences between methods of analysis were found, where the "Best result" analysis was the optimal method to assess the balance. Jumping and contralateral legs were similar. However, we found one leg with better balance ( $p < 0.05$ ). Conclusions. This study shows that static and dynamic balance can be assessed reliably in young healthy adults using very simple tests performed on a force platform. The analyses performed with the "Best result" method are more reliable than those performed with the "Mean result" method. The tests performed with the eyes open are more reliable than with eyes closed..

#### AGE-RELATED CONTRIBUTIONS OF ANKLE MUSCULAR COORDINATION TO POSTURAL EQUILIBRIUM

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Introduction Ankle joint muscles generally commence contracting first to restore the equilibrium when sway perturbations were applied during upright stance (Horak and Nashner, 1986). Aging reduces the ability to control the posture (Woolacott et al., 1986) and increases the instability elevating fall incidence. Therefore, this study examined two aspects of postural control: relationships to control ability of the ankle joint, and to age. Methods Eight older adults (Egroup,  $71.1 \pm 5.1$  yr), seven young adults (Ygroup,  $21.9 \pm 0.3$  yr) and eight boys (Bgroup,  $11.2 \pm 1.5$  yr) volunteered in this study. They performed two different motor tasks after maximum plantar flexion (MPF): attempts to track and maintain target positions (P task), and attempts to track and maintain target force (F task) for fifty seconds. They were requested to do the tasks as quickly and precisely as possible. The target values were displayed on a monitor and changed every five seconds. Differences between the target values and actual values exerted by the subjects (T-A difference) were calculated to evaluate the control ability. After the tasks, the subjects maintained upright stance as still as possible on a force plate for sixty seconds. Path length (PL), rectangular area, RMS area and environmental area were calculated from distance traveled by the center of pressure. EMG activities were recorded from soleus, gastrocnemius lateralis and medialis, and tibialis anterior muscles. Results Egroup showed larger T-A difference than the other groups in both plantar- and dorsi-flexion in P task. Bgroup showed larger T-A differences in F task. Ygroup showed the largest MPF force and the smallest postural sway. Close relationships were observed between T-A difference and MPF force, and between time when reached the target value (TRT) and PL per second in Egroup. Ygroup showed close relationships between T-A difference and RMS area. The shorter TRT in P task, the smaller T-A difference was in Bgroup. Subjects who showed large T-A difference tended to show co-activation of synergist and antagonist muscles and unclear EMG activity patterns. Discussion Older adults were difficult to control the position quickly and precisely, which influenced the postural equilibrium. This characteristic depended on the muscle strength are consistent with earlier reports of declines in muscle strength (Reimers et al., 1998) and sensory capabilities (Thelen et al., 1998). On the other hand, children secured the postural stability by quick control of the position. References Horak FB, Nashner LM. (1986). J Neurophysiol, 55(6), 1369-1381. Woolacott MH, et al. (1986). Int J Aging Hum Dev, 23(2), 97-114. Reimers CD, et al. (1998). J Neurol Sci, 159(1), 60-66. Thelen DG, et al. (1998). J Gerontol A Biol Sci Med Sci, 53(1), 33-38.

#### DYNAMIC BALANCE CONTROL OF THE BASEBALL PITCHER'S TRAIL LEG AND STRIDE LEG

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Introduction The trail leg and stride leg perform single-leg standing to support the body weight respectively while pitching. To the overall dynamic balance control in baseball pitching, the relative contributions of each leg are different during individual pitching phases. However, the difference between each leg in dynamic balance control is still unknown. Therefore, the aim of this study was to compare the dynamic balance performance between trail leg and stride leg in pitchers. Methods Seventeen college baseball pitchers (age =  $19.9 \pm 1.4$

years, height =  $178.2 \pm 6.6$  cm, weight =  $77.4 \pm 10$  kg) participated in this study. The star excursion balance test (SEBT) and Biodex balance system (BBS) was used to evaluate the dynamic balance. All participants' excursion distances in anterior (ANT), posteromedial (PM), and posterolateral (PL) directions were measured and normalized to leg length in SEBT. The BBS test mode was set to athletic single leg stability (level six) and the anterior-posterior stability index (APSI), medial-lateral stability index (MLSI), and overall stability index (OSI) were collected during the measurement. The paired t-test was used to compare the MLSI, APSI and OSI and the normalized reach distances in ANT, PM, and PL directions between stride legs and trail legs. Results The significant difference between stride leg and trail leg was found in OSI ( $p < 0.05$ ) and the normalized reach distance in PL direction ( $p < 0.05$ ). The results showed the dynamic balance control of the trail leg is significant better than the stride leg. Discussion The OSI is a composition index of the APSI and MLSI and the reliability of OSI measures is higher than the reliability of both the MLSI and APSI measures (Arnold & Schmitz, 1998., Cachepe et al., 2001). Since the normalized reach distance in PL direction showed significant difference between trail leg and stride leg, it is possible that differences from other directions other than AP and ML axes were ignored in the BBS measurement. It is concluded that the overall dynamic balance performance of the trail leg is better than the stride leg in baseball pitchers and there differences between each leg in PL direction. References Arnold, B. L., Schmitz, R. J. (1998). Examination of balance measures produced by the biodex stability system, *Journal of Athletic Training*, 33:323-327 Cachepe, W. J. C., Shifflet, B., Kahanov, L., & Wughalter, E. H. (2001). Reliability of the biodex balance system measure. *Measurement in Physical Education and Exercise Science*, 5:97-108

## DIFFERENCES IN MUSCULAR IMBALANCE RATIO CALCULATIONS USING FUNCTIONAL TEST DATA.

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**Introduction** Muscular imbalance assessment (MI) is important in identifying increased injury likelihood as well as performance deficit (Impellizzeri et al, 2007). However, use of left /right or strong/weak legs, as well as the reference value used for ratio calculations, can affect the MI value obtained. These different values may mask any MI differences (Zifchock et al, 2008), rendering the tests insensitive to detecting performance changes. Currently, limited comparisons exist between the various calculation methods, while a new calculation method has been proposed (Zifchock et al, 2008). Therefore, our aim was to compare the MI calculations obtained from two functional tests. **Methods** Twenty healthy, physically active young adults (females:  $n=6$ , height  $1.62 \pm 0.03$  m, body mass  $67.8 \pm 5.8$  kg; males:  $n=14$ , height  $1.79 \pm 0.07$  m, body mass  $80.2 \pm 13.3$  kg) performed two trials of the 6m timed and triple jump alternate hops (Reid et al., 2007). The best performance was used for analysis. MI ratios were calculated as (side 1-side 2)/reference value\*100, where reference value was left or right leg or average of the two when calculating left/right ratio, as well as strong or weak leg or average of the two when calculating strong/weak comparison. The symmetry angle (SA, Zifchock et al, 2008) was also calculated for both side combinations. A repeated measures MANOVA was utilised with significance level set at  $p < 0.05$ . **Results** Results indicated no significant effect of test, or interaction between test and side combination ( $p > 0.05$ ). However, significant interactions were found between test-MI ratio ( $p = .001$ ), side combination-MI ratio ( $p = .002$ ) and test-side combination-MI ratio ( $p = .002$ ). Significant effects were found for side combination ( $p = .001$ ) with strong/weak overestimating by 3%, and MI ratio calculation ( $p = .001$ ), with the SA overestimating MI by 9.3% for strong/weak comparisons for both tests and 5.6% and 5.9% for left/right comparisons for 6m and alternate hop, respectively. **Discussion** Our findings indicate that test selection does not affect MI ratio calculations but side combination does. Ratios calculations affected MI values, with the SA significantly overestimating MI ratio compared to all other ratio calculations. In particular, the difference in strong/weak comparisons by the SA could lead to different conclusions on the MI status of an individual. Future studies should examine relationships of ratios to sporting performance as an indicator of the more appropriate MI ratio calculation to be used. **References** Impellizzeri FM, Rampinini E, Maffiuletti N, Marcora SM. (2007) *Med Sci Sports Exerc*, 39, 2044-2050. Reid A, Birmingham TB, Stratford PW, Alcock GK, Giffin JR. (2007) *Phys Ther*, 87, 337-349. Zifchock RA, Davis I, Higginson, J, Royer, T. (2008). *Gait & Posture*, 27, 622-627.

## THE EFFECTS OF UNILATERAL STRENGTH TRAINING ON CONTRALATERAL BALANCE PERFORMANCE

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**Introduction** Unilateral strength training primarily has ipsilateral effects, whereas its secondary effects are termed as contralateral strength training effects. Studies have shown positive dependence between the lower limb strength and balance in elderly people (Pijnappels i sur., 2008). It is well known that combining strength and balance training has positive effects on balance in young adults (Thorpe and Ebersole, 2008). **Methods** Physically active young women participated in a 4-week progressive isokinetic training. The participants were separated into two groups: trained (15) and not trained group (15). The trained group carried out the con-con ankle and knee joint training on the isokinetic device known as Biodex System 3 at a relatively high speed (ankle-60, knee-180). The single leg balance of both trained and non-trained leg was tested on the Biodex Balance System. Statistical significance of the difference between the initial and final measuring values was assessed by using the two-way repeated measure ANOVA. **Results** The results have shown that the difference between the initial and final measures of the single-leg balance of a trained ( $F_{1,28} = 8.43$ ;  $p = 0.007$ ;  $\eta = 0.231$ ) and non-trained ( $F_{1,28} = 9.25$ ;  $p = 0.005$ ;  $\eta = 0.248$ ) leg in the EXP and CON group is statistically significant. In the experimental group the single-leg balance of the trained (non-dominant) leg was improved by 25.04%, whereas the non-trained (dominant) leg improved its balance by 18.8%. The control group did not demonstrate any change in balance performance. **Discussion** Given the fact that leg extensors and flexors have to be able to produce force very quickly (Izquierdo i sur., 1999) as to preserve and establish balance, it has been assumed that the strength training at relatively fast contraction rate would significantly affect the balance improvement. This research confirmed the above said. Unilateral isokinetic concentric-concentric strength training of extensors and flexors of the lower leg and foot in physically active women does not only result in ipsilateral, but also in contralateral change in balance. These findings open up many possibilities for application of the unilateral strength training not only in sport, but also in different rehabilitation processes. **References** Izquierdo M, Aguado X, Gonzalez R, López JL, Häkkinen K. (1999). *Eur J Appl Physiol Occup Physiol*. Feb;79(3), 260-267. Pijnappels Mirjam, Reeves Neil D, Maganaris Constantinos N, van Dieën Jaap H. (2008). *J Electromyogr Kinesiol*, 18(2), 188-96. Thorpe, J.L. & Ebersole, K. (2008). *J Strength Cond Res*, 22(5), 1429-1433.

## THE EFFECTS OF PILATES TRAINING ON POSTURAL STABILITY AND JUMP PERFORMANCE IN YOUNG DANCER

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**Introduction** Dance is not only a performing art, but a highly rigorous athletic sport that is one of the most physically and mentally demanding athletic sports in the world (Shah, 2008). For excellent performance, it requires a high level of fine motor control, flexibility, and core stability in dancing. Pilates is a kind of body conditioning exercise which can build joint flexibility, strengthen muscles coordination, and improve movement control. The purpose of this study was to evaluate the effects of Pilates training on postural stability (PS) and jump performance (JP) in young dancers (YD). **Methods** Twenty-six YD were enrolled and obtained permission from their parents as participants, equally and randomly assigned as training group (TG, age: 11±1 yrs, height: 148±5 cm, weight: 38±6 kg) and control group (CG, age: 11±1 yrs, height: 146±6 cm, weight: 36±7 kg). Only the TG received extra 12 weeks of Pilates Mat exercise, 3 times a week, for 40 minutes. The PS was evaluated as Limits of Stability (LOS) by Biodex Balance System. The JP was evaluated by the maximum vertical jump height during the countermovement jump (CMJ) on force plate. Single-factor ANCOVA was used to analyze the differences between groups after training. **Results** 12 weeks Pilates training significantly improved the total (+26%), left (+34%), left-front (+37%), and left-back (+34%) directions LOS and the maximum height of CMJ (+7%) in TG than CG. **Discussion** The main goals of Pilates training are efficient movement, core stability and enhanced performance (Akuthota & Nadler, 2004). With regard to the results of this study, Pilates training were found to be an efficient training method with significant improvements in PS and JP in YD. Previous studies demonstrated that regular Pilates training increase transversus abdominal muscle coordination, which helps maintain better lumbo-pelvic control (Herrington & Davies, 2005), improve the stability of the upper body segments and the coordination of lower extremity limb during running (Lugolarcheveque et al, 2006). A recent study also showed that both transverses abdominis and obliquus internus muscles activity were significantly increase in order to help stabilize or protect the spine (Endleman & Critchley, 2008). In dancers, intact muscular coordination and well-balanced antagonists could be decisive factors for excellent performance and in protection against injury because dancers often have jump and their ankle joints often bear full body weight in an extreme position. It is concluded that regular Pilates training can improve the dynamic PS and JP in YD with the strengthened core strength and improved postural neuromuscular coordination. **References** Akuthota V, Nadler SF (2004). Arch Phys Med Rehab, 85(3S1), S86-S92. Herrington L, Davies R (2005). J Bodywork Movement Ther, 9, 52-57. Lugolarcheveque N, Pescatello LS, Dugdale TW, Veltri DM, Roberts WO (2006). Curr Sport Med Rep, 5(3), 137-140. Shah S (2008). Curr Sport Med Rep, 7(3), 128-132. Endleman I, Critchley DJ (2008). Arch Phys Med Rehab, 89, 2205-12.

## COMPARISON OF EFFECTS OF SHORT-TERM HOPPING AND BALANCE TRAINING ON MUSCLE POWER AND FUNCTIONAL FITNESS IN THE ELDERLY: SINGLE-BLIND RANDOMIZED CONTROLLED TRIAL

NAKATANI, T., TERADA, K., SHIRAIISHI, A., NADAMOTO, M., HAYASHI, T.

DEPT. HEALTH AND HUMAN PERFORMANCE

**Introduction** With increasing age, older adults may experience loss of strength and power, which may lead to functional impairments and frailty (Porter et al., 1995; Caserotti et al., 2008). Strength and power training are considered promising interventions for reversing loss of muscle function. The purpose of this study was to compare the effects of short-term hopping and balance training on lower extremity muscle power and functional fitness in the elderly. **Methods** Twenty-six community-dwelling elderly individuals (4 men and 22 women; age range, 63–83 years) were randomly assigned to either the hopping training (HT, n = 13) or balance training (BT, n = 13) groups. Training programs consisted of a 60-min supervised group exercise session held once every 2 weeks at a local welfare center and additional home exercises. The training lasted for 10 weeks. The HT group performed 2–3 sets of normal two-legged hopping at their preferred frequency until they reached the Borg rate of perceived exertion scale of 16 (hard). The BT group performed balance exercise on a foam stability pad or a narrow beam. Outcome measures included peak power output (PP), vertical jump (VJ), rate of force development (RFD) in sit-to-stand (STS), reaction time (RT), timed up and go (TUG), and postural stability. **Results** After the training session, the HT group demonstrated significant increases in the values of PP and RFD in STS (5.3%, 8.7%, respectively;  $P < 0.05$ ) and a decrease in the length of the sway path in a particular unit of time (–16.4%,  $P < 0.05$ ); however, no differences were observed in VJ, RT, and TUG. Furthermore, the BT group demonstrated significant changes in PP (5.1%,  $P < 0.05$ ) and TUG (–8.7%,  $P < 0.01$ ), but no differences in VJ, RT, RFD in STS, and postural stability were observed. The percentage changes in values of RFD in STS and TUG differed significantly between the two groups. **Conclusion** Our results suggested that short-term two-legged hopping training was more effective than balance training in improving lower extremity muscle power and postural stability in the elderly. It appears that hopping training may be recommended as a technique to reduce fall risks, but future studies should examine the safety of the method for the elderly. **Acknowledgment** This study was supported in part by a grant from Tenri University Grants-in-Aid for activities on Academic, Research, and Education. **References** Porter M M, Vandervoort A A, Laxell J (1995) Scand J Med Sci Sports, 5(3), 129-142. Caserotti P, Aagaard P, Puggaard L (2008) Eur J Appl Physiol, 103(2), 151-161.

## STUDYING STATIC BALANCE IN ELDERLY WOMEN AFTER AQUATIC EXERCISE

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**Introduction** Falls causing fatal and nonfatal injuries in the elderly population are well recognized health and socioeconomic problems. One of the main factors in falls, happens with ageing, is the decline of balance ability; it is markedly lower in those who are 60 years old or older. A rapid step is the most important protective strategy, acting to recover balance and prevent a fall from initiating. As the elderly are less fearful of movement in water, exercise in aquatic environment is appropriate for them (Kaneda et al., 2008; Ruoti et al., 1997). **Methods** Thirty healthy elderly women were assigned equally to either experimental (63.6± 2.8 years old) or control group (64.8± 2.6 years old). Total Path Length (TPL) and Area of Center of Pressure (CoP) were evaluated, before and after doing exercise in water, while standing on force distribution using the Zebris FDM measuring system. The experimental group underwent balance program applied for 8 weeks, with three sessions per week, each session lasting 60 minutes. Paired t-test and independent t-test were used respectively to analyze the data within and between groups. **Results** The result of this study indicated that; aquatic exercise promoted significant increases in the elderly women's static balance, as assessed using TPL and Area of CoP with both opened and closed eyes ( $p < 0.05$ ), while, no significant difference was observed in control group ( $P \geq 0.05$ ). Also there were significant differences between control and experimental groups ( $P \leq 0.05$ ). These results show us the aquatic exercise program increases static balance. **Discussion** According to the



results, static balance increased significantly after the aquatic exercise program. This was similar to the results obtained by many other authors (Hara et al., 2007; Lord et al., 1993). These results possibly occurred because fear of falling is less in water, making the elderly willing to experience greater movement variability and errors, furthermore activity in water may facilitate vestibular inputs (Ruoti et al., 1997). References HARA, T., YOSHIKAWA, T., NAKAO, H., WANG, L., SUZUKI, T. & FUJIMOTO, S. (2007) The effects of aqua exercise on balance function in middle-aged women. *Jpn J Phys. Fitness Sports Med* 56, 357-364. KANEDA, K., SATO, D., WAKABAYASHI, H., HANAI, A. & NOMURA, T. (2008) A comparison of the effects of different water exercise programs on balance ability in elderly people. *Aging and physical activity*, 16, 381-392. LORD, S., MITCHELL, D. & WILLIAMS, P. (1993) Effect of water exercise on balance and related factors in older people. *Australian Journal of Physiotherapy*, 39, 217-222. RUOTI, R. J., MORRIS, D. M. & COLE, A. J. (1997) *Aquatic Rehabilitation*, Philadelphia, Pa, Lippincott.

## THE EFFECT OF HIP ABDUCTOR FATIGUE ON LOWER LIMB COORDINATION DURING A CUTTING MANEUVER

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**Introduction** The purpose of this study was to assess how sub-maximal fatiguing exercise of the hip abductors affects lower limb coordination. Anterior cruciate ligament of the knee (ACL) injuries are serious and have a significant rate of occurrence in athletes. Nowadays, research has focused on the role of the hip abductors in preventing ACL injuries (Geiser et al., 2010). Previous studies have found that shift to hip abduction and knee abduction during a single leg squat because of their weak hip abductors (Zeller et al., 2003), which is associated with ACL injury. However, the coordination between hip and knee joint has not yet been evaluated under the fatiguing condition. **Methods** Eleven female athletes were investigated. Participants performed six cutting maneuvers at a 90° angle from a 40 cm-high box before and after the fatigue protocol which is repeated hip abduction. The isokinetic dynamometer was used as the fatigue protocol (Jacobs et al., 2007). The speed of the isokinetic resistance was set at 60°/s during concentric hip abduction and at 180°/s during adduction phase. This task was continued until exhausted (Mean repetition 112.2 ± 40.4 reps). Using the surface EMG, the power spectrum in median frequencies of Gluteus medius (Gmed) were obtained during 120 ms from 40 ms before the initial contact. To capture the motion, a ten-camera motion analysis system was used. Coordination graph of hip and knee angle were obtained as same period as the power spectrum data in the frontal and horizontal plane. Results Gmed median frequency was significantly decreased after the fatigue protocol ( $p < 0.01$ ). Hip-Knee coordination graphs showed no significant difference in variability of six trials between pre and post fatigue conditions in both the frontal and horizontal planes. In the horizontal plane, all participants showed increases in internal rotation at the knee joint and external rotation at the hip joint. **Discussion** Despite hip abductor fatigue, it was observed that there is no significant difference in variability of hip and knee coordination within the group. However qualitative Hip-Knee plots showed two characteristic coordination patterns in the horizontal plane between some participants. Most participants showed an increase in external rotation post-fatigue but maintain a similar coordination pattern. On the other hand, some participants showed a gradual change from hip internal rotation to hip external rotation. Kinematic data showed that lower limb alignment did not approach the "point of no return" (Quatman et al., 2010) which was knee-in and toe-out. This may be due to participants adopting a landing strategy that minimizes the likelihood of this point being reached. References Geiser F, O'Connor M, Earl E. (2010) *Med Sci Sports Exerc*, 42(3), 535-545 Zeller L, McCrory L, Kibler B, Uhl L. (2003) *Am J Sports Med*, 31(3), 449-456 Jacobs A, Uhl L, Mattacola G, Shapiro R, Rayens S. (2007) *J Athl Train*, 42(1), 76-83 Quatman C, Quatman-Yates C, Hewett T. (2010) *Sports Med*, 40 (9), 729-746

## STUDY ON BODY BALANCE IN HYPERTENSIVE PATIENTS

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**Introduction** This upright position is called the orthostatic or erect position. Consequently, even an everyday behavior such as maintaining an erect position is an intricate task which involves a complex association of sensorial information and motor activity (BANKOFF, 2007). Bankoff (2006) reports an association between balance and postural positions, with postural balance being modified within milliseconds. The association of antihypertensive drugs which are indicated for patients with arterial hypertension is a consummate fact. These drugs are prescribed for ingestion immediately after breakfast. Among the most commonly prescribed drugs are: Hydrochlorothiazide 50mg, Furosemide 40 mg, Methyldopa 250mg, Nifedipine 20mg, Propranolol 40 mg, and Captopril 25 mg. **Methods** The study was performed on three groups of male subjects, namely: group 01 = 15 hypertensive subjects who take antihypertensive medication; group 02 = 09 hypertensive subjects who do not take such medication; and group 03 = 12 non-hypertensive patients. Mean age was 42.7 years. **Instrument Used** The tests were conducted using an Electronic Baropodometer comprised of a modular platform by Physical Support Italy. This device is comprised of platinum electronic sensors covered with an alveolar captor that recognizes plantar support information while preserving natural mobility. Image acquisition is accurate, instantaneous, reproducible and non-invasive. Results The results presented herein show higher values for hypertensive patients who take antihypertensive drugs (group 01) and for non-medicated hypertensive subjects (group 02). The subjects with normal blood pressure (group 03) swayed much less than the other two groups, irrespective of which variable was analyzed (bipedalic or monopodalic posture, eyes open or closed). Thus, it was shown quite clearly that arterial blood pressure and antihypertensive drugs have an influence on body balance in static postures. **Discussion** When a person is standing upright, the body sways forward and backward (Y axis) and side to side (X axis). The neuromuscular activity that prevents the person from losing balance and falling is the body's automatic posture control. As the individual sways along the X and Y axes, his or her visual, somatosensory and vestibular receptors detect those variations and generate compensatory responses in the adequate muscles (Dietz, 1992). References BANKOFF, A.D.P. et al. Análise do equilíbrio corporal estático através de um baropodômetro eletrônico. *Revista Conexões*, v. 4, n. 2, 2006. BANKOFF, A.D.P.; BEKEDORF, R. Bases neurofisiológicas do equilíbrio corporal. Buenos Aires: Revista Edeportes, Año 11, n. 106, mar/2007. DIETZ, V. Human neuronal control e automatic functional movement: Interaction between central programs and afferent input. *Physiological Reviews*, 72, 33-69. HORAK, F.B., SHUPERT, C.L.; MIRKA, A. Components of postural dyscontrol in the elderly: A review. *Neurobiology of Aging*, 10, 727-738. Financial Support - CAPES Proceeding N° 1788-09-4

## Poster presentations

### PP-BN11 Biomechanics: Lower Limb/Foot

#### LOWER LIMB MUSCLES COCONTRACTION DURING PERTURBATIONS ON AN UNEAVEN SURFACE

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**Introduction** The neuromuscular system must respond with strategies to re-establish the balance or to prevent the loss of stability. One of these strategies is to improve the antagonist cocontraction, which causes a higher joint stiffness. In this context, the objective of this study was to analyze the cocontraction of Rectus Femoris/Biceps Femoris (RF/BF) and the cocontraction of Tibialis Anterior/Gastrocnemius Lateralis (TA/GL) during perturbations to four directions: anterior, posterior, right and left sides. **Methods** Thirteen healthy women, mean age  $21.31 \pm 2.39$  years, height  $1.67 \pm 0.06$ m, and weight  $63.58 \pm 11.84$ Kg, recruited from a university setting participated in this study. The subjects were positioned above a balance board and a mechanism was created to induce perturbations. Each situation was repeated three times. The electromyographic activity from the RF, BF, TA and GL was recorded on the right lower limb of the subject. Then the cocontractions of RF/BF and TA/GL were calculated using the method of common area (Winter, 2005; Candotti et. al, 2009). The cocontraction was analyzed after the perturbation, in a window of 200ms. After that, the means of the cocontraction in the three attempts were compared using the two-way ANOVA test. The significant level was set at  $p < 0.05$ . **Results** The mean values ( $\pm$ SD) of the cocontraction to RF/BF and TA/GL during the four direction perturbations were, respectively:  $84.59 (\pm 7.01)$ ,  $33.97 (\pm 16.21)$  to anterior;  $84.85 (\pm 4.73)$ ,  $73.19 (\pm 11.29)$  to posterior;  $83.45 (\pm 5.92)$ ,  $67.34 (\pm 7.08)$  to right; and  $87.99 (\pm 5.77)$ ,  $86.59 (\pm 5.77)$  to left. These results show that the RF/BF cocontraction is higher than the TA/GL cocontraction ( $p = 0.01$ ), regardless the direction of the perturbation. **Discussion** This higher cocontraction of the RF/BF suggests that the perturbation caused a great displacement of the center of mass. Therefore, the compensatory cocontraction TA/GL was not sufficient to re-establish the balance. However, the increase of muscular co-contraction enhances joint stiffness, which could decrease the effectiveness of this response to fast perturbations like a tripping (Ishida et al., 2008). **References** Ishida A, Masuda T, Inaoka H, Fukuoka Y. Stability of the human upright stance depending on the frequency of external disturbances. *Med. Biol. Eng. Comput.* 2008, 46(3):213-221. Winter DA. *Biomechanics and motor control of human movement*. New Jersey: John Wiley & Sons, Inc., Hoboken; 2005 Candotti CT, Loss JF, Bagatini D, Soares DP, da Rocha EK, de Oliveira AR, Guimarães ACS. Cocontraction and economy of triathletes and cyclists at different cadences during cycling motion. *J. Electromyogr. Kinesiol.* 2009, 19(5):915-921.

#### HIGHER INCIDENCE OF FATIGUE-INDUCED ASYMMETRICAL BETWEEN-LIMB STRATEGIES IN CHRONIC ANKLE INSTABILITY : A SINGLE-SUBJECT ANALYSIS

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**Higher incidence of fatigue-induced asymmetrical between-limb strategies in Chronic Ankle Instability (CAI): A Single-Subject Analysis** McGrath, D.I, Patterson, M.I, Caulfield, B.I 1:UCD (Ireland) **Introduction** The effect of a functional fatigue protocol (FFP) on the magnitude of end-point variability in spatio-temporal parameters during running was examined in both limbs of a group with unilateral CAI and a control group. It was hypothesised that the injured limb would demonstrate a stereotypical increase in variability due to fatigue. This was not borne out in group analyses however, where no effect for side (injured/uninjured) was observed in any parameter. A single-study analysis was then carried out to investigate the various strategies employed by each subject. **Methods** The magnitude of variability (measured by standard deviation (SD)) of stride time, stance time, swing time and stride length during running was calculated in two groups (CAI,  $n=15$ , control,  $n=17$ ) over 10 strides at the beginning of a FFP and at the end of the FFP in both limbs. Individual graphs were plotted and visually examined for all subjects where the SD was plotted at both time points, for both limbs. **Results** A number of strategies were observed: increased variability in both limbs, decreased variability in both limbs, or unchanged variability in both limbs. These were termed symmetrical strategies. Asymmetrical strategies were defined as increased levels of variability due to fatigue in one limb, while variability decreased in the other limb, or vice versa, or unchanged levels of variability in one limb while the other limb either decreased or increased. The results showed that for all spatio-temporal parameters, the CAI group exhibited more asymmetrical variability strategies (irrespective of the direction of differences) than the control group. **Discussion** The injured limb of the CAI group did not exhibit a consistent increase or decrease in levels of variability due to fatigue. It is possible that the higher incidence of heterogeneous variability behaviours observed between limbs in the CAI group is suggestive of centrally mediated control mechanisms in operation in CAI. The "uncontrolled manifold" hypothesis proposed by Scholz and Schoner (1999) states that elements involved in the performance of a task are restricted to a particular range of operation such that the desired task is successfully achieved. Provided elements stay within the restricted range, they remain uncontrolled. If we were to assume that the appropriate goal function for locomotion in subjects with CAI – particularly in the presence of fatigue – is to protect the injured ankle from further injury while allowing deviations to persist in either limb once this goal is not threatened, it is highly likely that both limbs would exhibit differing patterns of movement variability. **References** Scholz, J.P., Schroner, G. (1999) *Experimental Brain Research* 126(3):289-306

#### DATA MINING IN ANALYSIS OF FORCE PLATE SIGNALS

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**Data mining in analysis of force plate signals** Fan, Y.I.\*, Li, Z.Z, 3 1 Center for Scientific Research, Guangzhou Institute of Physical Education, Guangzhou 510500, P. R. China 2 School of Physical Education and Sports Science, South China Normal University, Guangzhou 510631, P. R. China 3 College of Foreign Studies, Jinan University, Guangzhou 510632, P. R. China \* E-mail: tlyf@gipe.edu.cn **Introduction** The force plate plays an important role in the human motion analysis (Zivanovic et al. 2005, Fan et al. 2011). But there has been an absence of a widely accepted method to process data acquired from the force plate (Donelan et al., 2002, Zivanovic 2005). In this study, a method of condition equation to process such data is brought forward by a case study of force plate signals. **Methods** The experiment is conducted by using Kistler Force Plates (Kistler 9281CA) and analysis software program of SIMI Motion 7. The measurement is taken at the frequency of 1000Hz. Before each measurement, the equipment is positioned by the gradienter and is returned to zero-position. According to the characteristics of human motion when walking, gait kinematic and kinetic data processing method is proposed based upon the Hamilton's Principle. **Results** The force plate signals processed by the constraint equations (i.e. condition equations) reveal satisfactory results to

explore and analyze the characteristics of center of mass in human walking. In addition, the standardization of data prepares for a further mining of them. Discussion Based upon the least-action principle in gait (Fan, et al., 2009), our research explores the validity to process the signals acquired from force plate at steady speeds (Kokshenev et al. 2004) by establishing a constraint equation. Though the employment of such condition equations yields satisfactory results, it also shows its limit in analyzing data from the non-steady-speed gait. This is an agenda for future research. Acknowledgements This project was funded by Natural Science Foundation of China (10772053, 10972061). References Donelan J M, Kram R, and Kuo A D. (2002). *J. Biomech.* 35, 117-124. Fan Y F, Loan M, Fan Y B, Li Z Y and Luo D L. (2009). *Europhys. Lett.* 87, 58003. Fan Y F, Fan Y B, Li Z Y, Lv C S and Luo D L. (2011). *PLoS ONE*, in press. arXiv: 1012.3816. Kokshenev V B. (2004). *Phys. Rev. Lett.* 93, 208101. Zivanovic S, Pavic A, Flint A, Reynolds P. (2005). *J. SOUND VIB.*, 279, 1-74.

## EFFECTS OF LOADING ON MAXIMUM VERTICAL JUMPS: IVE EFFECTS OF WEIGHT AND INERTIA

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**EFFECTS OF LOADING ON MAXIMUM VERTICAL JUMPS: SELECTIVE EFFECTS OF WEIGHT AND INERTIA** Leontijevic, B.1, Pazin, N.1, Bozic, P.1,2, Kukolj, M.1, Ugarkovic, D.1, Jaric, S.3 1: The Research Center, Faculty of Sport and Physical Education, University of Belgrade, Belgrade, Serbia 2: Serbian Institute of Sport, Belgrade, Serbia 3: Department of Kinesiology and Applied Physiology, University of Delaware, Newark, US Introduction A load that originates from added mass inevitably adds to both the body weight and body inertia, while some other loading methods could mimic either additional weight or inertia. The main aim of this study was to explore the selective effects of the added weight and inertia on the both the pattern and output of the maximum vertical jump. Methods Fifteen male college students were tested on maximal countermovement jumps (CMJ) performed with the arm swing. External loading (0-40% of body weight) was applied by using either stretched rubber bands pulling downward, or loaded vest, or both where the bands pulled upward, that mimicked an increase in the subjects' weight (W), weight plus inertia (W+I), or solely inertia (I), respectively. Results An increase in added W and W+I was associated with an increased GRF, while the jumps performed with increased I revealed somewhat prolonged concentric phase. Subjects lowered their center of mass more when loaded with additional W and I then with W+I, while the overall magnitude of the applied loads did not affect the body lowering. Both the force recorded at the instant of transition from the eccentric to concentric jump phase and the peak force increased with the load magnitude, but most prominently with W+I. The peak velocity (that inevitably leads to reduced jumping performance) decreased with the load magnitude, but the most with W+I and the least with W. Both the peak and mean power output decreased with the load magnitude and the effect was the most and least prominent for I and W, respectively. Discussion This is the first study that examines the effects of selective manipulation of different loading components during vertical jumping. The observed changes in the kinematic and kinetic patterns have some similarities with previous studies that investigate vertical jumps (Markovic and Jaric, 2007) under of various loadings. Taken together, the result of this study revealed that W+I cause the larger decline in Vmax, but it effect could be predominantly attributed to the effect of I, rather than to the increased W. The similar adaptation of the recorded vertical forces was obtained by Chung et al. (2000). If extended to other movement tasks, this line of research could not only contribute to better understanding of the effects of external loading on our maximum performance, but also serve for refining athletic training and rehabilitation procedures. References Markovic G, Jaric S. (2007). *Med Sci Sports Exerc.* 39(10), 1757-64. Chang YH, Huang HWC, Hamerski CM and Kram R. (2000). *J. Exp. Biol.* 203, 229-238.

## GROUND REACTION FORCE VARIABLES IN HANDBALL JUMP SHOTS

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**Introduction** The jump shot is one of the most important elements in team handball (Pori et al., 2005). The shooter takes off from behind the goal area line, six metres from goal, and must release the ball before landing. Shooters running towards goal must therefore brake before the goal area line and jump vertically above the reach of any defenders while maintaining some forward momentum so that the shot is taken as close to the goal as possible. The aim of this study was to measure and analyse key ground reaction force (GRF) variables involved in the jump shot. **Methods** Ten experienced handball players (stature: 1.79 m ( $\pm$  0.05); mass: 73.9 kg ( $\pm$  7.3)) participated in this study. Each player ran for three steps, dribbled the ball, and took another three steps ending with a jump shot into a standard handball goal. Shots were taken 6 m from the goal and one defender stood with arms raised in front of the 6 m line. For the jump shot, the players took off from a Kistler force plate. The force plate's dimensions were 900 mm X 600 mm and it recorded at 1000 Hz. Each player took three jump shots and the average results for each GRF parameter were calculated. Pearson's r was used to find associations; a confidence level of 5% was set. **Results** There were two main phases during the jump shot. The first was the initial landing phase from the last step during which horizontal velocity decreased by  $-1.53$  m/s ( $\pm$  .51). This was associated with a large horizontal braking force of  $-1.34$  BW ( $\pm$  0.64) ( $p = .009$ ). The entire braking phase lasted 92.4% ( $\pm$  3.6) of contact time with only a very small period of horizontal acceleration following this. The players also experienced a mean vertical impact force of 2.43 BW ( $\pm$  .69) during the landing phase. After this braking phase, a vertical push-off phase occurred prior to shooting. The vertical push-off force of 2.83 BW ( $\pm$  .38) occurred during the last 50% of contact (the mean contact time was 0.260 s ( $\pm$  .028)). The mean flight time was 0.47 s ( $\pm$  .10) during which the vertical displacement of the centre of mass was 0.28 m ( $\pm$  .10). Flight time was correlated with vertical push-off force ( $p = .008$ ). **Discussion** The objective of the jump shot in handball is to get into an airborne position that allows for the most accurate, powerful shot to be taken. In this study, the player's decrease in horizontal velocity during contact of 1.5 m/s was enough to both prevent crossing the goal line and keep moving forward during the flight phase. This brought them closer to the goal increasing their chances of scoring. Large forces occurred during both the landing and take-off phases. Handball players are advised to develop leg strength to withstand the impact forces occurring during the jump shot (vertical and shear) and also to develop push-off forces to increase jump height. **References** Pori P, Bon M, Šibila M. (2005). *Kinesiology*, 37(1), 40-49.

## THE RELIABILITY OF PLANTAR PRESSURE ASSESSMENT IN CHILDREN AGED 7 TO 11 YEARS

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**Introduction** Plantar pressure assessment is commonly used in the clinical evaluation of the foot and provides useful information on the loading characteristics during gait. However plantar pressure measurement systems must be tested to assess their repeatability in order to help standardise and document methodologies. The reliability of plantar pressure measurements has been established in adult popu-

lation (Gurney et al. 2008; Zammit et al. 2010) however subsequent work on children is lacking. It is acknowledged that children's gait is associated with increased variability and therefore it is necessary to establish the feasibility of repeatable plantar pressure measurements in this population as the value of this clinical assessment is undetermined. The aim of this study was to determine the reliability of plantar pressure measurements in children aged 7 to 11 years. Methods 45 participants were recruited from local primary schools in East London. Participants were asked to walk at a self-selected speed on a pre-defined walkway with the MatScan® (TekScan, USA) placed in the centre. The following variables were extracted for further analysis: peak pressure, peak force and pressure-time and force-time integrals. Data for 3 trials were used to determine the reliability. Reliability of the data was explored using Intra Class Correlation Coefficients (3,1) and variability with Coefficients of Variation. Results Within the sample the lateral heel, medial heel, midfoot, 1st metatarsal and 2nd-5th metatarsals demonstrated good reliability (0.69-0.95) and reduced variability (10.22-27.15%) for all the measured variables. In all cases the lesser toe region demonstrated poor reliability (0.17-0.50) and increased variability (27.15-56.08%) within trials. Discussion These results demonstrate that the collection of reliable plantar pressure data is possible in children for all segments of the foot except the toes and can also provide a baseline of normative data that may be used to evaluate loading characteristics of the foot in specific disease populations. The lower reliability and increased variability at the toes has also been reported in adult studies and may be as a result of the plantar pressure sensors having difficulty isolating small areas such as the toes accurately (Gurney et al. 2008; Urry and Wearing 2001). It must also be acknowledged that the results presented can only apply to the sample under investigation and to the instrumentation described. Further work is required to explore the reliability of plantar pressure data in children of varying ages and where deformity is present. References Gurney J, Kersting, U, Rosenbaum, D. (2008). Gait and Posture, 27, 706-709. Urry S, Wearing S. (2001). The Foot, 11, 151-157. Zammit G, Menz H, Munteanu S. (2010). J Foot Ankle Res, 3, 11.

## BIOMECHANICS AND PODIATRIC ANALYSIS OF FOOT FOOTBALL PLAYERS

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Since the majority of soccer injuries are directly related to morphology and function of lower limb, it becomes essential to characterize the foot of soccer players in order to establish correct strategies to prevent and treat injuries and, to respond to their specific needs, such as choosing correct footwear. The purpose of this study was to morphologically and functionally characterize the footballer's foot in a static situation and while moving, establish a comparison between the dominant and non-dominant leg and positions occupied by the football players. Thirty males from the Football Portuguese League, age 27.1 yr (SD 4.3), height of 178.9 cm (SD 5.7), and body mass 78.0 (SD 7.6), participated voluntarily in this study. For the podiatric study, a Table-bed, a Podoscope, a Goniometer, a Perthes ruler, a Pelvimeter, a Tape-measure, and a Pedigraph were used. For the dynamometric study, a Bertec force plate (1000 Hz) and a Pedar System (50 Hz) with synchronized acquisition was used. Three successful trials were required for each foot. For the data analysis, a descriptive statistic was used and a data base was then created. The homogeneity was studied with the Levene test and the distribution normality with the Shapiro-Wilk test. The One-Way Anova test was also used to verify the existence of significant differences, and the t student was later applied to compare the average of the left and right foot. The adopted level of significance was  $\alpha=0.05$ . Results showed a high incidence of digital and unusual changes, a predominance of hollow foot, heel varus, squared foot morphology and index plus minus, with high incidence of plantar support asymmetry. A smooth light gait was registered with some asymmetries between the left and the right feet. The plantar pressure showed, in general, significant higher results in the left foot. The most common digital deformities were the claw toes and hallux abducts valgus, which is consistent with other studies. The high prevalence of dysmetries and asymmetries causes different capacities to dissipate load. The prevalence of heel varus and cavus foot may be associated with highly demanding tasks in football (Viladot, 2000). Force values were higher in unilateral support to those reported in the literature, suggesting a lower attenuation of weight induced by balancing the contra-lateral limb. Horizontal component of force reflect a high symmetry of footballer's gait. The increased rate of the insoles on the external rearfoot and midfoot reflects a supination heel strike and suggests a tendency for cavus foot or cavus varus foot. The highest pressure was located in the external forefoot, followed by internal forefoot (Cavanagh, 1991). This may be related to metatarsal verticalization of the cavus foot, which induces a decrease in the support surface. The existence of high incidence of asymmetries in several parameters, suggests some functional specificity of the lower limb in soccer players, imposed by the specificity of the tasks performed.

## ATHLETE-SPECIFIC ANALYSES OF THE EFFECT OF SHOE BENDING STIFFNESS ON FOOT FUNCTION DURING SPRINT RUNNING

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ATHLETE-SPECIFIC ANALYSES OF THE EFFECT OF SHOE BENDING STIFFNESS ON FOOT FUNCTION DURING SPRINT RUNNING Smith, G.1, 2, Lake, M.2, Lees, A.2 1: University of Chester (Chester, UK), 2: LJMU (Liverpool, UK) Introduction The Metatarsophalangeal (MPJ) joint has been shown to be potentially wasteful in maximising athletic performance, absorbing energy and producing little during push off (Stefanyshyn and Nigg, 1997). Increasing the longitudinal bending stiffness of sprint shoes has been suggested to improve sprinting performance (Stefanyshyn and Fusco, 2004). The aim of this study was to determine the effect of sprint spike bending stiffness on sprinting performance, MPJ kinematics and kinetics and pressure distribution for a single subject. Methods Over four separate testing sessions, one female sprinter performed maximal sprints (6 in baseline shoe and 6 in test shoe in each session) on an indoor runway, contacting a force platform (Kistler, Switzerland, sampling at 1000 Hz) and a pressure mat (RSScan, sampling at 250 Hz, 6 mm track surface cover) at approximately 35 m. Kinematic data was also captured at 1000 Hz using 6 opto-electronic cameras (Qualisys Inc, Sweden). Four stiffness conditions were used: a baseline Asics sprint spike (stiffness  $191 \pm 10$  N/mm) and three Puma sprint spikes with stiffness's of  $276 \pm 30$ ,  $388 \pm 29$ ,  $486 \pm 20$  N/mm. Results Mean sprint velocities were highest in the two stiffest conditions ( $8.20$  m/s  $\pm 0.18$  m/s) and lowest in the baseline condition ( $8.07$  m/s  $\pm 0.18$  m/s), although not significant. Overall the stiffer conditions resulted in decreased MPJ angular range of motion, increased MPJ moment and MPJ energy production at takeoff, but also increased MPJ energy loss during stance. Peak pressures on the toes increased in the stiff conditions and peak metatarsal heads loading occurred earlier in the stiffer conditions. Discussion Agreeing with previous findings (Smith and Lake, 2009), during sprinting loading was mostly confined to the medial forefoot and the push off was performed about the transverse axis of the Metatarsophalangeal joint. The loading transition from the lateral to the medial portion of the forefoot seemed to occur faster in the stiffer conditions, possibly indicating a focussed influence of stiffer sole materials. It is possible that stiffer shoe conditions may improve the efficiency of the push off during sprinting, as this subject demonstrated improved sprinting performance in the stiffer conditions (although not significant). The results from this study support the notion of tuning of an athlete's shoe stiffness to their individual characteristics in order to maximise performance. References Smith, G., Lake, M. (2009).

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## PLANTAR-PRESSURE DEMONSTRATES THE CHANGE IN FOOT FUNCTION DURING BEND RUNNING

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**Rationale** During bend sprinting, athletes have to cope with centripetal forces which are detrimental to sprint performance (Bezodis et al. 2007). The metatarsophalangeal joints contribute to forward propulsion, whilst also coping with the curvature of the bend. It is reported that the foot has a two speed construction (Bojsen-Møller, 1978), as it adopts either a transverse axis (MT1-MT2) during straight running or an oblique axis (MT2-MT5) used when walking uphill or during increased loading. The aim of this study was to determine which of these axes are used during curved sprinting. **Methodology** Twelve participants ran at maximal and sub-maximal running speeds along a straight path, a path curved to simulate a standard outdoor running track and a path curved to simulate an indoor running track. Ground reaction forces and barefoot pressure measurements from the inside foot (left) were recorded at 500 Hz. Peak pressures and loading rates of the first and fifth metatarsal heads (MT1 and MT5) and the time of forefoot transition from lateral to medial were obtained. Data were analyzed using a Two-way repeated measures ANOVA over three different curvatures and two different speeds. **Results** During fast running the tightest curvature significantly increased the loading rate under the MT5 head. The loading rate for MT1 increased significantly with speed but also increased significantly as the curve radius lessened. Peak pressures of MT5 were very similar for slow running, but during fast running it increased significantly. The peak pressure under MT1 increased significantly during fast running and was significantly greater during straight running. Forefoot transition occurred significantly later in the tightest bend for both running speeds. **Discussion/ conclusion** During straight sprinting, the transverse axis of the forefoot is dominant, this was evident with increased peak pressure and loading rate under MT1. Bojsen-Møller (1978) reported that the transverse axis is an efficient mechanism to provide propulsion by causing the arch structure to become rigid, this is caused by the plantar aponeurosis becoming tense pulling both ends of the longitudinal arch together. We found that at maximal speed and as radius increases, the forefoot pressure shifts from medial to lateral side. This means that the oblique axis of the forefoot was used predominantly during bend running. This was also supported by the forefoot transition data which moved from lateral to medial as the bend became tighter. In conclusion, the oblique axis is used to stabilise and support the body at slower speeds, whilst forwards propulsion is compromised. **References** Bezodis, I, Salo, T & Kerwin, G. (2007). J Sport Sci, 25, 236-237. Bojsen-Møller, F. (1978). Proc 6th Int Congress Biom, 261-266. University Park Press, Baltimore.

## COMPARISON OF GRAND REACTION FORCE CHARACTERISTICS OF NORDIC WALKING INSTRUCTORS AND ELDERLY PERSONS DURING NORDIC WALKING AND WALKING.

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**Introduction** Walking is one of the most popular health-oriented activities in Japan. However, even walking, one of the safest exercises may cause joint problems in the elderly people. Nordic Walking (NW) may be favorable to the elderly, because the use of two poles during walking was believed to reduce the load to lower extremities. The results of the recent studies, however, evaluating the load to lower extremities are inconsistent. We hypothesized longer experience in NW may not lead to the reduction of lower extremities load during NW in the elderly people. Therefore, we evaluated the ground reaction force (GRF) profiles of elderly NW experts and compared them to those of young NW instructors **Methods** 8 young NW instructors (seven men, one women: mean age 33.88±6.06 years old) and 12 elderly NW experts (eight men, four women: mean age 67.58±4.78 years old) were recruited for this study and gave their full informed consent to participate in this study which was approved by the Tohoku Fukushi University Research Ethics Committee. The elderly NW experts regularly walked using poles more than 1 hour per day for more than twice a week for more than 3 years. They had no history of knee and ankle joint pain and disorders. GRF was measured using serially placed GRF platforms (Kistler, Switzerland) on which the subjects walked 3 times using poles (NW) and 3 times without walking. The order of the walking speed was 4 km/h±0.5 and 6 km/h±0.5. All motions were recorded using a three-dimensional motion analysis system (Cortex, USA). Motion and force plate signals were synchronized on the Cortex software. GRF was normalized to the body weight. Differences in GRF were analyzed using a two-way analysis of variance (ANOVA) with a confidence level set at 5%. Specific contrasts were identified with a Tukey post hoc analysis. **Results** Vertical GRF of instructors was higher in NW as compared to walking at 4km/h ( $p<0.0002$ ). There was no difference, however, in the elderly people between NW and walking at 4km/h. Vertical GRF during NW was larger than during walking in both instructors and elderly experts when walking at 6km/h ( $p<0.02$ ). Vertical GRF was smaller in the elderly, when walking without poles at 6km/h. **Discussion** GRF does not seem to be reduced in NW as compared to walking in both elderly NW experts and NW instructors. This seemed mainly due to the efficient use of poles to produce driving force so that at each contact of heels larger force was required to brake even in the elderly persons with enough NW experience. This study was supported by Program of Funding Basic Res. Ctr. In Private Univ. (MEXT) to the Kansei Fukushi Res. Inst., Tohoku Fukushi Univ. (2008-2012) **References** John W, Michael T, Michael D, Thomas K. (2001). Medicine & Science in Sports & Exercise, 33(1), 142-147. L. Hansen, M. Henriksen, P. Larsen, T. Alkjaer. (2008). Scandinavian journal of Medicine & Science in Sports, 18(4), 436-441. Keizo S. (2010). Report of Kansei Fukushi Reserch Institute, 11, 145-155.

## Poster presentations

### PP-PM39 Training and Testing: Sports Performance 1

## ANALYSIS OF TEST BATTERIES' RESULTS OF YOUTH ICE HOCKEY PLAYERS

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**Analysis of test batteries' results of youth ice hockey players** Géczi G., Velenczei A., Bognár J. Semmelweis University, Faculty of Physical Education and Sport Sciences (TF) **Introduction** Ice hockey requires high level of the physical skills to perform in elite sport (Géczi et al, 2008). The athletes' physical level and state have a very high importance in the coaches' all around job. Valid motor test batteries are very useful tools to measure the affect of the workout routine in each season. Hungarian ice hockey players are measured by the coaches of

the Hungarian Ice Hockey Federation from 2005 order to recognize every athlete's physical level and also to select the players to the national teams. The purpose of this research was to present the level of development in two age-groups in a four-year course and to verify our hypothesis about the younger age groups' better results. Methods During the one-day long event 102 players (N1990-1991 = 50; N1992-1993 = 52) did the test on-ice (36 m skating forward and backward, slalom, 6\*9m shuttle skating and transition drill) and off-ice (60 m forward run, standing long jump, 6\*9 m shuttle run, 400 m and 1500 m run). Data was obtained once in each season for four years. Data was analyzed by Repeated Measures and MANOVA using the SPSS 17.0 for Windows. Results Results show that in the first three years performances in both groups were increasing, but in the last year only a few every test had better results than before. Also the younger age group could not justify significantly better result than the older age group. Discussion We can recognize that the older age group should work harder to achieve development and to reach the elite level. The main result of this investigation was to identify the MUST value by every motor test and this MUST value is relevant information for the club coaches as well. Also important effect of our investigation detecting all deciding factors which are important for the youth players' development. In one hand we recommend to the coaches testing the players during the competition season to have up to date information about their physical fitness level. On the other hand the tests are really important for the players also, they can recognize their weaknesses and can develop them. References Géczi G., Bogrnár J., Tóth L., Sipos K. and Fügedi B. (2008). International Journal of Sport Science and Coaching Science, 2, 277-285.

### TACTICAL TRAINING IN SOCCER WITH 3D- OR 2D-TECHNOLOGY

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Introduction Tactical training in sports is usually supported by two-dimensional (2D) video information. In recent years three dimensional (3D) technology has been made widely available, but to date only few studies have been conducted about it's potential benefits in the area of tactical training. Thus, our aim was to examine if the assignment of the 3D-technology improves the tactical understanding of soccer-specific scenarios. Methods Two randomized experimental groups of sport students participated in the study: one 3D- (n=12) and one 2D-group (n=12). All subjects were healthy and had no 3D-experience related to sports. Prior to the experiments, 3 typical football game-scenarios with player's positions spread over the whole soccer field were filmed in 2D- or 3D technology from different player's positions using plastic figures. Furthermore, a 2-minute film presenting a typical player's formation from the perspective of the goalkeeper was prepared using a 145° turning camera. The main study included following tests: "Recognize the unmarked teammate": Both groups watched all 3 videos in either 2D- or 3D technology. The task was to find the player, who was not tightly marked by an opponent while watching the scenario. Results were evaluated via a multiple choice questionnaire. "Marking a typical player's formation": Both groups watched the 2-minute film. Following this, each subject was asked to mark the position of the ten players of his or her team on a millimeter paper. The distance of each player towards his or her correct position was determined. Results Correct answers to scenario 1: 3D: 10 and 2D: 9; Chi-square significance test:  $p > 0.05$ . Correct answers to scenario 2: 3D: 6 and 2D: 9; Chi-square significance test:  $p > 0.05$ . Correct answers to scenario 3: 3D: 12 and 2D: 7; Chi-square significance test:  $p < 0.05$ . For the definition of the player's position in the 2nd test we calculated the following total deviations: 3D:  $106 \pm 29$  mm and 2D:  $102 \pm 38$  mm;  $p > 0.05$  (t-test). Conclusions We found a significant difference between the 2D- and 3D-group in one out of three scenarios. Interestingly, in this task every subject of the 3D-group gave the right answer. A possible explanation for this result is the better spatial differentiation of the 3D-technique compared to the 2D-technology in this special situation. 3D-recordings of typical player's positions might improve tactical understanding of playing situations in the future and might therefore contribute to tactical training effects.

### PERFORMANCE MODEL IN FULL CONTACT – STICK FIGHTING

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PERFORMANCE MODEL IN FULL CONTACT – STICK FIGHTING Distaso M. 1; Marcoccia R.1; Villani R.1 1:Italian Union Trainers of Combat Sports (UIPASC) Introduction Full contact-stick fighting is a combat sport with weapons, where speed and accuracy of shots to the opponent, are key features for the athletes who practice this discipline. The aim of our research was to analyze what was the performance model for athletes of Stick Fighting. Materials and Methods For an indication of functional characteristics that an athlete must have, we ran several tests on 20 male athletes (years 18/30; height 1,67/1,85 cm; weight 67/90 kg) divided into two groups: 10 professional athletes formed the experimental group and 10 amateurs formed the control group. We examined the maximum number of shots taken in 30 seconds, the speed endurance and we also made a match analysis of the meetings between professionals and amateurs. The maximum number of shots in 30 seconds was calculated by the SOS test (Speed of Stick), a system composed of photocells and ergometer that allows us to accurately count how many shots they get pulled to the punching bag and their frequency. Speed endurance was studied by the analysis of lactate blood. The match analysis was performed by video of the meetings, in order to study the time of attack / defense and study / recovery in the match, also, what were the areas of the body more targeted. Results The results showed un significant difference in the two groups (17%) of the number of shots in 30 seconds (average: professionals 145.5; amateurs 120.2), and also by analyzing the frequency of shots, is known as the professionals we have a split time between shots, shorter and regular until the end. Then we analyzed the lactate blood in the two groups into three distinct phases: baseline, at the end of the match and after three minutes from the end of combat. The results show no significant differences between groups (professionals 6,40 - 11.77 - 8,58; amateurs 3.64 to 12.26, 9.58). The match analysis shows that the area of the body most targeted is the head (64%), followed by upper limbs (16%), corpus (12%) and finally from the lower limbs (8%). Regarding the study of time attack / defense during the match, the data show that it is greater than the professionals (55%), compared with the amateurs (42%), therefore the recovery time / study are more in the second group (58%), compared to the first (45%). Discussion From our results, we can say that the characteristics of an athlete's full-contact stick fighting, is the speed and frequency techniques. In fact, it does not matter the amount of force exerted on the shot stick, but rather the speed of the athlete in making repeated sequences. References Villani R., Distaso M., (2003), 8<sup>th</sup> Annual Congress of the ECSS, 233, Salzburg Lehmann, G. (1999). Leistungssport, 29, 30-33.

## EVALUATION OF TECHNICAL, TACTICAL AND CONDITIONAL COMPETITIVE LOADS IN PROFESSIONAL MMA MIXED MARTIAL ARTS FIGHTERS

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**Introduction** Recording maximum reliable information on changes in an athlete during the training process and competition - control and evaluation, respectively (Seirul-lo, 1998) – is the main principle of the design of training monitoring (Viru, 2004). The aim of this study was to integrate the evaluation of technical, tactical and conditional competitive loads in one of the professional MMA fights of the Bellator 25 Fighting Championship 2010 held in Chicago. **Methods** In every minute and in every of the three 5-minute rounds of the fight the following parameters were evaluated for each fighter: a) tactical load (based on the difficulty of making decisions - assessed 1 to 10 by expertise judgment), b) technical-conditioning load (based on the quality, scored 1 to 10 by expertise judgment, and the number of effective actions, scored 1 point for every 10 point of quality –overall assessed 1 to 10), c) sum of qualities of effective actions, d) auto-evaluation by the fighter and coaches of technical-tactical execution qualities, strategies, fatigue states and psychological effectiveness. For each of the three rounds and for the total fight the tactical load (mean of each minute and round), technical load (mean of each minute and round), the conditional load (sum of the technical-conditioning load of each minute and each round). **Results** The sum of qualities of effective actions for RLL and CK fighters in rounds 1, 2, 3 and total fight, respectively, are 69/227, 45/84, 94/235 and 208/546. The tactical, technical and conditional loads for RLL fighter in rounds 1, 2, 3 and total fight, respectively, are 6.4, 4.2, 8.2 and 6.27 (tactical load), 5.4, 2.1, 6.3 and 4.6 (technical load), and 27, 10.7, 31.3 and 69 (conditional load). **Discussion** The integration of the evaluation of tactical, technical and conditioning competitive loads in professional MMA fighters is effective to help the coach in training guide and making necessary changes in training design. In order to improve the effectiveness in competition, the most relevant analysis is the auto-evaluation of the fighter and coaches. This methodology to evaluate competition is applied to many other martial arts fighters. **References** Seirul-lo Vargas F. (1998). Control and evaluation of training. In: Long term planning in team sports. Barcelona University Press, Barcelona. Stavropoulos N., Ribera-Nebot D. (2009). Integrated evaluation of basketball games and practices. Basketball Bobby Knight Coaching Clinic, Bilbao. Viru A., Viru, M., Volver A. (2004). Training Monitoring. 7th International Sports Science Conference, Vilnius.

## THE EFFECT OF SHORT-LASTING, ONE-TIME 3D VERSUS 2D VISUALIZATION ON MENTAL REPRESENTATION OF COMPLEX BADMINTON SKILLS

ODYSSEOS, P., FROHNERT, A., FRIESE, C., SCHNAASE, C., THRA, D., PLATEN, P., FERRAUTI, A.

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**Introduction** New methods aimed at helping athletes develop, stabilize and optimize their skills are of utmost importance in sport. Recently, 3D-technology products (TVs, Camcorders) have been made available for consumers. However, the usage of this technology in sports has not been widely examined until today. Thus, our aim was to examine in a pilot study, if the assignment of the 3D-technology improves the mental representation of complex sport skills in badminton novices. **Methods** Two randomized experimental groups of sport students participated in the study: a 3D (n=12) and a 2D group (n=12). All subjects were healthy, had no 3D-experience related to sports and were badminton novices (no team players and non-educated in badminton clear technique). All subjects took part in a three session test: (1.) Students were filmed with a high speed camera (40 fps) by feigning a badminton specified movement ("clear"). (2.) Following this, they watched a video of a perfect "clear" for three times in either 3D or 2D technique. (3.) Then they were presented with seventeen printout pictures of sequences of this movement from different perspectives. The task was to put the pictures in the right chronological order. (4.) Finally, all subjects were filmed again by repeating the "clear" movement. Effects on mental representation were measured by means of quantitative and qualitative measurements. Quantitative measures consisted of controlling the order of position and sequence of the pictures during session 3 by means of a code-word based point system. In a qualitative attempt we compared the quality of the movements filmed in session 1 and 4 according to defined technique criteria (0-1-2-3-phase-modell from Poste & Hasse 2002). **Results** No significant differences were found in mental representation during test session 3 between the 3D (147±8 points) and the 2D group (145±8 points). Analyzing the quality of movement, we found an improvement in both groups from pre to post recording without any significant intervention effect. **Conclusion** Our tests did not find any significant impact of a short-lasting, one-time 3D presentation of a complex badminton movement pattern on mental representation, and no effect on short-time motor learning. This might be due to the not very well developed technical standard of the 3D Camera used (converging point at 1.50 m, no recording of whole body movements). Future studies are necessary with higher technical standards and with longer-lasting visualization sessions. **Literature** Poste, D. & Hasse, H. (2002). Badminton Schlagtechnik- Mit dem Schläger denken lernen. Velbert: SMASH-Verlag

## THE PHYSIOLOGICAL DEMANDS OF COMPETITIVE ONE-DAY EVENTING IN NOVICE FEMALE RIDERS

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**Introduction** One-Day Eventing (ODE) is an equestrian discipline that is comprised of three phases: Dressage (DR), Show Jumping (SJ) and Cross Country (XC). Developing sports specific conditioning requires an understanding of the demands experienced by athletes during competition. At present little is known about the competition demands of ODE as previous research has either focussed on non-competitive athletes in simulation scenarios (Roberts et al., 2009) or has presented the athletes as equestrians per se rather than ODE athletes (Westerling, 1983; Devienne and Guezennec, 2000). The aim therefore was to evaluate the physiological demands of competitive ODE in female novice riders. **Methods** Heart rate (HR, Polar RS800CX Multi, Polar Electro Europe), blood lactate (BLa), and handgrip strength (GS) data were collected from 27 novice female event riders (age 34±10.4 yrs; ht 169.3±6.2 cm; mass 67.4±9.6kg) during competitive events. HR was classified based on percent time spent in five heart rate zones (<35%, 35-54%, 55-69%, 70-89% and 90-100% HRmax, calculated as the highest of either 220-age or the highest HR achieved). BLa was measured at the start of the day (baseline) and 6 minutes post completion of each phase. GS was measured at the start of the day (baseline) and immediately post each phase. **Results** Riders spent a greater percentage of phase time in the high exertion HR zone (90-100% HRmax) in the XC (75%) and SJ (43%) phases compared to the DR phase (28%; p<0.01). Mean BLa increased throughout the event (DR 2.2±1mmol; SJ 3.5±2.2mmol; XC 4.7±1.8mmol, p<0.01). Post XC phase mean GS (26.8±6.2kg) was lower than baseline GS (31.2±4.2kg, p<0.05) in the dominant hand evidence of asymmetry between the dominant and non-dominant hand throughout the events (p<0.01). **Discussion** The high levels of cardiovascular exertion experienced during and the high mean and peak blood lactate levels observed following the SJ and XC phases indicate a need for both aerobic and 'lactate tolerance / threshold' training in these athletes in order to provide cardiovascular and muscle fatigue resis-

tance through improved hydrogen ion buffering and facilitation of lactate removal following high intensity jumping efforts. Strength training may also be beneficial in order to improve hand dominance asymmetry in order to enhance symmetry when controlling the horse and to reduce the potential negative performance impact of muscular fatigue in the upper body. References Devienne, M. and Guezennec, C. (2000). *J Appl Physiol* 82 (5), 499-503. Roberts, M., Shearman, J., Marlin, D. (2009). *Comp Exercise Physiol* 6 (3), 129-135. Westering, D. (1983). *Eur J App Phys Occu Phys* 50 (3), 373-382.

## THE IMPACT OF RESISTANCE DRY-LAND TRAINING ON PERFORMANCE AND BODY COMPOSITION OF ELITE SWIMMERS

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Nikolopoulos, A.1, Mourtakos, S.P.2, Nafpaktitou, D.1, Soultanakis, H.1 1:Aquatics Division, Dep't of Physical Education and Sport Sciences, University of Athens; 2: Laboratory of Nutrition and Clinical Dietetics, Dep't of Nutrition and Dietetics, Harokopio University of Athens, Greece. Introduction Resistance training increases muscular strength and aerobic power, although its contribution in swimming performance has been questioned (Tanaka et al.,1993). Swimming coaches often have to select dry-land weight training programs based on limited research focusing on this area (Girord et al., 2007). The purpose of this study was to determine the effect of two weight training methods of dry-land training, on muscle mass, bone density, strength and sprint performance in elite swimmers. Methods Seventeen elite swimmers with a mean age of  $14.9 \pm 1.14$  years were randomly assigned to either a high resistance-low repetition (HR), or a low resistance-high repetition (LR) weight training program. Bone mineral density (BMD), body mineral content (BMC) and areal bone mineral density (aBMD), total body calcium (TBC), muscle mass and total body fat (TFat%) were determined before and after 6-weeks of training by dual energy X-ray absorptiometry (DXA). Strength of the dominant hand (by a Takei Grip-A-5001, strength dynamometer) and swim time trials on 25, 50 and 100 m were also determined pre and post weight training. A two-way analysis of variance for repeated measures on both factors and a Tukey post-hoc test were used to locate differences between means at a  $p < 0.05$  level of significance. Results The results showed that BMD (pre  $1.01 \pm 0.08$ ; post  $1.12 \pm 0.08$ ), BMC (pre  $2672.7 \pm 527$ ; post  $2736.6 \pm 561$ ), TFat% (pre  $14.9 \pm 5.3$ ; post  $13.3 \pm 5.4$ ) and TBC (pre  $1015 \pm 200$ ; post  $1039.6 \pm 213.3$ ) significantly improved under both types of training but without a training type effect ( $P < 0.05$ ). Strength of the swimmers' dominant hand was increased similarly under both types of training and best times at 25 and 50m but not at 100m of their competitive stroke improved to the same extend in both groups ( $P < 0.05$ ). No changes in muscle mass were observed. Discussion Although the duration of training was relatively short to elicit great gains, speed, strength and certain bone characteristics improved similarly under both weight training programs. The lack of gains in muscle mass with the concomitant improvement in certain strength characteristics and sprinting ability could be attributed to the improved neural recruitment that is initially reported with weight training (Narici M.V. et al, 1989). Girolid S., Maurin D., Dugue B., Chatard J.C., Millet G. (2007). *J of Strength & Conditioning Research*, 21(2), 599-605. Narici M.V., Roi G.S., Landoni L., Minetti A.E., Cerretelli, (1989). *Eur. Journal of Appl. Physiology*, 59 (4), 310-319. Tanaka H., Costill D.L., Thomas R., Fink W.J., and Widrick J.J, (1993). *Med.Sci.Sports Exerc.*, 25 (8), 952-959.

## PACING STRATEGIES ASSOCIATED WITH SUPERIOR DUATHLON PERFORMANCE

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Introduction Pacing strategies involving a slow start and fast finish have been associated with superior performances in endurance running and cycling events (St Clair Gibson et al 2006). However, little research has examined the optimal pacing strategy during multi-sport events requiring completion of several sequential stages. The aim of this study was to analyse differences in run and cycle performance between the fastest and slowest of two competitive duathlons. Methods Performance data was analysed for 31 participants (29 male, 2 female) who completed two competitive duathlon events (run 3.2 km, cycle 16 km, run 3.2 km) on the same course. Chip timing was used to record both total and individual stage times. Transition times were removed. Total times were divided into fastest (FAST) and slowest (SLOW) individual performances, and T-tests for repeated measures were used to assess differences on each individual stage. Results Of the 31 participants, 18 (58%) achieved their fastest overall performance in race 1 ( $2981 \pm 237$ s) and 13 (42%) achieved their fastest in race 2 ( $2990 \pm 239$ s). Comparison of race 1 with race 2 also revealed no significant differences in performance or relative percentage of total time spent on any individual stage. Comparison of FAST and SLOW reveals no significant differences in performance on run 1 (FAST  $719 \pm 69$ s, SLOW  $724 \pm 62$ s) or run 2 (FAST  $724 \pm 62$ s, SLOW  $758 \pm 62$ s). However, performance was significantly faster ( $P < 0.01$ ) on the cycle stage during FAST (FAST  $1463 \pm 101$ s, SLOW  $1546 \pm 149$ s). Discussion The results suggest performance on the cycle stage of a competitive duathlon is largely responsible for variations in individual performance. In the present study 58% of participants achieved their fastest overall performance in race 1 and 42% in race 2, suggesting differences between fast and slow performances were not simply the result of familiarisation or environmental conditions. The mechanisms for these observations are unclear. If overall pacing was based on a telioanticipatory strategy (Ulmer 1996), then a faster first run would be anticipated during the fastest overall race as the pacing regulatory centre in the brain would have allowed a higher muscular work rate based on a peripheral physiological status more conducive to the coming exercise bout. Alternatively, if work rate in run 1 was too high during slowest overall races due to inappropriate performance goals, then a comparatively greater performance decrement would be expected during run 2. Further research is warranted in order to identify the reasons underpinning the apparent independence of run and cycle performance during a competitive duathlon. References St Clair Gibson A, Lambert E, Rauch L, Tucker R, Baden D, Foster C, Noakes T. (2006). *Sports Med*, 36(8), 705-722. Ulmer H.V. (1996). *Experientia*, 52, 416-420.

## FACTORS INFLUENCING PROPELLING EFFICIENCY IN COMPETITIVE SWIMMING

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NATIONAL INSTITUTE OF FITNESS AND SPORTS

Introduction The propelling efficiency (ep) is defined as the ratio of the power used to overcome drag to the total power output, and has been suggested as an important determining factor of swimming performance (Toussaint 1988, Huang 2010). While several studies determined propelling efficiency using swimmers of different performance level, little is currently known which factors influencing swimming performance are related to ep. Therefore, this study aimed to examine the relationship between ep and various factors, such as drag, swimming economy, stroke parameters, and propulsive surface area. Methods The subjects were 10 well-trained male swimmers (age:  $20 \pm 1$  yrs) including a finalist in Japan Swim Championship. Drag-swimming speed relationship and ep were determined by the use



of the measurement of active drag system, according to the methods described by Toussaint et al.. Drag-swimming speed relationship was then used to estimate the drag at given swimming velocities. Oxygen uptake as swimming economy was measured during swimming at the water flow rate of  $1.25\text{m}\cdot\text{s}^{-1}$  in swimming flume. At the same time, the video picture during swimming was recorded, and it was used to calculate the stroke rate (SR) and length (SL). Those measurements were performed by arm stroke only, and their legs were supported and fixed together by a small buoy. Furthermore, the projected area of hand and forearm was measured as propulsive surface area (PSA). Results The mean value of ep was  $67\pm 5\%$  (range: 60 to 73%). When the relationship between ep and each measured value was examined, individual ep was significantly correlated to individual SL and PSA ( $P<0.05$ ), but not to swimming economy, SR, and estimated drag. Furthermore, a significant positive correlation was observed between PSA and SL ( $P<0.05$ ). Discussion/Conclusion Since propulsive force during swimming is given as the product of the mass of water and the velocity change, a swimmer with larger PSA who can push off against a larger mass of water should generate an equal propulsive force with a smaller velocity change, which should induce a longer SL, too. Furthermore, since stroke with a smaller velocity change decreases the power spent on moving water backward, i.e. a loss of kinetic energy to water during swimming, it should increase ep. Consequently, ep would be more closely related to SPA and SL, rather than swimming economy or drag. References 1. Toussaint, H.M., et al. (1988) Propelling efficiency of front-crawl swimming. *J Appl Physiol*, 65: 2506-2512. 2. Huang, Z., et al. (2010) Relationship between propelling efficiency and swimming performance in elite swimmers. *XIth Biomechanics and Medicine in Swimming, Book of Abstracts*: 106-107.

## NORMATIVE DATA FOR LABORATORY ANAEROBIC PERFORMANCE IN ICE HOCKEY PLAYERS AGED 15 TO 35 YEARS

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**NORMATIVE DATA FOR LABORATORY ANAEROBIC PERFORMANCE IN ICE HOCKEY PLAYERS AGED 15 TO 35 YEARS** Heller, J., Vodicka, P. Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic Introduction From the physiological assessments, anaerobic exercise testing is of a primary importance in ice hockey players. Regardless that the Wingate anaerobic test (WAnT) is world wide frequently used in ice hockey players (Cox et al. 1995), there are no available normative values for peak power (PP) and anaerobic capacity (AnC) as regards age and position of the players (Vescovi et al. 2006). Therefore, the aim of this study was to reanalyse the data obtained in 7495 tests done in Czech ice hockey players to create age- and positional-related norms for PP and AnC in ice hockey players. Methods The data were collected from 1999 to 2008 seasons. Altogether 7495 ice hockey players (forwards:  $n=3054$ , defensemen:  $n=255$ , goalkeepers:  $n=586$ ) aged 15 to 35 years performed a 30-s WAnT on a cycle ergometer Monark E824 using a breaking force of 6  $\text{W}\cdot\text{kg}^{-1}$  that equals 0.106  $\text{kg}\cdot\text{kg}^{-1}$  (Vandewalle et al., 1985). The main results were 5-s PP [ $\text{W}\cdot\text{kg}^{-1}$ ] and total work or anaerobic capacity AnC [ $\text{J}\cdot\text{kg}^{-1}$ ]. The dependence of PP and/or AnC on age was calculated using a polynomial function of the third order. Peak values were calculated using derivation of the function. Results In forwards,  $\text{PP}/\text{kg} = 0.0007x^3 - 0.0668x^2 + 1.9251x - 2.6599$  ( $R^2 = 0.9155$ ,  $x = \text{age}$  [yrs]), with peak values 15.0  $\text{W}\cdot\text{kg}^{-1}$  at 22.7 years of age, and  $\text{AnC}/\text{kg} = 0.0143x^3 - 1.2333x^2 + 33.124x + 66.295$  ( $R^2 = 0.8665$ ,  $x = \text{age}$ , yrs), with peak values 350  $\text{J}\cdot\text{kg}^{-1}$  at 21.3 years of age. Defensemen attained  $\text{PP}/\text{kg} = 0.0011x^3 - 0.096x^2 + 2.5584x - 7.1553$  ( $R^2 = 0.9691$ ), with peak values 14.9  $\text{W}\cdot\text{kg}^{-1}$  at 22.0 years of age, and  $\text{AnC}/\text{kg} = 0.0166x^3 - 1.3741x^2 + 35.795x + 45.088$  ( $R^2 = 0.9068$ ), with peak values 344  $\text{J}\cdot\text{kg}^{-1}$  at 21.0 years of age. In goalkeepers,  $\text{PP}/\text{kg} = 0.0007x^3 - 0.0642x^2 + 1.8124x - 1.8468$  ( $R^2 = 0.9028$ ), with peak values 14.4  $\text{W}\cdot\text{kg}^{-1}$  at 22.0 years of age, and  $\text{AnC}/\text{kg} = 0.0048x^3 - 0.5158x^2 + 15.255x + 190.69$  ( $R^2 = 0.8905$ ), with peak values 328  $\text{J}\cdot\text{kg}^{-1}$  at 20.7 years of age. Discussion In general, PP and AnC rise with age and the values seem to peak at the end of the third decade (Inbar, O. et al. 1996). In specifically trained population, however, the effect of training seems to be more important than the effect of age. Small but evident position-related differences in PP and AnC are in agreement with the data published by Vescovi et al. (2006). The normative values of PP and AnC could be used by ice hockey coaches, and trainers to evaluate anaerobic performance with respect to the chronological age and playing position of the ice hockey player. References Cox MH, Miles DS, Verde TJ, Rhodes EC (1995). *Sport Med*, 19, 184-201. Inbar O, Bar-Or O, Skinner JS (1996). The Wingate anaerobic test. *Human Kinetics*, Champaign. Vandewalle H, Peres G, Heller, J, Monod H (1985). *Eur J. Appl. Physiol.* 54, 222-229. Vescovi JD, Murray TM, VanHeest JL (2006). *Int. J. Sports Physiol. Performance*, 1, 84-94.

## RELIABILITY OF THE BIOHARNESS MONITORING SYSTEM

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**Introduction:** The Bioharness monitoring system may provide physiological information on sporting performance by recording multiple data streams simultaneously during activity. Understanding the reproducibility of data is fundamental to having confidence in the monitoring equipment being used. This study assessed the reliability of the Bioharness monitoring system. **Methods:** 12 healthy males (age  $20.5\pm 2$  yrs, body mass  $70.4\pm 9.4\text{kg}$ , height  $1.77\pm 0.07\text{m}$ ) participated. Reliability of Heart rate (HR), Breathing Frequency (BF) and Accelerometry (ACC) and Infra-red skin temperature (ST) was tested via a discontinuous incremental (0-12km.h<sup>-1</sup>) treadmill protocol completed within a thermo-neutral ( $\approx 24^\circ\text{C}$ ) environment. A within subject design, assessing inter and intra ( $n=4$  devices) reliability, was completed using the same treadmill protocol. Posture (P) was assessed by securing devices to a tilt table which were moved through 160° at 100 intervals, which was repeated. **Results:** Between subject data ( $n=12$ ) report low Coefficient of Variation (CV) and strong Intra Class Correlation (ICC) for HR (CV 4.8;  $r=0.98$ ,  $p<0.01$ ), ACC (CV 6.5;  $r=0.99$ ,  $p<0.01$ ) and P (CV 7.6;  $r=0.99$ ,  $p<0.01$ ). In contrast ST (CV 3.7;  $r=0.61$ ,  $p<0.01$ ) and BF (CV 17.7;  $r=0.81$ ,  $p<0.01$ ) present more variable data. Weaker reproducibility was reported when data was analysed at each respective velocity with BF (CV 15.0 – 21.9;  $r<0.51$ ), HR (CV <6.2;  $r>0.83$ ) and ACC (CV <9.3;  $r=0.66$  to 0.99). Moreover, complete data sets for HR ( $n=6$ ) and BF ( $n=7$ ) reduced as treadmill velocity increased  $>10\text{km}\cdot\text{h}^{-1}$ . Intra device data set ( $n=4$ ) saw strong ICC ( $r>0.97$ ,  $p<0.01$ ) and low CV values ( $<10.1$ ) for HR, ACC and P. ST maintained strong results (CV<2;  $r>0.90$ ,  $p<0.01$ ) bar one device (CV=2.7;  $r=0.48$ ). BF produced low to moderate ICC values ( $r=0.41$  to 0.72) and CV (<13.7). Inter device data resulted in strong ICC values ( $r>0.89$ ,  $P<0.01$ ) and low CV (<9.3) for HR, ACC, ST, P. BF ICC were weak ( $r=0.33$  to 0.59) and CV range was 12.3 to 17.4. **Discussion:** Data suggest that the Bioharness is a reliable monitoring device within ambulatory laboratory testing. Breathing frequency demonstrated the largest variance in both testing designs which may be linked to the technical single strap set-up for this variable. Increased variance of breathing frequency and heart rate data with higher velocity could be also be attributed to EMG or movement artefacts. Inter/intra data analysis suggests better reproducibility. Moreover, the latter testing design accomplished full sets of data at all velocities unlike the between subject test. The subject's upper body physical profile, issue of fitting and securing the device during activity could be a consideration to improve the reproducibility of data. Bioharness devices provided by Zephyr Technology

## Poster presentations

### PP-PM40 Sports Nutrition: Supplements 3

#### EFFECTS OF INTERVAL TRAINING & CREATIN SUPPLEMENTATION ON ANAEROBIC FACTORS AND SPRINT PERFORMANCE

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Eslami, S1 Hemmati, J.2 1: PNU (Delfan/Iran), 2: IAU (Islamic Azad University, Khoramabad Branch, Iran) Introduction Suitable nutrient is based physical performance. Because it provide fuel for organic activities and provide chemical materials for energy producing and using of potential energy in chemical materials (Hoffman JR et.al2005).There fore the aim of this study was to investigate of effects four week interval training with creatin supplementation on peak power, mean power, fatigue index and sprint performance in amatory female swimmers. Methods The subject in supplement group (N=10) ingested 20gr Creatin supplementation per day for 5 day (2x10 per day) (loading phase) and then ingested 5 gr pre day for 23 days (maintenance phase). In placebo group (N=10), the subject ingested the same dose of placebo and in same time. Both groups participated in interval training for four weeks. Wingate test used to evaluation the anaerobic factors (peak power, mean power, fatigue index), and for staminate the sprint performance all subjects performed sprint swimming (25m). These tests performed by all subjects before and after 4 week training. Results Results of one way ANOVA test showed that four week interval training with Creatin supplementation improved anaerobic factors such as peak power ( $F= 4.8$ ,  $P= 0.02$ ), fatigue index ( $F= 4.95$ ,  $P= 0.01$ ), but don't effect on mean power ( $F= 4.1$ ,  $P= 0.02$ )and sprint performance ( $F= 1.52$ ,  $P= 0.23$ ). Discussion Findings in our research showed that using Creatin supplement, increase storage of muscle Creatin that it related to improved peak power and fatigue index. Because it due to increase in available fuel (Hall et al 2007, Anomaciry 2006). in the other hand interval training with short time and acute activities periods and recovery periods between activities periods due to improve performance of phosphate system . Major energy system in interval training is phosphate system but so Gelycoletic system is involved in this training. Thus improving in mean power that it evaluated anaerobic Gelycoletic capacity and sprint performance can be related to interval training. Therefore using Creatin supplement in power athletes that trained more than 1 per day can increase fatigue tolerance and made high capacity of training that is due to better adaptabilities to power training (Barnet et al 2005). Reference Anomasiry (2006).Journal Medicine Associated Thui. Suppl 2:s228-32. Barnet C et al (2005). Muscle metabolism during sprint exercise in man.Sep; Vol7, No (3): pp314-22. Hall.RD.et al (2007).Journal of strength cond Reaserch.Vol 18, No (2): pp 272-5. Hoffman et al (2005).Journal of strength cond Research. Vol 19, No (2): pp 260-4.

#### BLOOD BICARBONATE BUFFERING DURING REPEATED SHORT-TERM INTENSE EXERCISE

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Blood bicarbonate buffering during repeated short-term intense exercise Yunoki, T.1, Yamanaka, R.1, Arimitsu, T.1, Lien, CS.1, Afroundeh, R.1, Matsuura, R.2, Yano, T. 1: Hokkaido University (Sapporo, Japan), 2: Kyushu Kyoritsu University (Kitakyushu, Japan) Introduction During short-term intense exercise (STIE), decreased pH can become a factor limiting exercise performance. During repeated STIE, decrease in pH is attenuated due to decreased lactate production associated with muscle glycogen reduction. In this situation, the primary limiting factor would be decrease in rate of ATP synthesis from the glycolytic system. However, since the glycolytic pathway is inhibited by low-ered pH, defence against pH decline must be important even during repeated STIE. Bicarbonate buffering is neutralization of  $H^+$  by  $HCO_3^-$  and is linked to elimination of  $CO_2$  by hyperventilation (respiratory compensation). Since decreased blood pH is one of the factors that contribute to hyperventilation during exercise, bicarbonate buffer power ( $\beta_{bi}$ ) during STIE may be decreased by repetition of exercise because of attenuation of pH decline. The purpose of this study was to examine  $\beta_{bi}$  during repeated STIE. Methods Eight subjects performed three STIEs (120 s, 100-105% of  $VO_{2max}$ , 60 rpm) using a cycle ergometer. STIEs were separated by 20 min of recovery, 40 min of middle-intensity (= ventilatory threshold) cycling, and a further 40-60 min of recovery. Respiratory variables were measured during each STIE and 20 min of recovery. Blood gas, acid-base status, and lactate concentration ( $[La^-]$ ) were measured in arterialized-capillary blood withdrawn from pre-warmed fingertips before and after each STIE.  $\beta_{bi}$  was calculated from change ( $\Delta$ , difference in the value at rest and at 3 min of recovery) of  $HCO_3^-$  and pH ( $\Delta[HCO_3^-]$ - $\Delta pH$ -1). Results Increase in  $[La^-]$  was significantly lower in the 3rd STIE than in the 1st STIE. Consequently, decrease in pH ( $\Delta pH$ ) was significantly attenuated in the 3rd STIE (from  $7.425 \pm 0.005$  (mean  $\pm$  SE) to  $7.270 \pm 0.009$ ) compared to that in the 1st STIE (from  $7.431 \pm 0.007$  to  $7.231 \pm 0.012$ ). There was no significant difference in  $\beta_{bi}$  between the three STIEs (1st:  $55.2 \pm 3.9$ , 2nd:  $58.0 \pm 2.8$ , 3rd:  $59.3 \pm 2.4$  mmol-l-l). Ventilation (VE) during exercise was significantly higher in the 3rd STIE than in the 1st STIE, and  $PaCO_2$  during exercise tended to be lower in the 3rd STIE than in the 1st STIE. Discussion The significant decreases in  $[La^-]$  increase and pH decline observed in the 3rd STIE suggest that muscle glycogen was reduced by the repetition of STIE. Despite attenuation of pH decline, VE during the 3rd STIE was significantly higher than that in the 1st STIE. Respiratory compensation was thus maintained even during the 3rd STIE and, as a result,  $\beta_{bi}$  could not have been decreased by the repetition of STIE. This implies that in repeated STIE, maintenance or enhancement of respiratory compensation supports the function of the glycolytic system by maintaining  $\beta_{bi}$ .

#### THE EFFECT OF SODIUM BICARBONATE ON EXERCISE RECOVERY AND SUBSEQUENT PERFORMANCE OF MAXIMAL SHORT TERM EFFORT

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Purpose: To examine the effect of Sodium Bicarbonate ( $NaHCO_3$ ) on exercise recovery and subsequent performance of maximal short term effort and to establish side effects of GI distress that may result from the supplement use. Methods: 9 trained subjects ( $VO_2$   $64.65 \pm 6.81$  ml/kg/min) competing at national level 800m ( $115.50 \pm 4.98$  s) or 1500m ( $237.89 \pm 4.98$  s) were recruited to Dublin City University. Each subject undertook a treadmill familiarisation and  $vVO_2$  maximal incremental test ( $23.96 \pm 0.73$ kph) to determine 110% of max. Subjects then took either a control (maltodextrin) or  $NaHCO_3$  (SB) supplement on two separate days one week apart in a double blind fashion. The test involved two supra-maximal trials three hours apart, with time to exhaustion recorded. Blood gas ( $CHCO_3^-$ -(P,st), pH,  $pCO_2$ ,  $pO_2$ ) and lactate were taken from the ear at 11 times during testing. Heart rate and RPE was measured, and GI distress was measured

with questionnaires and a 0-5 scale. Results: Subjects displayed large individual responses to SB supplementation. Mean subsequent performance was not significant ( $p=0.266$ ) but was higher than the placebo group, and some subjects ( $n=5$ ) improved significantly. Lactate, pH and  $\text{CHCO}_3^-$  (P,St), was significantly higher ( $p=0.033$ ,  $p=0.000$ , and  $p=0.000$  respectively) in the SB group, whilst  $\text{pO}_2$  and  $\text{pCO}_2$  did not show any difference ( $p=0.457$  and  $p=0.057$  respectively). GI distress displayed no significant difference ( $p=0.511$ ) and mean values were low (0.64 being the highest). Recovery times were not improved in the SB group. Conclusion: This study adds to the limited evidence that SB may improve subsequent performance, but does not improve recovery times with regard to pH. Effects seem to be subject dependent, with some displaying no change where others perform significantly better. New methods of SB ingestion yield very little side effects of GI distress.

## EFFECTS OF CAFFEINE ON EXERCISE PERFORMANCE IN SEDENTARY MEN

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EFFECTS OF CAFFEINE ON EXERCISE PERFORMANCE IN SEDENTARY MEN George J Laurence, Karen E Wallman, Kym J Guelfi, School of Sport Science, Exercise and Health, The University of Western Australia, Perth, Western Australia Introduction: Caffeine is an easily accessible central nervous system stimulant that has minimal negative side effects and high social acceptability (Fredholm, Battig, Holmen, Nehlig & Zvartau, 1999). While various studies have reported an ergogenic effect of caffeine in an athletic population, there has been minimal investigation into the effects of caffeine on exercise performance in a sedentary population (Engels & Haymes, 1992, Wallman, Goh & Guelfi, 2010). This is an important area of research, as caffeine may benefit this population by lowering the perception of effort and pain during exercise, possibly resulting in an increased amount of work being performed, and more energy being expended during an exercise session. This could lead to increased motivation in establishing a regular pattern of exercise. Therefore the purpose of this study was to examine the effect of caffeine ingestion on total work, mean power, oxygen consumption ( $\text{VO}_2$ ), energy expenditure (kJ), respiratory exchange ratio (RER), ratings of perceived exertion (RPE) and heart rate (HR) during 30 min of self-paced stationary cycling in a sedentary population. Methods: Using a counterbalanced, double-blind, crossover design, twelve healthy, sedentary, male, non-regular caffeine users completed two exercise trials 7 days apart, following ingestion of either caffeine (6 mg/kg body mass) or placebo 1 hour prior to exercise. Exercise trials were performed on a cycle ergometer and consisted of 30 min of stationary cycling in which participants were instructed to complete as much work as possible in the time allowed. Results: The total amount of work completed and power output maintained during the caffeine trial were significantly higher compared to placebo ( $p = 0.001$  and  $p = 0.001$ , respectively). In addition, there was a significant increase in HR,  $\text{VO}_2$  and energy expenditure during exercise after caffeine ingestion ( $p = 0.031$ ,  $p = 0.009$  and  $p = 0.018$ , respectively), however RPE and RER were similar between trials ( $p = 0.877$ ,  $p = 0.760$ , respectively). Conclusion: Acute caffeine ingestion resulted in sedentary men performing more work in a 30 min cycle exercise session, compared to the placebo trial, without any change in substrate utilization or the perceived effort of the exercise. Engels, H., & Haymes, E. (1992). *Int J Sport Nutrition*, 2, 386. Fredholm, B., Battig, K., Holmen, J., Nehlig, A., & Zvartau, E. (1999). *Pharmacological Reviews*, 51, 83. Wallman, K., Goh, J., & Guelfi, K. (2010). *J Sports Sci & Med*, 9, 183-189.

## EFFECT OF CAFFEINE ON FATIGUE DURING SUBMAXIMAL ISOMETRIC CONTRACTIONS AT DIFFERENT KNEE ANGLES

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Introduction Time to fatigue during intermittent submaximal isometric contractions of knee extensors is muscle-length dependent (Kooistra et al., 2005). The time to fatigue of knee extensors can be increased by caffeine ingestion (e.g. Plaskett and Cafarelli, 2001). It is not clear whether the effect of caffeine on fatigue is muscle-length dependent. We determined the effect of caffeine on fatigue during intermittent isometric contractions of knee extensors at two knee joint positions. Methods Ten male subjects ( $24 \pm 3$  yr,  $177 \pm 5$  cm,  $75 \pm 6$  kg), non-smoking and with low caffeine intake ( $<200$  mg/wk) volunteered. The study had a double-blind, counter-balanced design. Familiarized subjects were administered caffeine (C, 6 mg/kg) added to a non-caloric beverage or placebo (P), 1 hr before performing functional testing. Maximal voluntary isometric torque (MVIT) and intermittent isometric contractions at 50%MVIT (15 s contraction, 5 s rest) of knee extensors were performed at knee angles of  $30^\circ$  (long muscle length) and  $90^\circ$  (short muscle length) (Humac Norm, CSMi) until torque fell below 45%MVIT for more than 2 s providing time to fatigue. Fatigue was quantified by measurement of a MVIT, 20 s after completion of the intermittent protocol. Surface EMG (Bagnoli-8, Delsys) of m.vastus lateralis was recorded and analysed for root mean square (RMS). Data were analysed with 2-way ANOVA and paired t-tests with significance set at  $P < 0.05$ . Results Similar MVIT values were obtained for caffeine and placebo at both knee positions [e.g.  $30^\circ$ :  $151 \pm 29$  Nm (C),  $152 \pm 30$  Nm (P)]. Caffeine showed increased time to fatigue, being equal by 15% ( $30^\circ$ ) and 13% ( $90^\circ$ ) at both knee positions [ $30^\circ$ :  $150 \pm 18$  s (C),  $131 \pm 19$  s (P);  $90^\circ$ :  $101 \pm 11$  s (C);  $90 \pm 14$  s (P)]. Time to fatigue was higher at  $30^\circ$  (long muscle length) for both conditions. Fatigue index was similar for both conditions and knee positions [e.g.  $30^\circ$ :  $19.8 \pm 1.7\%$  (C),  $19.6 \pm 1.9\%$  (P)]. Changes in RMS ( $n=6$ ) were similar for both conditions and knee positions [e.g.  $30^\circ$ :  $154 \pm 14\%$  (C),  $154 \pm 16\%$  (P)]. Discussion Similar increases in time to fatigue following caffeine ingestion with an identical endurance protocol were shown before (Plaskett and Cafarelli (2001). These authors proposed that the caffeine-induced increase in time to fatigue may be due to alterations in muscle sensory processes. In addition, caffeine's enhancing effect may be related to calcium reuptake (Meyers and Cafarelli, 2005). Caffeine enhances time to fatigue during submaximal intermittent isometric contractions. However, potential mechanism(s) seem not to be muscle length dependent. References Kooistra RD, de Ruiter CJ, de Haan A. (2005). *J Appl Physiol*, 98, 810-816. Meyers BM, Cafarelli E. (2005). *J Appl Physiol*, 99, 1056-1063. Plaskett CJ, Cafarelli E. (2001). *J Appl Physiol*, 91, 1535-1544.

## CAFFEINE AFFECTS TIME TO EXHAUSTION AND BLOOD LACTATE CONCENTRATION AT MAXIMAL LACTATE STEADY STATE IN ACTIVE SUBJECTS DURING CYCLING.

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Caffeine affects time to exhaustion and blood lactate concentration at maximal lactate steady state in active subjects during cycling. Caputo, F.<sup>1</sup>, Turnes, T.<sup>1</sup>, de Aguiar, R.A.<sup>1</sup>, Cruz, R.S.O.<sup>1</sup>, Faraco, H.C.<sup>1</sup>, Guglielmo, L.G.A.<sup>2</sup> 1 – UDESC (Florianópolis, Brazil); 2 – UFSC (Florianópolis, Brazil) Introduction The factors that can affect the exercise tolerance ( $\text{Tlim}$ ) at the velocity associated with maximal lactate steady state ( $\text{vMLSS}$ ) are still unclear (Baron et al., 2008; Fontana et al., 2009). Recently, Fontana et al. (2009) showed that  $\text{Tlim}$  at  $\text{vMLSS}$  was not different between cycling and running despite of differences in blood lactate concentration ( $[\text{La}]$ ), heart rate (HR), oxygen uptake ( $\text{VO}_2$ ) and

ventilation (VE) between exercise modes. Caffeine ingestion has presented increase in both Tlim and blood metabolites such as lactate, glucose and glycerol (Graham and Spriet, 1995). Thus, our hypothesis is that caffeine intake could also increase the Tlim at vMLSS regardless of its effects on [La], since Tlim does not seem to be affected by changes in [La]. Therefore, the aim of this study was to analyse the effect of caffeine ingestion on Tlim during exercise at vMLSS. Methods MLSS was determined in nine male active subjects ( $51.4 \pm 5.1$  ml.kg<sup>-1</sup>.min<sup>-1</sup>;  $24.6 \pm 3.9$  years;  $175.7 \pm 7.9$  cm,  $78.3 \pm 12.5$  kg) by 2-4 constant-load tests (30min). vMLSS was defined as the highest velocity that can be maintained with an increase in [La] lower than 1.0 mMol.L<sup>-1</sup> during the final 20 minutes. In two different occasions, all subjects were asked to perform a test until exhaustion at the vMLSS with either caffeine (6 mg.kg<sup>-1</sup>) or placebo (dextrose). Blood lactate concentration was measured every 10 min. A two-way ANOVA with repeated measures was used for statistical analysis. Results Tlim was significantly higher after Caffeine ingestion (CAF) compared to placebo (PLA). The [La] was significantly higher in both 30th min and immediately after the end of exercise during CAF compared to PLA, however it was found no differences on [La] for 10th min between CAF and PLA. During CAF trial, [La] at 30th min and immediately after the end of exercise were not different, but higher compared to 10th min. During PLA trial, [La] was higher immediately after the end of exercise compared to 10th min, but similar between 10th min and 30th min. Conclusion The caffeine ingestion caused a significant ergogenic effect (17%) on Tlim performed at vMLSS, regardless of the changes on [La]. However, besides increasing the [La] relative to placebo, the CAF condition has presented an increase in [La] higher than 1.0 mMol.L<sup>-1</sup> ( $1.77 \pm 0.6$  mMol.L<sup>-1</sup>) between the 10th and 30th min suggesting that caffeine ingestion, at least a dose of 6 mg.kg<sup>-1</sup>, can affect the MLSS determination and its corresponding velocity. References BARON, B. et al.(2008). Br J Sports Med, 42, 828-33. FONTANA, P. et al. (2009). Eur J Appl Physiol, 107, 187-92. GRAHAM, T.E.; SPRIET, L.L. (1995). J Appl Physiol, 78, 867-74

### DETRAINING PROMOTES AN INCREASE IN FAT VOLUME, BUT DOES NOT AFFECT GLUCOSE TOLERANCE AND INSULIN SENSITIVITY IN RATS SUPPLEMENTED WITH LEUCINE

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Introduction The changes promoted by physical training in fat mass, glucose tolerance and insulin sensitivity, as well as in the activity of enzymes involved in energy metabolism can be rapidly reversed with the initiation of detraining. Thus, the total interruption of training can lead to metabolic disturbances consistent with a pre-obesity condition. Therefore, the aim of this study was to evaluate the effects of detraining on fat volume, glucose metabolism and enzyme activity in rats supplemented with leucine. Methods The study was conducted with 23 male adult Wistar rats subjected to treadmill training for 8 weeks. Subsequently, the animals were divided into three groups: (1) trained (T: n=8) and (2) detrained (D: n=8), maintained on a diet AIN93-M; and (3) detrained + 5% leucine supplementation (DL: n=7). These three groups were kept in this experimental protocol over a period of six weeks and were subjected to an oral glucose tolerance test (OGTT) and an intraperitoneal insulin tolerance test (ipITT). After sacrifice, samples of epididymal white adipose tissue and soleus muscle were excised for analysis. Data were analyzed using one-way ANOVA followed by post-hoc Tukey test ( $P < 0.05$ ). Results Both groups D ( $20.20 \pm 5.94$ ) and DL ( $18.81 \pm 5.52$ ) showed fat cell hypertrophy when compared to trained animals ( $10.47 \pm 2.45$ ). The area under the curve for OGTT showed no significant difference between groups D ( $12850 \pm 692,6$ ), DL ( $13440 \pm 323,4$ ) and T ( $12470 \pm 255,8$ ). The rate of glucose disappearance during insulin tolerance test (Kitt) was similar in all groups (D:  $2.10 \pm 0.44\% \cdot \text{min}^{-1}$ ; DL:  $2.39 \pm 0.45\% \cdot \text{min}^{-1}$ ; T:  $2.22 \pm 0.44\% \cdot \text{min}^{-1}$ ). The enzymatic activity of citrate synthase was similar between groups D ( $5.18 \pm 0.43$ ) and DL ( $5.01 \pm 0.26$ ), but differed from group T ( $7.52 \pm 0.65$ ). Discussion We found that detraining promoted fat cell hypertrophy, which corroborates previous studies showing increased fat mass (Yasari et al, 2007); lower citrate synthase activity in detrained animals, with leucine supplementation not capable to reverse such conditions. On the other hand, six weeks of detraining did not affect glucose metabolism in the experimental groups, differing from a previous study performed in humans (Chen et al, 2006) which demonstrated increased insulin plasma levels after OGTT. References CHEN, S. Y.; CHEN, S. M.; CHANG, W. H.; LAI, C. H.; CHEN, M. C.; CHOU, C. H.; KUO, C. H. (2006) Int J Obes, 30, 40-4. YASARI, S.; DUFRESNE, E.; PRUD'HOMME, D.; LAVOIE, J. M. (2007) Physiol Behav, 91, 281-289.

## Poster presentations

### PP-PM41 Biochemistry 2

#### RAT MODELS SELECTIVELY BRED FOR LOW AND HIGH RESPONSE TO TRAINING

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Introduction On average, populations derive physiological benefit through exercise training. Yet, there is wide heterogeneity for response to exercise, whereby some individuals experience little or no gain in variables such as VO<sub>2</sub>max (i.e. non-responders). Given the potential for exercise as prescription for cardiovascular disease risk, we were motivated to develop animal models of low and high response to training by two-way (divergent) artificial selection in rat. Methods Starting with a genetically diverse population, 10 generations of selection (n= 1816) has produced heterogeneous lines of Low Response Trainer (LRT) and High Response Trainer (HRT) rats that differ markedly for gain in running performance after 8 weeks of classic treadmill training. We used 6 weeks of high-intensity interval treadmill training to evaluate for exercise stimulated changes in VO<sub>2</sub>peak and cardiac function. Isolated left ventricular cardiomyocytes from sedentary (SED) and exercise trained (TR) LRT and HRT rats (n=5 per group) were measured for morphology, contractility, and Ca<sup>2+</sup> handling. A whole-genome microarray experiment was designed to compare SED and TR expression patterns from LRT and HRT cardiac left ventricles. Results HRT and LRT rats were similar at baseline for VO<sub>2</sub>peak but after training, HRT VO<sub>2</sub>peak increased from 65 to 90 ml/kg/min whereas LRT VO<sub>2</sub>peak was not altered. Left ventricular weights were lower (-8%), cardiomyocytes shorter (-6%) and wider (32%) in LRT-SED compared to HRT-SED. Post-training, these differences became larger in HRT hearts whereas LRT did not change. Fractional shortening and intracellular Ca<sup>2+</sup> cycling were not different between untrained LRT-SED and HRT-SED hearts. Exercise training improved contractility and intracellular Ca<sup>2+</sup> handling in HRT-TR, but not LRT-TR. Similarly, T-Tubule density, an assessment of active remodeling response, did not change in LRT but increased 12% with training in HRT rats. The microarray analysis revealed p53 tumor suppressor-dependent, IGF and TGF-beta signaling pathways as the main divergence between SED HRT and LRT hearts. mRNA levels of the 3 genes with highest expression differential, osteoglycin (Ogn), early growth response 2 (Egr2), and galanin (Gal) for LRT vs HRT in SED condition were validated with qPCR as significantly more abundant in LRT-SED than HRT-SED, LRT-TR and HRT-TR. Discussion By artificial selection, we developed a

contrasting animal model system useful for deeper exploration of exercise adaptation response at several levels of biological organization. We find that inherited cardiac flexibility for growth and remodeling are important for expansion of maximal O<sub>2</sub> transport capacity.

## MONITORING THE EFFECTS OF TRAINING LOAD ON BIOCHEMICAL PROFILE IN INDIAN MALE CYCLISTS

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**MONITORING THE EFFECTS OF TRAINING LOAD ON BIOCHEMICAL PROFILE IN INDIAN MALE CYCLISTS.** Pralay Majumdar, S. Srividhya Introduction Biochemical tests are widely used to assess the health, fitness of the intensively training athlete, to improve the performance of players. Several studies have shown the physiological approach to training in the sport of cycling (Boulay, 1995) and our study is concerned about the biochemical changes during the training cycle. Methods A total of 12 male cyclists volunteered to participate in this study. The training program is divided into four phases during phase I, phase II, phase III and phase IV, the volume of training is based on duration of hours and the km traveled by the cyclist (I – 560, II – 680, III – 720 & IV – 560 km). The intensity was measured on the percentage of heart rate, wherein E1= Up to 60% HR, E1b= 60-69% HR, E2= 69-80% HR (Threshold), E2S= Working at 80% HR (Threshold, S=Strength), E3= 81-90% HR, E4= 90-100% HR. The blood samples are collected in each phase to find out the impact of training load on Indian male cyclist. Results Iron, TIBC, Lactate dehydrogenase and cortisol level increases till III phase and decrease in the IV phase of training. Ferritin, creatine phospho kinase and testosterone level decreases in II, increases in IV and again decreases in the IV phase. Hemoglobin level increases whereas testosterone/cortisol ratio level decreases subsequently in the periodized cycle. Discussion The present study was designed to find out the impact of training on cyclist's biochemical profile. The values of biochemical profile are within the normal range except enzymes and cortisol level. Hematological profile of cyclists fluctuates depends on the volume/frequency/intensity of training. The demand of iron increases as volume/intensity of training increases, so there was increase in TIBC level to use the maximum amount of iron available. The depletion of iron store is more in II phase which is due to the increment of 21% of training volume whereas in III phase the increment is only 6%. The hemoglobin level of the cyclists increases subsequently in the training cycle whereas the iron level decreases in the fourth phase due to alteration in training and revealed that the hemoglobin level is high during the lowest volume/frequency of training. The highest intensity, volume and frequency of E2S training in III phase increases the CPK, LDH and cortisol level the most (Majumdar et al., 2010) and decreases the testosterone level the most. The testosterone/cortisol ratio decreases subsequently due to more training load in subsequent cycle. Hence, the above mentioned biochemical markers are to be monitored in all the phases to prevent anemia and over training. References 1.Boulay, M.R. (1995). Physiological monitoring of elite cyclists practical methods. *Sports Medicine*, 20 (1), 1-11. 2.P.Majumdar, S.Srividhya, M.Malay & Kalinski M.I.(2010). Response of selected hormonal markers during training cycles on Indian female swimmers, *Biology of sport*, 27(1), 53-57.

## AMINO ACID CHANGES IN TYPE I AND II FIBRES OF HUMAN SKELETAL MUSCLE AFTER MAXIMAL CONCENTRIC AND ECCENTRIC EXERCISE

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**AMINO ACID CHANGES IN TYPE I AND II FIBRES OF HUMAN SKELETAL MUSCLE AFTER MAXIMAL CONCENTRIC AND ECCENTRIC EXERCISE** Birgitta Essén-Gustavsson<sup>1</sup> and Eva Blomstrand<sup>2</sup> <sup>1</sup>Department of Clinical Sciences, Swedish University of Agricultural Sciences, Uppsala, Sweden <sup>2</sup>Department of Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden Introduction Sustained endurance exercise leads to a pronounced reduction in the concentration of glutamate in muscle along with an elevation of tyrosine in both type I and type II fibres, with no alterations with respect to taurine and glutamine (Essén-Gustavsson and Blomstrand 2002). During resistance exercise glutamate is lowered in both fibre types, especially in type II fibres and alanine is elevated in both fibre types (Blomstrand and Essén-Gustavsson, 2009). These observations indicate that amino acid metabolism plays an important role in both types of fibres during exercise. The aim of this study was to investigate how amino acid concentrations were affected in type I and type II muscle fibres by maximal concentric and eccentric exercise. Material and Methods Four healthy young men performed 4x6 maximal isokinetic (30 degrees/sec) contractions with one leg, both concentric and eccentric with one hours rest period in between. Muscle biopsies (vastus lateralis) were taken before and after both exercise bouts. Freeze-dried muscle tissue was used to separate single fibres and fragments of these were identified as type I or type II after staining for myosin ATPase. Pools (50-500 µg) of either type I or type II fibres were weighed and extracted in perchloric acid. After centrifugation concentrations of free amino acids in the supernatant were analysed using HPLC-technique. Results After both the concentric and eccentric exercise bouts the glutamate levels decreased (30-40%) in both type I and II fibres and the levels of alanine increased (40-60%). Glutamine levels were unchanged in both fibre types, whereas branched chain amino acids decreased (20-30%) in type I fibres after both exercise bouts. The levels of taurine were higher in type I than type II fibres and were not influenced by the exercise. Discussion Although data are available from only four subjects, the results indicate that certain amino acids, such as glutamate and alanine in both fibre types and branched chain amino acids in type I fibres, plays an important role in amino acid metabolism during both concentric and eccentric exercise. Furthermore, the changes seen in amino acids support that both type I and type II fibres are recruited during maximal concentric and eccentric exercise. References Essén-Gustavsson B, Blomstrand E (2002). *Acta Physiol Scand* 174: 275-281. Blomstrand E and Essén-Gustavsson B (2009). *Amino Acids* 37: 629-636.

## EFFECTS OF ENDURANCE TRAINING ON SKELETAL MUSCLE MEF2-HDAC5 INTERACTIONS

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**Introduction** As a co-repressor of myocyte enhancer factor 2 (MEF2) transcription factor, histone deacetylase 5 (HDAC5) is abundant in skeletal muscle of mammals and can repress MEF2-mediated transcription when MEF2 associated with HDAC5. In vitro AMPK could phosphorylate HDAC5 and induce its nuclear export, thereby removing HDAC5 transcriptional repressive function to MEF2. However, in vivo there have been no experiments revealing the relationship among AMPK, HDAC5 and MEF2. Therefore, the aim of this study was to explore the role of AMPKα2 in regulating HDAC5 and MEF2 interaction after a four week period of endurance training. **Methods** Two month old C57BL/6J wild-type (WT) mice (n=20), AMPKα2 over-expression (OE) transgenic mice (n=20) and AMPKα2 whole-body knock-out (KO) mice (n=20) were randomly subdivided into control groups and exercise groups. After four weeks of treadmill running (12m/min, 1h/day), the MEF2-associated HDAC5 activity in the nucleus of quadriceps femoris muscle was measured by co-immunoprecipitation. Total and nucleus HDAC5 protein expressions were measured by western blot. **Results** After four weeks of endurance training: (1) the

MEF2-associated HDAC5 activities in skeletal muscles of OE, KO and WT mice were all significantly lower than their control groups, but there were no significant differences among their exercise groups; (2) nucleus HDAC5 protein expressions in skeletal muscles of OE, KO and WT mice were also significantly lower than their control groups, and they were significantly lower in the exercise group of OE mice than in the exercise group of WT mice; (3) total HDAC5 protein expressions in skeletal muscles of OE, KO and WT mice had no significant changes when compared to their control groups and among their exercise groups. Discussion Exercise may disrupt MEF2/HDAC5 complexes and increase the accessibility of MEF2 transcription factors to their binding domains on DNA to increase MEF2/DNA interactions (McGee and Hargreaves, 2004; Beato and Eisfeld, 1997). Consistent with this theory, we observed that HDAC5 association with MEF-2 decreased 35% after 28 days of exercise training. Also observed was a 27% decrease in nuclear HDAC5 protein, whereas there was no change in total HDAC5 protein, suggesting that HDAC5 was exported from the nucleus. Additionally, the increase in AMPK activity associated with AICAR treatment decreased the abundance of HDAC5 found at the MEF2 binding region on the GLUT4 promoter (McGee et al., 2008). However, in the present study, OE or KO of the AMPK $\alpha$ 2 isoform did not have any effect on the content of nuclear HDAC5 association with MEF-2 after 28 days exercise training, although 35% lower nuclear HDAC5 protein content was found in  $\alpha$ 2-OE training muscles. Therefore, we reasoned that the observed decrease in nuclear HDAC5 association with MEF-2 was likely the result of other factors. Reference McGee SL, Hargreaves, M. (2004). *Diabetes*, 53, 1208–1214. Beato M, Eisfeld K. (1997). *Nucleic Acids Res*, 25, 3559–3563. McGee SL, van Denderen BJ, Howlett KF. (2008). *Diabetes*, 57(4), 860–867.

## HYPOXIA MODULATES MUSCLE SIGNALING IN RESPONSE TO SPRINT EXERCISE

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Sprint exercise elicits signaling in skeletal muscle through AMPK, presumably resulting in ACC phosphorylation. AMPK is phosphorylated and activated when the AMP/ATP ratio increases and may be when the redox state of the cell is changed. Purpose. To determine if CamKII is implicated in the sprint exercise-induced AMPK phosphorylation, and to ascertain if CamKII phosphorylation is modulated by free radicals. To this purpose we determined AMPK phosphorylation in response to sprint exercise in normoxia (N, FIO<sub>2</sub>=0.21; barometric pressure 735–745 mmHg) and hypoxia (H, FIO<sub>2</sub>=0.10; barometric pressure 735–745 mmHg) to have two conditions with different levels of oxidative stress. Methods: Ten healthy males (age: 25±5 yrs; VO<sub>2</sub>max: 51±6 ml.kg<sup>-1</sup>.min<sup>-1</sup>; means ± SD) performed on separate days and random order two 30s-isokinetic Wingate tests at 100 rpm under N and H. Immediately before the start, at the end of the test, and at 30 and 120 min into the recovery period, muscles biopsies were taken and CamKII, AMPK $\alpha$  and ACC $\beta$  phosphorylation determined by Western blot. Results: Peak power output, peak blood lactate and fatigue index were similar in N and H. Mean power output and mean VO<sub>2</sub> were, respectively, 6% and 37% lower in H than in N. Thirty min after the normoxic sprint, CamKII phosphorylation was increased 1.5 fold compared to resting (P<0.05) whilst there was no significant changes in CamKII phosphorylation after the hypoxic test. Compared to pre-exercise levels, AMPK phosphorylation was increased by 21% 30 minutes after the sprint (P<0.05). ACC $\beta$  phosphorylation, a downstream kinase for AMPK and CamKII was increased 3-fold immediately after the normoxic sprint and ~4-fold 30 min later (both P<0.05). In contrast, no significant changes in ACC $\beta$  phosphorylation were observed in response to the hypoxic sprint. In hypoxia, but not in normoxia, the 30 kDa skeletal muscle oxidized proteins increased immediately after the sprint (1.4-fold, P<0.05) and remained elevated during the next two hours (~1.5-fold, P<0.05). Conclusion: This study shows that muscle oxygenation modulates the signaling response to sprint exercise in human skeletal muscle by a mechanism that may involve free radicals. Our findings are compatible with CamKII as having a role in sprint exercise-induced phosphorylation of AMPK. Neither AMPK nor CamKII phosphorylations appear to be mandatory for the immediate postexercise ACC $\beta$  phosphorylation. Supported by Ministerio de Educación y Ciencia, (DEP2010-21866), Innova and Real Madrid football club.

## EFFECT OF DIFFERENT RESISTANCE TRAINING PROTOCOLS ON THE WNT SIGNALING PATHWAY

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**Introduction** The wingless-type MMTV integration site family (WNT) has recently been shown to be involved in adaptations to mechanical overload. For instance, this pathway was activated during skeletal muscle hypertrophy induced by an ablation protocol which overloaded the plantaris muscle in mice (Armstrong and Esser 2005). Armstrong and Esser (2005) observed that key components of the WNT pathway were up-regulated in overloaded plantaris muscles, i.e. the ligand receptor Frizzled 1, DVL1,  $\beta$ -catenin, LEF1 and the target gene Cyclin D1. Although some data are available on WNT modulation in animal models, it is still unclear whether WNT pathway components are regulated following different resistance training regimens in humans. Therefore, the aim of the present study was to investigate the effect of different resistance training regimens (ST or PT for 8 weeks) on the gene and protein expression of the canonical WNT signaling pathway components in physically active men. **Methods** Twenty five subjects (27.4±4.6 yrs) were randomly assigned to strength training (ST) (n=10), power training (PT) (n=10), and control (C) (n=5) groups. The ST and the PT groups performed high and low intensity squats, respectively, 3 times per week, for 8 weeks. Muscle biopsies from the vastus lateralis muscle were collected before and after the training period. **Results and Discussion** Relative strength and power increased similarly in both ST and PT groups (P<0.001). Fiber cross-sectional area also increased similarly in both ST and PT groups.  $\beta$ -catenin protein expression levels was assessed by Western blot. Certain genes were up-regulated in the ST group (WNT1: 6.4-fold, P<0.0001; SFRP1: 3.3-fold, P<0.0001 and LEF1: 7.3-fold, P<0.0001) and also in the PT group (WNT1: 24.9-fold, P<0.0001; SFRP1: 2.7-fold, P<0.0001; LEF1: 34.1-fold, P<0.0001 and Cyclin D1: 7.7-fold, P<0.001). In addition, the expression of key WNT pathway genes was substantially more responsive to PT than to ST (WNT1: P<0.0001; LEF1: P<0.0001 and Cyclin D1: P<0.001). Finally, the total  $\beta$ -catenin protein content increased only in the PT group (P<0.05). The results of the present study indicate that a PT regimen triggers greater responses in key elements of the WNT pathway. **References** Armstrong, D.D., Esser, K.A. (2005). Wnt/ $\beta$ -catenin signaling activates growth-control genes during overload-induced skeletal muscle hypertrophy. *Am J Physiol* 289 (4):C853–859.

### INTERACTION OF MYOGLOBIN WITH MITOCHONDRIA IN SKELETAL MUSCLES

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**INTRODUCTION** The mechanism of myoglobin (Mb)-mediated oxygen transport remains unclear. Recent evidences suggested that in the myocardium, the transverse diffusion of Mb is too slow to supply oxygen effectively to meet the immediate mitochondrial oxygen demand at the onset of muscle contraction (Lin et al., 2007); however, Mb supplies oxygen in response to mitochondrial activation (Takakura et al., 2010). This implies that Mb might exist close to or on mitochondria. The objectives of this study were to investigate the co-localization of Mb and mitochondria and confirm a possible interaction of Mb with mitochondrial respiratory chain proteins. **METHODS** Hindlimb muscles (m. soleus, m. plantaris, and m. gastrocnemius) and myocardia from male Wistar rats were used in the present study. Cellular sub-fractions were separated by serial centrifugation, and western blotting assessed the presence of Mb in whole cell (except nuclear), cytosol, and mitochondrial fractions. In transverse sections of muscles, the co-localization was examined by double immunohistochemical staining of Mb with mitochondrial marker proteins. Co-immunoprecipitation was performed to confirm a protein-protein interaction of Mb with COX-IV. **RESULTS** In all skeletal muscles, western blotting confirmed the presence of Mb protein in the mitochondrial fraction. The Mb content in the mitochondrial fraction was significantly higher in oxidative slow muscles (m. soleus, red portion of m. gastrocnemius) than in glycolytic fast muscles (other muscles). Immunohistochemical analysis also indicated an obvious co-localization of Mb with mitochondria. The area of co-localization in oxidative low muscles was greater than that in glycolytic fast muscles. In the protein-protein interaction assay, COX-IV was found to co-immunoprecipitate with Mb. **DISCUSSION** The present study revealed that Mb localizes on mitochondria. We provide evidence of strong association of Mb with COX-IV. This suggests the presence of a complex that enables immediate and effective submitochondrial oxygen transport. Mb has important roles in oxygen storage and translational diffusion, but it is not considered to contribute to mitochondrial respiration positively (Jürgens et al., 2000). Our findings should provide new paradigm of intracellular oxygen transport and mitochondrial respiration. **REFERENCES** Jürgens KD, Papadopoulos S, Peter T, Gros G. (2000). *News Physiol Sci*, 15, 269-274. Lin PC, Kreutzer U, Jue T. (2007). *J Physiol*, 578, 595-603. Takakura H, Masuda K, Hashimoto T, Iwase S, Jue T. (2010). *Exp Physiol*, 95, 630-640.

### CHANGES OF AUTOPHAGIC REGULATIONS IN RESPONSE TO VOLUNTARY EXERCISE TRAINING IN RAT CARDIAC MUSCLE

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**Introduction** Autophagy is a bulk degradation system in lysosome, and plays an important role in maintenance of cellular homeostasis. Under conditions of starvation, autophagy is drastically induced in various cells (Mizushima et al., 2004). Autophagy is also upregulated by reactive oxygen species, exercise, and ischemic preconditioning in cardiac muscle (Gottlieb et al., 2009). However, it remains unclear whether the levels of autophagic makers LC3-I/II would be changed by voluntary exercise training. Therefore this study examined the effects of voluntary wheel run training on the atophagic regulation in rat cardiac muscle. **Methods:** Twenty-four female Fisher344 rats (9 wk-old; 136.3±3.7 g) were used in this study. Rats were randomly divided into three groups; pre training (Pre, n=6), control (CON, n=8) or voluntary wheel run training (TR, n=7) groups. Training rats were housed individually in cages equipped with running wheels and allowed to run at their own pace for 4 weeks. After the training period, the cardiac muscle was removed. The expression of LC3-I/II, PPARγ coactivator -1α (PGC-1α) and Mn-superoxide dismutase (Mn-SOD) protein in the muscle was determined by Western blotting. **Results:** A mean running distance was 7.4±0.6 km/day. After 4 weeks training period, there were no significant differences in the expression levels of PGC-1α and Mn-SOD. Although the levels of LC3-II was unchanged, that of LC3-I was significantly increased in TR group compared with CON (p<0.05). **Discussion** In present study, LC3-I protein expression was significantly increased in Training group. This shows that wheel run training induced the upregulation of a basal form of LC3 protein expression; it may contribute to enhancement the ability to induce autophagy. These data suggest that LC3-I protein upregulates by voluntary exercise training. In conclusion, although short-term voluntary wheel run training upregulates the LC3-I expression, run training doesn't activate autophagy and mitochondrial biogenesis at the resting condition. **References** Gottlieb, RA., Finley, KD., Mentzer, RM Jr. (2009). *Basic Res Cardiol.*, 104(2), 169-180. Mizushima, N., Yamamoto, A., Matsui, M., Yoshimori, T. & Ohsumi, Y. (2004). *Mol. Biol. Cell*, 15, 1101-1111.

### NEUROCHEMICAL EFFECTS OF PHYSICAL EXERCISE IN THE BRAIN OF RATS WITH PARKINSON'S DISEASE

PINHO, R.A., TUON, T., TROMM, C., BOM, K., ROSA, G.L., LUCIANO, T.F., SOUZA, D.R., SILVA, L.A., DE SOUZA, C.T.

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**Introduction** Beneficial effects of exercise on Parkinson's disease (DP) has been suggested (Bloomer et al., 2008; Elokda et al., 2010), but the mechanisms responsible for these effects are poorly understood. Thus, the aim of this study was to evaluate the effect of training physical on the neurochemical and oxidative stress markers in the striatum of rats with DP. **Methods** Twenty-four 2-month-old male Wistar rats were divided into untrained+sham-operated (USO), untrained+DP (UDP), trained+Sham-operated (TSO), trained+DP (TDP), n=6. The animals were submitted to training on the treadmill (8-week, 4 days/week on alternate days, 50 min/day, 13-17 m/min). Twenty-four hours after training, DP was induced by lesion unilateral on the left hemisphere with an injection of 6-OHDA (8 µg in 1 µl in 0.2% ascorbic acid). Seven days after the lesion the animals underwent rotational test (rotameter) and euthanasia by decapitation ensued. The striatum was homogenized in specific buffer for Western Blot and immunoblotting with anti-tyrosine hydroxylase (TH), anti-brain-derived neurotrophic factor (BDNF), anti-superoxide dismutase (SOD), anti-catalase (CAT), anti-glutathione peroxidase (GPX), and specific buffer for oxidative damage in lipid (TBARS) and protein (carbonyl content). **Results** The UDP and TDP groups showed a clear rotational asymmetry when compared to sham groups and TDP group showed less asymmetry in relation to UDP group, apart from a significant reduction in the expression of TH, BDNF, SOD, CAT, GPX as well as an increase in TBARS and carbonyl content. The expression of TH was not significantly altered by exercise, but the TDP group increased the expression of BDNF, SOD, GPX and decreased the oxidative damage in lipids and protein. **Discussion** Similar post-lesioning results were found in other studies (Smith and Cass, 2007; Khan et al, 2010), suggesting that the model utilized was effective and the involvement of oxidative stress in the lesion induced by 6-OHDA. The effects of exercise on DP indicate the possibility that exercise, to a certain extent, modulates neurochemical status in the striatum of rats, possibly by improving the antioxidant defense system. In addition, the drop in oxidative stress restores the redox state and may result in the maintenance of NMDA channel function (Lu et al., 2001; Bustos et al., 2009) increasing levels of BDNF. **References** Bloomer RJ et al. (2008). *Med Sci Sports Exerc.* 40:1385-1389. Elokda A et al. (2010). *J Neurol.* 257:1648-1653. Smith MP and Cass WA (2007). *Neurosci Lett.*

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### PROTEOMIC ANALYSIS OF HEART OF OBESE AND NON-OBESE MICE. UNDERSTANDING THE ACUTE EFFECTS OF EXERCISE ON OBESITY

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Exercise has been proven to prevent and attenuate several metabolic and cardiovascular disorders. Metabolic dysfunction such as obesity is commonly related to cardiovascular diseases, frequently resulting in heart failure and death. In order to elucidate how exercise may influence acutely these pathologic dysfunctions in heart tissues from obese individuals, twelve-week-old C57BL6/J obese (ob/ob) and non-obese (ob/OB) mice were submitted to a single bout of swimming and had their hearts analyzed by proteomic techniques. Mice were divided into three groups: control without exercise (ob/ob, n=3; ob/OB, n=3); a moderate intensity consisting of 20 min of swimming around 90% of Maximal Lactate Steady State (ob/ob, n=3; ob/OB, n=3); and a severe intensity exercise with increasing overload until exhaustion (ob/ob, n=3; ob/OB, n=3). Obesity modulations were analyzed by comparing ob/ob and ob/OB control groups. Differential 2-DE analysis revealed that single session of exercise was able to acutely up-regulate: myoglobin, aspartate aminotransferase and zinc finger protein (Zfp) and down-regulate: nucleoside diphosphate kinase B and mitochondrial aconitase. Alpha-actin and Zfp were up regulated by the effect of obesity on heart proteome. These data demonstrate the immediate response of metabolic and stress-related proteins after exercise so as contractile protein by obesity modulation on heart proteome.

### WEEKLY TRAINING HOURS AND CATECHOLAMINE LEVELS DURING VITA MAXIMAL TEST

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**Introduction** Catecholamines like adrenalin and noradrenalin play an essential role in glucose metabolism in response to exercise. Adrenalin is a powerful regulator of a number of metabolic and physiological functions, and noradrenalin reflects the actions of the sympathetic nervous system. Exercise performed on intensity above anaerobic threshold leads to a marked increase in catecholamine levels. **Methods** A total of 99 elite athletes (24 male and 75 female) participated in this study. They were separated into two groups based on the weekly training hours. Team-sports: handball, soccer, waterpolo (18,83 hours/week) and individual sports: kayaking/canoeing, triathlon(31,5 hours/week). After a medical examination and anthropometric measurements, the subjects completed a vita maximal treadmill protocol while VO<sub>2</sub>rel (ml/min/kg) was measured. Subsequently, 10mL of venous blood was extracted at rest (r) and after the test was over (max). Adrenalin (A) and noradrenalin (NA) were measured in venous plasma (pg/ml). Statistical analysis was made by Statistica for Windows 9.0 software, linear correlation, Student t-test were used to learn about connections. **Results** The mean age of athletes was 23,53 ± 5,29 years. Correlation analysis confirmed significant relation between Ar and Amax in the whole sample (p<0,05) while no significance was found between NAr and NAmx. Significant correlations were found between VO<sub>2</sub>rel and NAr (p<0,05) among the examined athletes. We compared the two groups based on the training hours and there was significant difference between them in Amax, NAr and NAmx (p<0,05). Significant difference was found also in VO<sub>2</sub>rel values (individuals: 60,62; team players:49,29; p<0,05). The differences between adrenalin values (Amax-Ar) were significantly higher in the group, where the training hours were lower (p<0,05). The same pattern can be observed in case of noradrenalin values (NAmax-NAr, p<0,05). **Discussion** In this pilot study we observed higher differences at the catecholamine values (calculated: max-r) in case of the team sport players. The Vo<sub>2</sub>rel was remarkably higher at the athletes with higher training hours. Our future aim is to increase the number of the subjects, and examine the relationship between catecholamines from more aspects. **References** Zouhal H, Gratas-Delamarche A, Rannou F, Granier P, Bentue-Ferrer D, Delamarche P. Between 21 and 34 Years of Age. Aging Alters the Catecholamine Responses to Supramaximal Exercise in Endurance Trained Athletes. Int J Sports Med 1999; 20: 343 - 348 Christophe Hausswirth and Didier Lehénaff: Physiological Demands of Running During Long Distance Runs and Triathlons Laboratory of Biomechanics and Physiology, French National Institute of Sport and Physical Education (INSEP), Paris, France

## Poster presentations

### PP-PM42 Genetics

#### MCT1 GENETIC POLYMORPHISM ROLE DURING A CIRCUIT WEIGHT SESSION IN MEN AND WOMEN

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(Clinical trial gov number: NCT01116856) **Introduction** Lactate moves across the sarcolemma mainly through the monocarboxylated transporters (MCT) 1. Recently it has been reported that men carrying the MCT1 A1470T polymorphism (rs1049434) showed a higher capillary lactate accumulation slope than non-carriers during circuit weight training (CWT) 2. The aim of the present work is to study whether the A1470T polymorphism effect is present also in women and if it is influenced by gender. **Methods** 15 men (mean±standard deviation; 22,53±2,59 yrs; 76,66±6,45 kg; 177,21±3,77 cm) and 14 women (20,14±2,77 yrs; 60,38±5,43 kg; 164,46±5,06 cm) performed a CWT of 8 machine exercises at 70% of 15RM. Venous blood lactate during the session was analyzed using the YSI 1500 SPORT Lactate Analyzer. The MCT1 A1470T polymorphism was determined by direct sequencing. Two ways ANOVA with repeated measures was used to determine differences between genetic groups in each gender. The significant level was set at  $\alpha \leq 0.05$ . **Results** Interaction between genetic group and measurement was found in men (p=0.004) but not in women (p=0.361). Bonferroni post hoc showed higher venous lactate values for AA compared to TT in men (p=0.008). **Discussion** Our results show different blood lactate accumulation depending on the



A1470T polymorphism in men, confirming the influence of this genetic variant on lactate metabolism reported previously 2. However, with the same circuit we did not find effects of the polymorphism in the lactate curves in women, maybe because of their lower lactate concentrations when compared with men. If, as presumed, the lactate transporter MCT1 has a lactate threshold, the polymorphic MCT1 could have different effects in men than women. Moreover, when compared with previous studies, the polymorphism has different effect in capillary (arterialized blood) than in venous lactate levels<sup>2</sup>. These differences could be explained because a bidirectional function of MCT1<sup>3</sup>. In conclusion, our results confirm an influence of A1470T polymorphism on lactate metabolism in men, but not in women, and a potential different effect in the arterial and venous lactate levels. However, further research is required to better define the MCT1 function and the polymorphism role during high intensity exercises. References 1. Juel, C. *Eur J Appl Physiol* (2001); 86: 12-6. 2. Cupeiro, R, et al. *J Sci Med Sport* (2010); 13: 526-30. 3. Manning Fox, JE, et al. *J Physiol* (2000); 529 Pt 2: 285-93.

## THE IMPACT OF ACE GENOTYPE ON SERUM ACE ACTIVITY AND POWER PERFORMANCE IN THE KOREA POPULATION

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**Introduction** The deletion (D) rather than insertion (I) of a 287 bp fragment in the human ACE polymorphism is associated with higher circulating ACE activity and with power performance amongst Caucasians. However, there was no association between ACE genotype and ACE activity or human performance in some African populations, indicating the ethnic differences of the ACE genetic influence on the phenotypes (Payne et al., 2006; Scott et al., 2005). There is little information of the association of the ACE polymorphism with the phenotypes in the Asian population. Therefore, this study investigated this issue in the geographically and ethnically well-defined (Jin et al., 2003) Asian-Korean population. **Methods** A total of 940 Korean subjects were recruited, composing of 55 international level power-oriented athletes (High-performance), 100 power-oriented elite athletes (mid-performance) and 765 healthy adults (Control). Blood samples for the whole blood and serum were obtained and assayed for circulating ACE activity and the ACE I/D genotype. The distribution of ACE polymorphism throughout the groups was analyzed. Results In the Korean population, ACE I/D genotypes significantly associated with circulating ACE activity, showing I allele had low ACE activity and D allele did high (II vs. ID vs. DD =  $31.6 \pm 9.0$  vs.  $40.5 \pm 10.0$  vs.  $48.3$  nmol/ml/min;  $p < 0.01$ ). The ACE I/D polymorphism explained 22.8% of variation in circulating ACE activity levels ( $p < 0.01$ ). In genetic association to human power performance, there was a gradual decrease of frequencies of the DD genotype with advancing levels of power performance (Control vs. Mid-performance vs. High-performance = 17.2% vs. 100% vs. 5.5%,  $p < 0.01$ ). Therefore, power-oriented athletes at the top level had a markedly diminished frequency of the DD genotype. **Discussion** The findings of this study show the Asian-Korean population has the genetic association of ACE polymorphism with circulating ACE activity and human power performance. The DD genotype had the highest ACE activity and II genotype did the lowest, showing the results comparable to the Caucasian population (Rigat et al., 1990). However, it was not the DD genotype but the II genotype that showed higher power-oriented performance. Therefore, there was the ethnic difference in association of the ACE I/D genotype with power performance (Myerson et al., 1999). Further study will be needed for finding gene-to-gene interactions, gene-environment interactions, and mechanisms of ACE polymorphism on muscle functions. References Jin H-H, Kwak K-D, Hammer YN. (2003). *Hum Genet*, 114, 27-35. Myerson S, Hemingway H, Budget R. (1999). *J Appl Physiol*, 87, 1313-1316. Payne JR, Dhamrait SS, Gohlke P. (2006). *Ann Hum Genetics*, 71, 1-7. Rigat B, Huber C, Alhenc-Gelas F. (1990). *J Clin Invest*, 86, 1343-1346. Scott RA, Moran C, Wilson RH. (2005). *Com Biochem Physiol*, 141, 169-175.

## ACE, ACTN3 AND PTK2 GENOTYPE ASSOCIATIONS WITH HUMAN SKELETAL MUSCLE PHENOTYPES AND THE RESPONSES TO RESISTANCE TRAINING

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**ACE, ACTN3 AND PTK2 GENOTYPE ASSOCIATIONS WITH HUMAN SKELETAL MUSCLE PHENOTYPES AND THE RESPONSES TO RESISTANCE TRAINING** Erskine R.M.1, Jones D.A.2, Williams A.G.1, Stewart C.E.2, Degens H.2 1 Institute for Performance Research; 2 Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University, UK. **Introduction** It is equivocal whether the human angiotensin converting enzyme (ACE) I/D and alpha actinin-3 (ACTN3) R577X polymorphisms are associated with skeletal muscle strength, power and size, and the variable responses to resistance training. Furthermore, it is not known whether polymorphisms of the protein tyrosine kinase-2 (PTK2) gene, which encodes focal adhesion kinase (involved in cell interactions with the extracellular matrix), are related to these phenotypes. **Methods** Quadriceps femoris (QF) maximum muscle force, volume, physiological cross-sectional area (PCSA), specific tension (force per PCSA) and maximum power were determined in vivo before and after 9 weeks of leg-extension resistance training in 51 untrained young men. All participants were genotyped for the ACE I/D, ACTN3 R/X, PTK2 rs7460 A/T and rs7843014 A/C polymorphisms. DNA was extracted from 200 µL whole blood using spin columns and genotyping was performed via real-time PCR using a Chromo4 machine and a pre-designed Taqman genotyping assay. Results Larger post-training increases in the single repetition maximum (1-RM) were observed in ACE I/I ( $+103 \pm 26\%$ ) than in I/D ( $+65 \pm 27\%$ ) and D/D ( $+61 \pm 31\%$ ) genotype ( $P < 0.05$ ). Similarly, maximum power increased more in ACE I/I ( $+16 \pm 6\%$ ) than in I/D ( $+3 \pm 12\%$ ) and D/D ( $+4 \pm 11\%$ ) genotype ( $P < 0.05$ ). The ACTN3 R-allele was associated with greater baseline 1-RM ( $P < 0.05$ ), muscle volume ( $P < 0.05$ ) and power ( $P < 0.05$ ) but not with the responses to training. Baseline QF specific tension was higher in PTK2 rs7843014 A/A ( $P < 0.05$ ) and rs7460 T/T ( $P < 0.05$ ) homozygotes than in their respective rs7843014 C- and rs7460 A-allele counterparts, while power increased more in PTK2 rs7843014 C/C genotype ( $+13 \pm 8\%$ ) more than A/A ( $+1 \pm 12\%$ ) or A/C ( $+1 \pm 12\%$ ) following training ( $P < 0.05$ ). **Conclusions** The inter-individual variability in the response to strength training was associated with both the ACE I/D polymorphism (regarding changes in dynamic strength and power) and the PTK2 rs7843014 polymorphism (concerning the change in power). Differences in muscle strength, volume and power between untrained people were associated with the ACTN3 R/X polymorphism. Associations between muscle specific tension and polymorphisms of the PTK2 gene suggest that inter-individual differences in intrinsic muscle force might be related to variability in the lateral transmission of force. Future experiments should investigate potential associations between PTK2 genotype and skeletal muscle focal adhesion kinase concentration and activation, as well as the role of costameres in lateral force transmission.

### THE ACTN3 R577X NONSENSE ALLELE IS UNDER-REPRESENTED IN ELITE-LEVEL JAPANESE ENDURANCE RUNNERS

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**Introduction** Although previous reports have shown a lower proportion of the ACTN3 XX genotype (R577X nonsense polymorphism) in sprint/power athletes compared with controls, possibly attributed to the importance of skeletal muscle function associated with alpha-actinin-3 deficiency (Yang et al., 2003), the findings on association between endurance athlete status and R577X genotype are equivocal. The purpose of the present study was undertaken to examine the association of ACTN3 R577X genotype with elite Japanese endurance athlete status. **Methods** Subjects comprised 79 elite Japanese endurance runners (E) who participated in competition at national level and 96 Japanese controls (C). We divided endurance runners into two groups, i.e., 42 national level runners (E-N) and 37 international level runners (E-I) who had represented Japan in international competition. R577X genotype (rs1815739) was analyzed by direct sequencing. Frequency differences of polymorphisms between athletes and controls were examined by Chi-square tests. **Result** The R allele frequency tended to be higher in E group than in C group (0.557 vs. 0.458, OR: 1.49, 95% CI: 0.97-5.81,  $P=0.066$ ). When we divided endurance runners into two groups, the R allele frequency in E-I group was significantly higher than that in C group (0.595 vs. 0.458, OR: 1.73, 95% CI: 1.01-2.99,  $P=0.046$ ); whereas there were no significant differences between E-N and C groups. Then, the three genetic models were tested. The additive genetic model (RR>RX>XX) can be fitted to explain the differences between E-I and C (RR vs. XX, OR: 3.47, 95% CI: 1.04-11.56,  $P=0.038$ ), but not the dominant (RR vs. RX+XX) and the recessive (RR+RX vs. XX) genetic models. **Discussion** Although many previous studies suggest that R allele of the R577X in the ACTN3 gene was associated with sprint/power athlete status, this allele may also be one of determinants of competitive ability in endurance athletes. Our result agrees with those obtained by Ahmetov et al (2010). High-intensity intermittent training, which is also called "interval training", is now well known to improve endurance athletic performance (Lindsay et al, 1996). To improve endurance performance, very hard interval training is normally incorporated at least once a week in Japan, aimed at maximizing racing endurance performance and oxygen uptake capacity. It has been reported that subjects with RR genotype have a protective effect of muscle damage after eccentric training compared to subjects with XX genotype (Vincent et al., 2010). Thus, there is a possibility that people with R allele of ACTN3 R577X can adapt to high-intensity exercise training. **References** Yang N, MacArthur DG, Gulbin JP, et al., (2003). *Am J Hum Genet.* 73 (3), 627-631. Ahmetov II, Druzhevskaya AM, Astratenkova IV, et al., (2010). *Br J Sports Med.* 44 (9), 649-652. Lindsay FH, Hawley JA, Myburgh KH, et al., (1996). *Med Sci Sports Exer.* 28, 1427-1434. Vincent B, Windelinckx A, Nielens H, et al., (2010). *J Appl Physiol.* 109 (2), 564-573.

### THE ACE GENE INSERTION/DELETION POLYMORPHISM IN THE 2010 WORLD CHAMPION GROUP OF RHYTHMIC GYMNASTICS

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**Introduction** Genetic variants of some genes are related to athletic performance. The ACE gene codes for angiotensin converting enzyme (ACE), that is an integral part of Renin-angiotensin system (SRAA). It controls blood volume, blood pressure, electrolyte balance, cardiac and vascular function. Several polymorphic loci in the ACE gene have been identified but the most studied is Alu insertion (I allele) in intron 16. The insertion of a fragment of 287 bp is associated with lower ACE levels in serum and in tissues and may be associated with elite endurance performance. The Alu deletion (D allele variant) is associated with higher concentrations of serum ACE activity and this could lead to sprint and power performance. **Purpose:** The aim of this study was to examine if the ACE allelic variants have different frequencies between a group of elite rhythmic gymnasts and two different control groups matched for age and sex: one constitute by middle level gymnasts and the other one by sedentary university students. To date, very little is known about the frequencies of the ACE genotype in rhythmic gymnasts, and no data are available for the world champions in this sport. **Methods** The study included: a) 20 Italian National Rhythmic Gymnasts, six among them triumphed in the last World Rhythmic Gymnastics Championship (Moscow 2010); b) 23 rhythmic gymnasts middle level and c) 21 healthy nonathletic students from the University of Molise. The ACE genotype was evaluated by two independent polymerase chain reaction with two different primer pair. **Results** For these analysis a dominant model for allele D was assumed (DD vs ID/II). No significant differences were found for genotype ( $p=0.234$ ) or for allele ( $p=0.035$ ) frequencies within the two control groups, so we considered them as a unique reference population. Instead, the D allele of the ACE gene was more frequent in elite athletes respect to the control (Chi square=5.44  $p<0.01$ ); the data was confirmed also when compared to the middle level group alone ( $X^2 = 6.70$   $p<0.001$ ). **Conclusion** By the analysis of our data we observed that there is a significant association of ACE D allele in rhythmic gymnastics, sport in which anaerobic metabolism is more used.

### A POLYMERASE CHAIN REACTION-BASED METHODOLOGY TO DETECT GENE DOPING

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except close to the site of plasmid deposition, 1 hour after injection. Titration experiments demonstrated the specificity of the PCR assay for the exogenous FAK isoform and indicated that the threshold of detection situated at 4 femtogram DNA. Discussion: The findings show that the deposition of genetic medicine can be identified at the site of injection up to seven day after transection but not in serum. The findings suggest that under the current legislation the detection of gene doping in the immoral athlete is currently impossible with PCR technology as this requires collecting serum or muscling sample in temporal-spatial proximity of the doping intervention. References: Durieux AC, D'Antona G, Desplanches D, Freysenet D, Klossner S, Bottinelli R, Flück M. (2009), *J Physiol.* 587(Pt 14): 3703-17.

### THE COL6A1 GENE AND PERFORMANCE IN THE SOUTH AFRICAN IRONMAN TRIATHLON

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**Introduction** Mutations in the type VI collagen  $\alpha 1$  chain gene (COL6A1) cause myopathy and muscle weakness (Bertini and Pepe, 2002). In addition col6a1 knockout mice were shown to have impaired running performance and reduced muscle strength (Bonaldo et al., 1998). The COL6A1 IVS32-29 T/C polymorphism within intron 32 of the COL6A1 gene has been associated with several complex phenotypes (Kong et al., 2007; Tsukahara et al., 2005). The aim of this study was therefore to determine if the COL6A1 IVS32-29 T/C polymorphism is associated with performance in the South African Ironman triathlon. **Methods** Participants (661) were recruited at the registration of four South African Ironman triathlons. Finishing times for the swim-, bike-, and run-component, as well as the overall race were provided by the race organisers. All participants were genotyped for the COL6A1 IVS32-29 T/C polymorphism. **Results** Participants with the COL6A1 IVS32-29 TT genotype were significantly faster than those with a CC or TC genotype in the bike-component ( $p=0.014$ ) and overall race ( $p=0.030$ ). When participants were grouped into tertiles (fast, middle and slow finishers) for the bike-component, the TT genotype showed a significant linear trend ( $p=0.008$ ). The TT genotype frequency was highest in the fast group (TT, 35.7%), followed by the middle (TT, 29.0%) and slow groups (TT, 23.8%). No significant genotype frequency differences were observed for the swim-component or run-component of the South African Ironman triathlon. **Conclusion** This study identified, for the first time, the COL6A1 gene as a potential performance marker for endurance cycling. These effects may be mediated through changes to the composition of type VI collagen containing connective tissues, such as muscle and tendon. **References** Bertini E, Pepe G. (2002). *Eur J Paediatr Neurol*, 6, 193-198. Bonaldo P, Braghetta P, Zanetti M, Piccolo S, Volpin D, Bressan G. (1998). *Hum Mol Genet*, 7, 2135-2140. Kong Q, Ma X, Li F, Guo Z, Qi Q, Li W, Yuan H, Wang Z, Chen Z. (2007). *Spine*, 32, 2834-2838.

### INFLUENCE OF THE BRAIN DERIVED NEUROTROPHIC FACTOR GENE IN HEART RATE RECOVERY IMMEDIATELY AFTER EXERCISE

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**Introduction** A common single nucleotide polymorphism in the human brain derived neurotrophic factor (BDNF) gene (Val66met) may have a modulatory effect on the cardiac sympathovagal balance (Yang A., Chen, Tsai, Hong, Kuo, & Yang, 2010). Recovery of the heart rate immediately after exercise is a function of vagal reactivation. During exercise the increase of the sympathetic activity and the decrease of the vagal activity produce an increase of the cardiac heart rate. The parasympathetic activation, seems that causes the deceleration of the heart (Levy, 1971; Javorka, Zila, & Balhárek, 2002). **Methods** The sample was 67 healthy university Spanish students (age, 18-35 years), 17 females and 50 males, All of them were Caucasian for  $\geq 3$  generations. The genotype frequency was val/val ( $n=41$ ), val/met ( $n=22$ ) and met/met ( $n=4$ ). Hardy-Weimberg equilibrium  $\chi^2$  test ( $p = 0.65$ ). They performed a treadmill test with an inclination 3%, and speed increment (beginning at 6 km/h and increasing 2km/h every 2 minutes) until exhaustion, maximal heart rate was obtained as well as heart rate recovery immediately after the exercise during the first minute. Treadmill Lifefitness (USA), MP100 System Hardware. AcqKnowledge Software 3.9-Windows XP. Biopac Systems (USA) and Polar T31 (Finland) were used. Descriptives with Mean and Standard deviation were calculated using SPSS 18 package. **Results** Heart rate peak was 185.2 bpm. The results suggest that subjects with genotype met/met have a better heart rate recovery during the first minute (25.2 bpm.), Meanwhile subjects with val/val genotype showed 24.4 bpm. and last the val/met genotype (22.3 b.p.m.). **Discussion** It seems to be that the genotype met/met presents a main efficiency in the parasympathetic regulation, contrary to what expresses the study of Yang et al.(2010). Other studies associate the allele met of the polymorphism BDNF Val66Met with the increased BDNF serum concentrations. The decreased BDNF concentration in healthy people is more important in Val/Val subjects than in Val/Met. (Lang, Hellweg, Sander, & Gallinat, 2009). Our research was only a descriptive study and needs more research to determine the influence of the (BDNF) gene (Val66met) in the heart rate recovery. **References** Javorka, M., Zila, I., & Balhárek, T. a. (2002). Heart rate recovery after exercise: relations to heart variability and complexity. *Brazilian journal of medical and biological research*, 8 (35), 991-1000. Lang, U., Hellweg, R., Sander, T., & Gallinat, J. (2009). The Met allele of the BDNF val66met polymorphism is associated with increased BDNF serum concentrations. *Molecular Psychiatry*, 14, 120-122. Levy, M. (1971). Sympathetic-parasympathetic Interactions in the heart. *American Heart Association*, 29 (5), 437-445. Yang, A., Chen, T.-J., Tsai, S.-J., Hong, C.-J., Kuo, C.-H., & Yang, C.-H. a.-P. (8 de 03 de 2010). BDNF Val66Met polymorphism alters sympathovagal balance in healthy subjects. *American Journal of medical genetics Part B*.

### ACE I/D GENE POLYMORPHISM, BLOOD PRESSURE, C-REACTIVE PROTEIN AND PHYSICAL TESTS IN ZULU SOUTH AFRICAN CRICKETERS

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**Introduction** Angiotensin converting enzyme (ACE) polymorphism is the most extensively studied genetic variation related to physical performance, cardiovascular and muscle function and trainability in athletes (Wang et al., 2008). The aim of the study was to explore the ACE I/D polymorphism, blood pressure, C-reactive protein (CRP) and association with physical tests in Zulu cricketers. **Methods** Cricketers ( $n=14$ ) and students ( $n=17$ ) as controls were genotyped (blood spots) for ACE gene by PCR amplification (Alvarez et al., 2000). Systolic and diastolic blood pressure (SBP and DBP) and grip strength (kg), knee extension and flexion (Nm/kg) were measured, systolic tension time (STT) and metabolic rate (MR) were calculated. After ANOVA the association was probed using  $\chi^2$  maximum likelihood test and Fisher's exact test. **Results** ACE genotyping for the whole group displayed a complete absence of II genotype, 67.7% DD and 32.3% ID genotypes. The frequency of D allele was 83.8% and I allele 16.2%. In cricketers DD and ID genotypes were 50% each compared to controls-83% DD

and 17% ID. No differences in grip strength, knee extension and flexion between the groups were observed, but for the whole cohort 86% D allele frequency was associated with higher ( $> 43.3$  kg) grip strength ( $p < 0.037$ ). In cricketers CRP ( $< 3.0$  mmol/l) was associated with 79% D allele frequency. SBP and DBP were significantly lower by 3.2 mmHg and 4.25 mmHg, whereas increased values of STT by 5.5%, MR by 10.3% were found. Discussion Strength parameters contributed to cricketers performance. D allele has been associated with power output (Ruiz et al., 2010) and I allele with endurance (Collins et al., 2004). The limitation is the small number of participants. Null II homozygosity was established for the first time in Zulu athletes. Low frequency of II genotype was reported in African Americans, Kenyans, Jamaicans athletes (Scott et al., 2010) and Xhosa South Africans (Payne et al., 2007). Conclusions ACE I/D genotyping has shown a null II genotype and high D allele frequency associated with strength grip in the whole cohort. In cricketers no overrepresentation of DD or ID genotypes was noted and beneficial changes in blood pressure and metabolic rate were observed. References Alvarez et al (2000). *Eur J Appl Physiol*, 82, 117-120. Collins et al (2004). *Med Sci Sports Exerc*, 36, 1314-1320. Payne et al (2007). *Annals of Human Genetics*, 71, 1-7. Ruiz et al (2010) *J Appl Physiol*, 108, 561-566. Scott et al (2010) *Med & Sci in Sports & Exercise*, 42, 107-112. Wang et al (2008). *Sports Med*, 38, 1065-1079.

## Poster presentations

### PP-PM43 Training and Testing: Maximal Exercise 1

#### GRADED EXERCISE TESTING: RELATIONSHIP BETWEEN MAXIMAL RESPIRATORY EXCHANGE RATIO AND TEST DURATION IN RUNNERS

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**INTRODUCTION** The respiratory exchange ratio registered at maximal exercise in graded exercise tests (RERmax) is used as a criterion for test interpretation, and confirmation that maximal oxygen uptake has been obtained. Several arbitrary 'cut-off' values (i.e. 1.00, 1.10, 1.15) are used for acceptance or rejection of exercise tests. The steeper is the ramp slope (the work-rate increase per unit of time), the shorter is the duration of the incremental test, yielding greater rates of CO<sub>2</sub> output and higher RERmax values. However, the relationship between RERmax and test duration has not been clearly defined. The aim of this study was to determine the relationship between RERmax and duration of all-out incremental treadmill tests, in runners competing in different running events. **METHODS** The sample consisted of 48 male runners: 25 sprinters, and 23 middle/long distance runners. All subjects performed three incremental treadmill tests to the limit of tolerance in random order, with increases in running speed: a) 1 km/h each ½ minute (T0.5), b) 1 km/h each minute (T1), and c) 2 km/h every four minutes (T2). In all trials, the starting running speed was 8 km/h, with a constant inclination of 1.5%. Gas exchange data were recorded breath-by-breath and analyzed (Quark b2, Cosmed). Regression analysis of pooled data was used to model the relationship between RERmax and the duration of the tests. Two-way ANOVA was used to determine differences in the measured variables between the tests and the groups. **RESULTS** The average test durations were  $7.6 \pm 1.0$  min (T0.5),  $13.0 \pm 2.1$  min (T1) and  $22.8 \pm 4.1$  min. The mean VO<sub>2</sub>max values did not differ between protocols ( $p > 0.10$ ). With increasing duration of the test, a progressive decrease of maximal respiratory exchange ratio was found. The RERmax mean values were as follows:  $1.23 \pm 0.10$  (T0.5),  $1.18 \pm 0.08$  (T1) and  $1.12 \pm 0.07$  (T2), and the differences between tests were statistically highly significant ( $p < 0.001$ ). The regression analysis of pooled data showed an inverse linear relationship between RERmax and test duration ( $\text{RERmax} = 1.272 - 0.0064 \text{min}$ ). For the same absolute test duration, a trend towards higher RERmax values in sprinters than in aerobically trained runners was present. **CONCLUSIONS** In incremental treadmill tests of 5 to 30 minutes duration, performed to the limit of tolerance, runners of various predominantly anaerobic (100m-400m) and predominantly aerobic (800m-marathon) specific events show an inverse linear relationship between test duration and the respiratory exchange ratio at maximal exercise. For practical implications, the RERmax value used as a VO<sub>2</sub>max criterion in the interpretation of graded exercise testing should be protocol dependent.

#### COMPARING EQUATIONS THAT PREDICT PEAK VO<sub>2</sub> USING THE 20-M MULTISTAGE-SHUTTLE RUN-TEST IN 6-10-YEAR-OLD CHILDREN

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Comparing equations that predict peak VO<sub>2</sub> using the 20-m multistage-shuttle run-test in 6-10-year-old children António Vences Brito<sup>1,2</sup>; Tiago Santos<sup>1</sup>, Nádja Magalhães<sup>1,2</sup>, Nelson Valente<sup>1,3</sup>, João P. Brito<sup>1,2</sup> 1 Sports Sciences Research Laboratory Sports Science Institute of Rio Maior, Rio Maior, Portugal) 2 Centre of Research in Sports, Health and Human Development (CIDESD, Vila Real, Portugal) 3 Universidade da Extremadura, Espanha **Introduction** This study aimed to compare the validity of reported equations as predictors of VO<sub>2</sub> peak in 6-10 year-old children **Methods** Subjects, 128 children, aged 6 to 10 years old (67 were boys, age  $7.97 \pm 1.11$  years, weight  $31.47 \pm 8.99$  kg, height  $130.81 \pm 9.16$  cm, BMI  $18.04 \pm 2.84$ ; and 61 girls, age  $7.67 \pm 0.94$  years, weight  $29.26 \pm 6.22$  kg, height  $128.93 \pm 7.50$  cm, BMI,  $17.46 \pm 2.55$ ) performed the multistage-shuttle-run-test (MSRT) and VO<sub>2</sub> peak was measured in field using a portable gas analyzer (Cosmed K4b2, Cosmed, Rome, Italy). The equations that estimated VO<sub>2</sub> peak from the MSRT performance were chosen according to the age range of this study. As follows, the FITNESSGRAM reports and the equations of Leger et al. (1988) and Oliveira (1998) were used to estimate the VO<sub>2</sub> peak and compared with the directly measured value. **Results** The estimated VO<sub>2</sub> peak by the equations of Leger et al. (1988) and Oliveira (1998), respectively, underestimate the measured values of measured VO<sub>2</sub> peak ( $49.05 \pm 2.53$  ml/kg/min). In females the equation of Leger et al. (1988) overestimates the measured VO<sub>2</sub> peak. In the analysis by age and gender, in females of 7 to 8 years, the VO<sub>2</sub> peak estimated by the equation of Leger et al. (1988), overestimate the measured VO<sub>2</sub> peak. When applied the Pearson correlation coefficient, it was verified that Oliveira's equation (1998) had higher values of correlation ( $r = 0.51$ ,  $r = 0.46$  and  $r = 0.58$ ) for males, females and for the overall sample, respectively. However by applying the concordance coefficient was found that the equation of Leger et al. (1988) was the one that proved more consistent/concordant with the measured VO<sub>2</sub> peak ( $r_c = 0.21$ ,  $r_c = 0.27$  and  $r_c = 0.27$ ) for males, females and for the overall sample, respectively. **Conclusion** The shuttle test is presented as a valid instrument for assessing the VO<sub>2</sub> peak of school-age children. Although the Oliveira (1998) equation has been determined based on a sample of Portuguese children, but for the sample of the present study it is ended that the prediction equation of Leger et al. (1988) proved to be the most suitable to predict the VO<sub>2</sub> peak of children. **References:** Leger, L., Mercier, D.; Gadoury, C. and Lambert, J. (1988). The multistage 20-meter shuttle run test

for aerobic fitness. *Journal of Sports Sciences*, 6: 93-101. Oliveira, J. (1998). Validação directa do teste de vaivém em 20 m, de Luc-Léger em adolescentes portugueses. Master these. Technical University of Lisbon. Faculty of Human Motricity.

### CONSTRAINTS OF USE PORTABLE GAS ANALYZER IN THE CARDIO-RESPIRATORY EVALUATION OF CHILDREN AGED 6-10 YEARS WHILE PERFORMING THE 20 M MULTISTAGE SHUTTLE RUN TEST

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**Introduction** The aim of this study was to assess if the use of a portable respiratory gas analyzer is a constraint on performance in the 20 m multistage shuttle run test (20mMST). **Methods** 128 Portuguese children, 67 boys (age, 7.97 ± 1.11 years; weight, 31.47 ± 8.99 kg; height, 130.81 ± 9.16 cm; IMC, 18.04 ± 2.84) and 61 female (age, 7.67 ± 0.94; years; weight, 29.26 ± 6.22 kg; height, 128.93 ± 7.50 cm; IMC, 17.46 ± 2.55) performed the 20mMST in two different moments, each separated by 1 week in a randomly sequence, with (M1) and without (M2) the portable gas analyzer (K4b2, Cosmed, Rome, Italy). In M1, the peak oxygen consumption (VO<sub>2peak</sub>) was measured and the number of laps registered, while in M2, the maximum oxygen consumption (VO<sub>2max</sub>) was estimated with the Leger et al. (1988) equation and the number of laps also registered. **Results** The weight of the portable gas analyzer is 1000 grams, which represent approximately 3.3% of the children's medium body weight (30.41 ± 7.84 kg). When we analyzed all the children, there were no significant differences in the estimated VO<sub>2max</sub> between the two test trials. When compared by gender, there were significant differences in the female children between the mean values of VO<sub>2max</sub> estimated in M1 and M2 of -0.65 ± 1.46 ml/kg/min (p=0.005). When compared by the BMI category, there were significant differences in the categories, "normal weight" and "obesity" with mean difference values of 1.1 ± 8.08 and 1.5 ± 4.34 ml/kg/min, respectively (p=0.005). **Conclusion** Generally, the portable gas analyzer Cosmed K4b2 does not influence the 20mMST performance, although in female children, may cause some discomfort that possibly will lead to a decreased performance in the same test.

### THE INFLUENCE OF MUSIC ON MAXIMAL OXYGEN UPTAKE IN RUNNERS

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**Introduction:** The music was broadcast from the beginning and it is felt today by all. It would be impossible to live without it, because everything has rhythm, as the heart. In sport, music has been used to enhance performance and relax the contestants, but empirically. **Purpose:** To investigate if different musical styles significantly alter the maximal oxygen uptake (VO<sub>2max</sub>) from runners in the maximal exercise test. **Methods:** Participants (n=14) performed four exercise tests with a break of at least 48 hours between each other, we used three musical styles (rock, classical and a favorite one chosen by the runner) and a test without music to serve as a control group. The maximum oxygen consumption was measured indirectly and the protocol used for the maximal exercise test was the Bruce one. The statistical analysis was descriptive, Friedman and Qui-square using the statistical package SPSS 18.0, in a level of p<0.05. **Results and Conclusion:** There was a significant difference in maximum oxygen uptake by the use of music, \*2F = 17.74, p = 0.000, whereas the highest values were found in their favorite music, mean = 87.48 l/kg.min (SD = 4.50). New researchers should be done with different subjects to confirm the results.

### ATHLETES HAVING HIGH AEROBIC CAPACITY SHOW HIGHER AEROBIC CONTRIBUTION IN THE WINGATE ANAEROBIC TEST

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**Introduction** The wingate anaerobic test (WAnT) is widely used to evaluate anaerobic power and capacity (Bar-Or, 1987). A typical person uses the aerobic metabolic pathway to release 40% of the total energy required during WAnT (Medbø and Tabata, 1993); however, no study has tested the influence of aerobic energy supply on output power. Therefore, we aimed to investigate the individual effects of aerobic and anaerobic energy supply systems on the physical characteristics in WAnT. **Methods** Twenty-three male track and field college athletes (8 sprinters, 9 long-distance runners, and 6 decathletes) participated in this study. They performed WAnT on a cycle ergometer, and the peak power, mean power, and fatigue index were determined. The applied resistance was 7.5% of body weight, and the duration was 60 seconds. Aerobic capacity (maximal oxygen uptake [VO<sub>2max</sub>]) was determined by an incremental test, and anaerobic capacity (maximal accumulated oxygen deficit [MAOD]) was determined by a supramaximal constant load test (Medbø et al., 1988). The oxygen uptake during each test was recorded by a breath-by-breath method. The participants were divided into high VO<sub>2max</sub> group (High; n = 11) and low VO<sub>2max</sub> group (Low; n = 12). **Results** Although the VO<sub>2max</sub> was significantly higher in the High group, the MAOD was not significantly different between the 2 groups. The aerobic contribution was significantly higher in the High group than in the Low group (51.5 ± 8.8% vs. 42.1 ± 6.9%). In contrast, the anaerobic contribution was significantly higher in the Low group than in the High group (57.9 ± 6.9% vs. 48.5 ± 8.8%). The oxygen uptake during WAnT (WT-VO<sub>2</sub>) was significantly higher in the High group, and the accumulated oxygen deficit during WAnT (WT-AOD) was significantly higher in the Low group. The MAOD and WT-AOD showed a significant correlation (High: r = 0.85, p < 0.01; Low: r = 0.76, p < 0.01) in both the groups. WT-AOD was attained at 101.7 ± 12.3% MAOD in the Low group, and this value was significantly higher than that in the High group. **Discussion** Our findings show that the energy supply influences the physical characteristics during WAnT. Thus, athletes having a high aerobic capacity preferential use an aerobic metabolic pathway, whereas athletes with lesser aerobic capacity use an anaerobic metabolic pathway to satisfy the required oxygen demand during exercise. Therefore, even in WAnT, which is a short and maximal effort exercise, the individual's aerobic and anaerobic capacities should be considered when assessing WAnT performance. **References** Bar-Or. (1987). *Sports Med*, 4, 381-394. Medbø J I., Mohn A C., Tabata I., Bahr R., Vaage O., Sejersted O M. (1988). *J Appl Physiol*, 64, 50-60. Medbø J I., Tabata I. (1993). *J Appl Physiol*, 75, 1654-1660.

## ASSESSING AEROBIC CAPACITY AND PERFORMANCE USING PHYSIOLOGICAL AND BIOMECHANICAL PARAMETERS DURING AN INCREMENTAL SWIMMING TEST

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**ASSESSING AEROBIC CAPACITY AND PERFORMANCE USING PHYSIOLOGICAL AND BIOMECHANICAL PARAMETERS DURING AN INCREMENTAL SWIMMING TEST** Oliveira MFM.1,2, Caputo F.2, Lucas RDL.3, Denadai BS.1, Greco CC.1 1: UNESP (Rio Claro, Brazil), 2: UDESC (Florianópolis, Brazil), 3: UFSC (Florianópolis, Brazil) **Introduction** In human swimming metabolic changes detected by blood lactate concentration ([La]) are related to the changes observed in the stroke parameters (Wakayoshi et al. 1995; Keskinen and Komi 1993; Dekerle et al. 2005). Therefore, the purposes of this study were to identify the speed corresponding to anaerobic threshold using the D-max method for both blood lactate and biomechanical stroke parameters determined in an incremental swimming test and to compare this information with the speed corresponding to the maximal lactate steady state (SMLSS). **Methods** Five male long-distance swimmers and eight triathletes ( $n = 13$ ;  $23.8 \pm 9.5$  years;  $1.76 \pm 0.1$  m; and  $71.3 \pm 9.8$  kg) performed the following protocols: (1) 7 x 200-m incremental test to determine the speed corresponding to the D-max point (Cheng et al. 1992) on the blood lactate (SLa), stroke rate (SSR), stroke length (SSL), and stroke index (SSI) responses; (2) two to four 30-min sub-maximal tests to determine the SMLSS. **Results** SLa ( $1.18 \pm 0.08$  m\*s<sup>-1</sup>), SSI ( $1.18 \pm 0.08$ ), SSR ( $1.17 \pm 0.1$ ) and SSL ( $1.16 \pm 0.09$ ) were not significantly different from each other or from SMLSS ( $1.13 \pm 0.08$ ). There were high correlations between SLa, SSI, SSR, SSL and SMLSS ( $r = 0.91, 0.89, 0.85$ , and  $0.80$ , respectively). The typical error of estimate for SLa (3.2%), SSI (3.7%), SSR (4.1%), and SSL (4.7%) suggest good validity of these variables to predict SMLSS. **Discussion** It is possible to obtain a physiological index of aerobic capacity and performance using simple biomechanical measurements during an incremental test without performing blood lactate analyses. However, despite low TEE values, the physiological and biomechanical index may not represent [La] equilibrium over time. Therefore, we recommend that SMLSS be determined directly whenever precision is required. **References** Cheng B, Kuipers H, Snyder AC, Keizer HA, Jeukendrup A, Hesselink M. (1992). *Int J Sports Med*, 13, 518-22. Dekerle J, Nesi X, Lefevre T, Depretz S, Sidney M, Marchand FH, Pelayo P. (2005). *Int J Sports Med*, 26, 53-58. Keskinen KL, Komi PV. (1993). *J Appl Biomechanics*, 9, 219-26. Wakayoshi K, D'acquistio LJ, Cappaert JM, Troup JP. (1995). *Int J Sports Med*, 16, 19-23.

## VALIDITY OF A SUBMAXIMAL CYCLING TEST TO EVALUATE AEROBIC FITNESS IN ELITE ICE HOCKEY PLAYERS

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**Introduction** Several studies have shown the importance of aerobic capacity in improving ice hockey performance (Stone & Kilding, 2009). Hence, various tests have been proposed to evaluate aerobic fitness in team sports. Often, maximal tests are not well accepted by players or coaches because they require maximal effort of the athletes and can be strongly influenced by motivation. Thus, the aim of this study was to determine whether a submaximal bicycle ergometer test is valid for predicting lactate threshold as an indicator of aerobic fitness in elite ice hockey players. **Methods** Forty-nine male Swiss ice hockey players ( $18.6 \pm 0.5$  y;  $81.7 \pm 9.2$  kg) of the under 20 (U-20) national team were evaluated. Each subject performed a maximal incremental test (MIT) and a submaximal test (SMT) on a bicycle ergometer. The initial workload of the MIT was 130 W, with an increment of 30 W every 3 min until exhaustion. In the MIT relative power at lactate threshold (PLT) and relative maximal power (Pmax) were determined. The SMT test consisted of a single rectangular workload for 6 min with a power of 2.9 W/kg body weight. Maximal lactate value (LAm<sub>ax</sub>), difference between lactate concentration at rest and after the test (LADelta), mean heart rate during the last minute (HR) and rate of perceived exertion (RPE) were used for analysis. **Results** The MIT showed a mean PLT of  $3.1 \pm 0.4$  Watt/kg and a mean Pmax of  $3.9 \pm 0.4$  Watt/kg. In the SMT mean LAm<sub>ax</sub> of  $5.2 \pm 1.7$  mmol/l, mean LADelta of  $3.3 \pm 1.2$  mmol/l, mean HR of  $164 \pm 21$  beats/min and mean RPE of  $13.8 \pm 1.6$  were measured. Significant correlations (Pearson,  $p < 0.001$ ) were found for PLT as dependent variable with LAm<sub>ax</sub> ( $r = -0.79$ ), LADelta ( $r = -0.84$ ), HR ( $r = -0.62$ ) and RPE ( $r = -0.53$ ) as independent variables in the SMT. The highest correlation was between PLT and LADelta with an SEE = 0.20 Watt/kg. Using these parameters, we calculated the following linear regression equation:  $f(x) = 3.91 - 0.25x$ . **Discussion** Confirming previous research, we found significant correlations between parameters in the MIT and a rectangular SMT (Impellizzeri et al., 2004). These results suggest that this SMT could be used to estimate intra-individual progress and team-progress in aerobic fitness without using a MIT. Although MITs are the most accurate way to evaluate aerobic fitness individually, this SMT provides valid results and do not require the maximal effort of the athletes. Additionally this SMT can be performed during the season and is not influenced by motivation. **References** Impellizzeri, F., Mognoni, P., Sassi, A., & Rampinini, E. (2004). Validity of a submaximal running test to evaluate aerobic fitness changes in soccer players. *Journal of Sports Sciences*, 22, 547. Stone, N., & Kilding, A. (2009). Aerobic conditioning for team sport athletes. *Sports Medicine*, 39(8), 615-642.

## STUDY ON THE FORMULAS FOR ESTIMATION OF CARDIO- PHYSIOLOGICAL STATE DURING EXERCISE TEST IN BIKE SIMULATOR

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The purpose of this study is to develop the formulas for estimation of cardio-respiratory fitness during exercise test in bike simulator. To define the exercise intensity and work load, maximal heart rate (HR<sub>max</sub>) was used for exercise prescription. In addition, it is important to control exercise intensity and energy expenditure during exercise, because high intensity training hurts health and low intensity cannot be achieved the effect of exercise on health. Thirty-seven volunteers (17 men: age,  $21.1 \pm 2.5$  yr; weight,  $66.9 \pm 10.3$  kg; height,  $173.2 \pm 7.7$  and 20 women: age,  $20.9 \pm 1.3$  yr; weight,  $54.5 \pm 5.8$  kg; height,  $161.1 \pm 5.4$  (mean  $\pm$  SD)) were participated in this experiment. They executed maximal exercise test using ramp protocol and four interval training programs. They also executed sub-maximal test using YMCA protocol. We extracted the average heart rates between 10 seconds before and end of each step in YMCA protocol. Exercise load of the four interval training programs was controlled by manually to adjust participant's target heart rate during the interval training. MONARK bike was used for testing and obtained via a portable metabolic measurement system COSMED Quark b2 (Italy). Regression analysis was used to estimate factors such as HR<sub>max</sub>, exercise load and energy expenditure. Therefore, independent variables are heart rate, age, weight, height, target range etc. We developed two formulas to estimate HR<sub>max</sub> of the men and women, and an algorithm to feedback exercise load and energy expenditure for the four interval training programs to consider cardio-physiological state in real time. Estimated values were compared with measured to verify the accuracy of the results, and the results obtained were statistically significant ( $p < .05$ ). From the result, using YMCA protocol in bike simulator could be measured cardio-respiratory fitness, and collecting heart rate could be used to control the exercise load and estimate energy expenditure in real time basis.

**ADJUSTING HEART RATE RESERVE METHOD FOR INDIVIDUALIZED AEROBIC TRAINING PRESCRIPTION**

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DIAGNÓSTICOS DA AMÉRICA SA

The selection of adequate heart rate zones for aerobic training prescription is the key factor to efficient and safety design individualized exercise protocols. Cardiopulmonary stress testing is the gold standard for clinical evaluation and exercise prescription based on ventilatory thresholds, but some equations can accurately define these individual training zones. The heart rate reserve method (HRR) has proven to be very useful in many different clinical and exercise settings, but only recently, in their last guidelines, the American College of Sports Medicine recommended different intensities of exercise prescription based on HRR for each level of aerobic fitness to ensure the efficacy of training program (ACSM's Guidelines for Exercise Testing & Prescription. 8th Edition. Lippincott, Williams & Wilkins Inc, Philadelphia, USA - 2010). However, these recommendations are based on limited investigations and may not represent the specific populations of different countries. Therefore, the aim of this study was to identify the percentage of HRR recommended for aerobic prescription in Brazilian population and to compare the specific training zones between high and low fitness subjects. Methods Sixty eight healthy Brazilian subjects between 25 and 35 years old (49 men and 19 women) performed a maximal cardiopulmonary exercise test (ramping treadmill) to define the aerobic fitness level and to find the specific heart rate at the ventilatory thresholds. The subjects were then divided into 2 groups: low fitness (LF, n= 29,  $VO_{2peak} < 85\%$  predicted) and high fitness (HF, n= 39,  $VO_{2peak} > 85\%$  predicted). We analyzed heart rate (HR, bpm) and oxygen consumption ( $VO_2$ , ml/kg.min) in the anaerobic threshold (AT), the respiratory compensation point (RCP) and in the peak of exercise. Statistical analyses were performed using Student's T test ( $p < 0.05$ ) to compare the two groups. The results are presented as mean  $\pm$  standard deviation. Results In the AT, the recommended HRR prescription was significantly lower for LF than HF group ( $51 \pm 12\%$  vs  $61 \pm 10\%$ , respectively -  $p = 0.002$ ), and the same occurred in the RCP ( $84 \pm 7\%$  vs  $88 \pm 5\%$ , respectively -  $p = 0.014$ ). Discussion These results demonstrate that healthy young Brazilian subjects should be stratified by fitness level, prescribing higher intensities for individualized aerobic training in better conditioned individuals. The adequate training zones for Brazilian population should be more specific than ACSM's recommendations. Thus, it is possible to suggest that the prescription between 51-84% of HRR for LF and 61-88% of HRR for HF subjects could be more efficient to elicit aerobic training adaptations.

**APPLICATION OF A MULTIPLE LINEAR REGRESSION MODEL FOR THE PREDICTION OF PHYSICAL TEST PERFORMANCE**

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UNICAMP

APPLICATION OF A MULTIPLE LINEAR REGRESSION MODEL FOR THE PREDICTION OF PHYSICAL TEST PERFORMANCE Reis, R.A.1, Páscoa, M.1, Papaléo, F.1, Costa, K.G.1, Macedo, D.1, Brenzikofer, R.1 1: LABEX-IB, UNICAMP (Campinas, Brazil) Introduction Predicting future physical test performance of a group submitted to a training period is a complex challenge. The Brazilian Military Preparatory School implements systematic daily training to the students for one year. A minimum performance level is required at the end of the year, which allows the students to continue their career in the army. In this work, we propose a methodology able to reveal in advance subjects at risk of scoring below the level required on the final 3000-meter running test, using a Multiple Linear Regression model. Methods In total, 1030 subjects aged  $19 \pm 2$  years participated in the study, 504 of which were from the 2009 school year and 526 were from 2010. All volunteers were evaluated on 3000-meter running test, horizontal counter movement jump, repeated sprint ability test and body composition. These tests occurred three times during the year: February, June and October. New variables were calculated by their square and the difference between the results of June and February. We performed Multiple Linear Regression based on Stepwise method for the variable selection. The prediction model for the October 3000-meter running times was established using data from February and June 2009. We applied the model to the 2010 data to verify its accuracy. Subjects with times above 13.5 minutes are considered reproved in the final 3000-meter running test. Students were considered at risk of failure with predicted times above 13.5 minutes minus one standard error of estimate (SEE). Results The predicted time in the October 3000-meter running test ( $T_{3000oct}$ ) was given in terms of four variables: time in the February 3000-meter running test ( $T_{3000feb}$ ), the difference between June and February 3000-meter running test ( $D_{if3000}$ ), squared counter movement jump result (SCMJ) and the difference between June and February in counter movement jump ( $D_{ifCMJ}$ ). Thus, we found the following equation starting with the 2009 data:  $T_{3000oct}(min) = 0.865 * T_{3000feb}(min) + 0.793 * D_{if3000}(min) - 0.169 * SCMJ(m) - 0.539 * D_{ifCMJ}(m) + 1.967$   $R^2 = 0.73$ ,  $SEE = 0.43(min)$  Applying the data from February and June 2010, the model predicted a list of 74 subjects with times above 13.07 minutes (13.5-SEE). In the real test, performed in October 2010, out of the 526 subjects evaluated, 24 exceeded the threshold of 13.5 minutes, and 22 of them were on the list created in June. Discussion With the model developed in this study, we revealed in June 91.7% of the students at risk of failure in October. This way you can extend the time for intervention on those less able subjects, minimizing the risk of failure in the October final test. The use of a multiple linear regression model has proved to be useful, accurate and easy to apply.

**GENERAL FUNCTIONAL FITNESS INDEX IS ASSOCIATED WITH LOWER RISK FACTOR OF CARDIOVASCULAR DISEASE**

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Introduction: Physical exercise (PE) has been considered an important factor against cardiovascular disease. However, there are many controversies about the effects of PE due to the wide variety of exercises and how it can be performed (Brinkley et al 2009). Therefore, fitness level seems to be more appropriate to establish this relationship. Thus, the aim of this study was to analyze the relationship between fitness level and the risk factor of cardiovascular disease in adults and elderly people. Methods: The AAHPERD functional fitness test was designed to assess fitness level and it included the following tests: coordination, flexibility, muscular strength, agility and cardiovascular endurance (Rikli et al 1999). The general functional fitness index (GFFI) was calculated using the sum of the percentile score of each test as described by Zago et al. (2003). Participants (50-70 years-old) were divided in three groups: G1 – regular GFFI; G2 – good GFFI; and G3 – very good GFFI. Blood samples (12h overnight fast) were used to evaluate the total-cholesterol (CHOL), LDL-cholesterol (LDL), HDL-cholesterol (HDL), triglycerides (TG) and uric acid (UA) by enzymatic-colorimetric methods. Systolic and diastolic blood pressure (SBP and DBP) was measured after 15 min of seated quiet rest on three separate days. Results: ANOVA one-way showed significant differences between G1 and G3 in CHOL ( $221 \pm 40$  to  $177 \pm 28$  mg/dL), LDL ( $131 \pm 30$  to  $109 \pm 15$  mg/dL), TG ( $175 \pm 67$  to  $94 \pm 38$  mg/dL), UA ( $4.6 \pm 0.7$  to  $3.7 \pm 1$  mg/dL), BMI ( $31 \pm 5$  to  $24 \pm 3$  w/h<sup>2</sup>) and SBP ( $127 \pm 14$  to  $114 \pm 15$  mmHg). No differences were found in HDL ( $41 \pm 7$  to  $49 \pm 7$  mg/dL) and DBP ( $70 \pm 16$  to  $74 \pm 11$ ). Pearson analysis showed a significant correlation between GFFI and CHO ( $r = -0.4$ ;  $p < 0.01$ ), LDL ( $r = -0.5$ ;  $p < 0.01$ ), HDL ( $r = 0.3$ ;  $p < 0.05$ ), TG ( $r = -0.6$ ;  $p < 0.01$ ), UA ( $r = -0.4$ ;  $p < 0.05$ ), BMI ( $r = -0.7$ ;  $p < 0.01$ ) and SBP ( $r = -0.6$ ;  $p < 0.01$ ). Discussion: High level of GFFI (G3 group) results in a reduced risk factor of cardiovascular diseases, regardless of how PE was previously performed. This is in

agreement with Marques et al (2009) supporting the evidence that multicomponent exercise seems to be better than performing only one component such as resistance exercise. These data suggest that higher GFFI may induce favorable changes in risk factors of cardiovascular disease thus providing a better quality of life for the population. References: Brinkley, T.E., Fenty-Stewart, N.M., Park, J.Y., et al. (2009). Nitric Oxide 21(3): 234-8. Marques, E., Carvalho, J., Soares, J.M., et al. (2009). Maturitas 63(1): 84-8. Rikli, R.E., Jones, C.J. (1999). Journal of Aging and Physical Activity 7(2): 129-161. Zago, A.S., Gobbi, S. (2003). Brazilian Journal of Science and Movement 11(2): 77-86.

### **SUBJECT SPECIFIC COMPETENCES EXPECTED OF A GRADUATE OF THE MASTERS IN HEALTH REHABILITATION THROUGH PHYSICAL EXERCISE IN BULGARIA**

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**Introduction** The study of subject specific competences for masters' students in program health rehabilitation through physical exercises is a part of the Key competencies study from the Project no. 503202-LLP-1-2009-1-UK-ERASMUS-ECDSP funded by the LLP of the EC. The aim of the Project is to develop a Masters in Health Rehabilitation through Physical Exercise in non-clinical settings based on the "Tuning" project framework. This study will assist the project promoters in establishing the structure of the program and in formulating the learning outcomes in each module. This program will be implemented across four European Universities the European Qualification Framework will be used to benchmark the appropriate skill levels. This will relate different countries' national qualifications systems to a common European reference framework. Individuals and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems. **Methods** Surveys and desk research were conducted in Bulgaria involving university lecturers, PE teachers, hospitals managers, fitness instructors and practitioners in the field of rehabilitation. Descriptive statistics were completed to determine the frequencies and percentages. **Results** During collecting data from questionnaires for Bulgarian academics we found out the most important competences in their opinion are: Capacity of applying knowledge in practice (40%); Basic knowledge of the field of study (20%); Basic knowledge of the profession (15%). The Bulgarian practitioners indicated as specific competences the following: analyzing and interpreting data; planning, conducting and evaluating; health improvement practices; professional behaviour and ethics; coordination and management and carrying out research project. **Discussion** The use of learning outcomes and competences is necessary in order to make the study programme and its modules student centred and output oriented. This approach requires that the key knowledge and skills that a student needs to achieve during the learning process determine the content of the study programme. Learning outcomes and competences focus on the requirements both of the discipline and of society in terms of preparing for citizenship and employability. HARPE promoters recognize fully the importance of making maximum use of the available expertise of the staff, but this aspect should not dominate a programme. **References** 1.Tuning Educational Structures in Europe (2005). Universities Contribution to the Bologna Process. Final Report Pilot Project Phase 2. Published Universidad de Duesto and University of Groningen, 2005.

## **Poster presentations**

### **PP-PM44 Physiology: Cardiac Structure and Function**

#### **CARDIAC TROPONIN T IN HEALTHY HUMANS FOLLOWING DIFFERENT PROFILES OF EXERCISE**

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**Introduction** Troponin T (TnT) is a highly specific marker of cardiac damage, used clinically in identifying myocardial infarction. Recent studies have shown elevated TnT also in normal, healthy subjects following prolonged endurance exercise, such as a marathon. TnT response to different exercise parameters (intensity, duration, mode) is largely unknown. We examined whether: 1) TnT is released in young, healthy subjects following unaccustomed exercise; 2) this differs for endurance (END) versus repeated maximal-intensity interval exercise (RHIE); and 3) differs with arm versus leg exercise. We hypothesised that RHIE with arms or legs would elicit comparable responses to those with END exercise. **Methods** Twelve healthy, sedentary male participants (age: 23±3 y; VO<sub>2</sub> peak: 44±8 mL/kg/min) completed one END exercise session (50 min at 65% VO<sub>2</sub> peak) and one RHIE session each for arms and legs (5 x 30-s sprints with 4.5 min recovery), ~2 wk apart. Venous blood was sampled before exercise and at 0.5, 1, 3, 8 and 22 h after exercise. Cardiac TnT was analysed using a Roche Diagnostics high-sensitivity assay. The assay detects TnT in the range 3 – 10 000 ng/L. A result of <14 ng/L is considered normal, as this represents the 99th centile of a healthy population (Thygesen et al., 2007), whereas ≥14 ng/L is abnormal. **Results** Increased TnT (≥14 ng/L) was evident in 5/12 participants after END exercise (average HR during session 158±17 bpm); four peaking at 3 h and one at 8 h after exercise, in the range 16 – 70 ng/L. In contrast, no participant showed raised TnT after RHIE with either arms or legs. The mean (±95%CI) difference in peak TnT between END and leg RHIE was 11 (±13) ng/L, and between END and arm RHIE: 13 (±13) ng/L. All TnT results were normal by 22 h. **Discussion** These data indicate that TnT may be released in many (but not all) healthy, sedentary individuals following endurance exercise of moderate duration and intensity. The absence of a TnT elevation following repeated 30-s sprint exercise was unexpected, but adds support to the notion that duration of exercise may be more consequential than intensity. **References** 1. Thygesen K, Alpert JS, and White HD. Universal definition of myocardial infarction. J Am Coll Cardiol 50: 2173-2195, 2007.

#### **THE IMPACT OF THREE REPEATED 60 MIN CYCLING BOUTS IN ONE DAY ON CARDIAC TISSUE VELOCITIES IN TRAINED CYCLISTS**

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**Introduction** Prolonged strenuous exercise has been associated with a decline in cardiac function during a range of exercise modes, durations and intensities. With the emergence of a large number of events requiring repeated bouts of exercise, few studies have assessed the impact of repeated bouts of prolonged exercise in one day and whether this results in an accumulation of dysfunction and exercise induced cardiac fatigue. **Methods** Six trained cyclists completed three, 60 minute bouts of cycling exercise at 90% of ventilatory



threshold, in one day. The exercise bouts were separated by 2 hours of rest. Echocardiographic scans of cardiac function were completed on all cyclists prior to and immediately post each exercise bout. Echocardiograms analysed septal, left ventricular free wall and right ventricular free wall tissue velocities during systole and diastole. Results Changes in ventricular wall tissue velocities were minor and not cumulative. Peak atrial diastolic tissue velocity in the septal wall, left ventricular free wall and right ventricular free wall did not increase significantly ( $p > 0.05$ ) over the course of the repeated bouts of exercise therefore no significant impact upon the ratio of early to late diastolic wall motion was apparent. Peak atrial systolic tissue velocities in the septal, left ventricular free wall and right ventricular free wall also showed no significant increase over the course of the repeated bouts of cycling exercise ( $p > 0.05$ ). Discussion The lack of changes in cardiac function as measured by tissue velocities in the septal wall, left ventricular free wall and right ventricular wall during systole and diastole, during the course of three repeated bouts of 60 minute cycling at ventilatory threshold suggests that this intensity and duration of exercise was not enough to induce alterations and subsequent cardiac dysfunction in trained cyclists.

## COMPARISON OF SEISMOCARDIOGRAPHY TO ECHOCARDIOGRAPHY FOR MEASURING CARDIAC CYCLE EVENTS

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**Introduction** Echocardiography (Echo) is recognized as a standard for measuring cardiac performance but can be technically difficult and expensive. Seismocardiography (SCG) has been studied for over 60 yr but has been impractical until recently because of advances in computer software and micro-processors. SCG records the low frequency vibrations induced by the heartbeat, and provides information on cardiac mechanics and timing of atrial and ventricular contractions, including valve opening and closing. Limited research is available comparing SCG to Echo (Crow et al, 1994; Salerno & Zanetti 1990; Salerno et al. 1991) to determine whether SCG could be used as a screening tool in applied exercise science or clinical research. This aim of this study was to compare SCG with Echo to determine whether SCG provided a valid measure of cardiac performance. We hypothesized that the SCG measurements would not be different from Echo. **Methods** Twenty-four volunteer subjects with no known cardiac disease were recruited (age range = 18-70 yrs; 13 females). The SCG was recorded by placing the SCG device on the sternum of the chest 1cm above the xiphoid process. SCG was collected simultaneously with Echo on identical and consecutive heartbeats ( $n=10$ ). Both Doppler and M-mode Echo measurements were collected. A total of 234 beats were analysed (M Mode, PW mode and SCG). Each event was analyzed and stored for comparison in standard statistical software. The timing events included the Q-wave (ECG) to: atrial systole (AS), mitral valve open/close (MVO, MVC), aortic valve open/close (AVO, AVC), acceleration time ( $P/2T$ ) and early diastolic filling (ED) wave. Isovolumic relaxation time (IVRT) was computed. The same technician performed all Echos with an echocardiologist confirming all images. **Results** There were no statistical differences in timing of the MVC, AS or IVRT between methods. Although there were statistically significant differences ( $P < .001$ ) in the other timing events (MVO, ED,  $P/2T$ , AVO, AVC) the effect sizes ( $< 0.2$ ) and mean differences (MVO=8msec, ED=9.9msec,  $P/2T$ =7.9msec, AVO=7.5msec, AVC=33.1msec) were small, with the exception of AVC ( $P < .001$ ; 0.83). The SEM ranged from 2.1 - 7.0%. **Discussion** Although some significant differences were found between the SCG and Echo for cardiac timing events, the low effect size and small mean differences suggest that the SCG can be used to provide clinically relevant information about cardiac performance in healthy individuals. SCG is an easy-to-use, non-invasive technique to evaluate cardiac function in a minimum time period, and thus can be used as a valid screening methodology. Future applied and clinical research is needed to explore whether SCG can be used in unhealthy populations and during and after exercise training. Crow et al. Am J Noninvas Cardiol, 8:39-46, 1994. Salerno DM, Zanetti JM. Cardiovasc Technol, 9:111-118, 1990. Salerno et al. Am J Cardiol, 68:201-207, 1991.

## RELATIONSHIP BETWEEN DIASTOLIC FUNCTION AND HEART RATE IN ATHLETES AND IN NON-ATHLETES

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**Introduction** Characteristics of the athlete's heart can be divided into three groups: Morphologic: - LV hypertrophy - richer coronary capillary network Functional: - better diastolic function (higher E/A ratio) Regulatory: - lower heart rate (HR) (training bradycardia). One of the most important effects of the sedentary way of life is its effect on the cardiovascular system. While left ventricular (LV) hypertrophy is a marked characteristic of the athlete's heart, in non-athletic subjects it is a predictor of cardiomyopathy and it can lead to sudden death. **Method** The main aim of the present study was to establish differences of the diastolic function and regulation between highly trained athletes (75 women and 140 men) and non-athletic subjects (37 woman and 40 men), as the most important factors to differentiate physiologic from pathologic LV hypertrophy. We analyzed with pulsed Doppler echo and tissue Doppler imaging left ventricular (LV) regional function (velocities, such as E/A, heterogeneity and asynchrony indices) in the longitudinal (apical views, 4 segments) axis. The echocardiogram were performed according to the recommendation of the American Society of Echocardiography. In the second step a 5 minutes long, 12-lead resting ECG was recorded to establish heart rate (HR). Statistical analysis was done by using the Statistica 9.0 for the Statsoft. Significance was determined with t-test, independent, by group and the correlation with Correlation matrices. **Results** Heart rate was significantly lower in athletes, than in sedentary subjects (women: 55,72  $\pm$  9,68 vs. 66,91  $\pm$  10,85  $p < 0,01$ ; men: 54,41  $\pm$  8,91 vs. 64,09  $\pm$  9,83  $p < 0,01$ ). Both in the traditional measurements E/A was higher in the athletes than in the non-athletes (women: 2,06  $\pm$  0,51 vs. 1,68  $\pm$  0,51  $p < 0,01$ ; men: 1,920  $\pm$  0,43 vs. 1,85  $\pm$  0,46  $p < 0,01$ ). The difference in the tissue Doppler measurements between the two groups was not statistically significant ( $p < 0,6$ ). The correlation was significant between the heart rate and the E/A ( $r = 0,46$ ), but it wasn't significant between the heart rate and tissue Doppler measurements ( $r = 0,1$ ). **Discussion** Top-level athletes competitors showed functional and regulatory characteristics of the athlete's heart very markedly. The higher E/A in traditional Doppler measurements is only a consequence of the lower heart rate of athletes.

## INFLUENCE OF BREATH-HOLD AND DYNAMIC EXERCISE ON CARDIAC OUTPUT DURING ACUTE BLOOD VOLUME SHIFTS DUE TO CHANGES IN BODY POSTURE

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**Influence of breath-hold and dynamic exercise on cardiac output during acute blood volume shifts due to changes in body posture**  
Authors: Ansgar Steegmanns\*, U. Drescher\*, U. Hoffmann\* \* Institute of Physiology and Anatomy, German Sport University Cologne, Germany **Introduction** The combination of breath-hold in combination with dynamic exercise could be found in various daily life activities. Moreover, this is sometimes overlapped by an increase in venous return due to posture changes, e. g. at the start of competitive swim-

ming. The influence of these combined stimuli on cardiac output is in the focus of this analysis. Methods 16 healthy and normotensive subjects (13 males, 3 females; age:  $27 \pm 4.5$  years; height:  $177 \pm 8$  cm; weight:  $74.5 \pm 11$  kg (mean  $\pm$  SD)) were tested on a tilt-table with an ergometer mounted. The tilt-table was operated manually to change body position from  $75^\circ$  to  $6^\circ$ -head-down-tilt (HDT) within 2 s. 20 s of 200 W with breath-hold and with eupnea (interventions hiP&BH and hiP) were repeated three times in a randomized order combined with tilting to  $6^\circ$  HDT. The interventions were separated by 160 s pedaling at 30 W in  $75^\circ$  body position. The start of each intervention was announced by a countdown. The Task Force Monitor (CNSystems, Austria) was used to measure beat-to-beat heart rate (HR) via electrocardiography and stroke volume (SV) via impedancecardiography. Cardiac output (CO) was computed as  $CO = HR \times SV$ . A trigger was used to align the onset of intervention periods. 1 s data were calculated using cubic spline interpolation. Results With onset of intervention CO shows a steep rise in hiP as well as in hiP&BH. CO of hiP increase till second 13 with a maximum of  $12.28 \text{ L min}^{-1}$  ( $\pm 0.37 \text{ L min}^{-1}$ ) (mean  $\pm$  SE) and decrease slightly till end of intervention period. With begin of hiP&BH CO increase till second 10 with a maximum of  $10.81 \text{ L min}^{-1}$  ( $\pm 0.31 \text{ L min}^{-1}$ ) and decrease slightly till the offset of intervention. With end of intervention CO show a second steep and rapid increase within a few seconds with a new maximum of  $11 \text{ L min}^{-1}$  ( $\pm 0.39 \text{ L min}^{-1}$ ). Discussion These results indicate a loss in exercise capability during high intensity dynamic exercise in combination with breath-hold when changing body posture to  $6^\circ$ -HDT position. Reductions in CO are possibly caused by reductions in heart rate due to a bradycardic response to breath-hold in concert with a diminished increase of venous return due to a loss of the breathing pump. References Hoffmann U, Smerecnik M, Leyk D, Essfeld, D (2005) Cardiovascular responses to apnea during dynamic exercise, *Int J Sports Med* 26: 426-431 Hoffmann U, Draeger T, Steegmanns A, Koesterer T, Linnarsson D (2009) Influence of combined exercise and gravity transients and apnea on hemodynamics, *Eur J Appl Physiol* 106: 589-597

### CARDIAC AUTONOMIC MODULATION IN SIMULATED JUDO COMPETITION: HEART RATE VARIABILITY AND HEART RATE RECOVERY

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CARDIAC AUTONOMIC MODULATION IN SIMULATED JUDO COMPETITION: HEART RATE VARIABILITY AND HEART RATE RECOVERY Carbalreira, E.I, Iglesias-Soler, E.I, Mayo, J.I, García-Ares, N.I, Seijas-González, L.M.1. Department of Physical Education and Sport. University of A Coruña (Spain) Introduction The aims of this study were (1) to assess heart rate recovery (HRR) in the successive judo bouts, and (2) to measure the acute effects of judo competition over cardiac autonomic modulation at rest. Methods Eleven national and international level male judokas participated in the study (mean  $\pm$  SD):  $19.72 \pm 3.06$  years,  $175.54 \pm 5.83$  cm,  $81.21 \pm 12.59$  kg. They performed 4 judo bouts with decrease rest time to simulate the schedule of judo competition. Pre and post fight (1st and 3rd minute) blood lactate (LA, Lactate Scout®) was collected and RR-interval was registered during fight and two minutes after in stand position with Polar S810 (Kempele, Finland). Competition day and next morning athletes remained still for 10 min after awakening to collect HRV (nuLF, nuHF = low and high frequency in normalized units; LF/HF ratio) during supine rest. Results Blood lactate (1 and 3 minute measure) was higher in the first bout (B1:  $11.93$ ; B2:  $10.94$ ; B3:  $9.65$ ; B4:  $9.57$ ) and decreased among the competition. LA clearance rate in bout 1 was higher than bout 3 ( $p = 0.023$ ). Heart rate variability analysis at rest in the morning after competition reached higher values in nuLF and lower values in nuHF ( $p = 0.032$ , both). In the same way it was obtained that values of LF/HF ratio increased in post-competition morning ( $p = 0.043$ ). Short-term HRR index (HRR30 = first 30 seconds of HRR semilogarithmic regression) (Buchheit et al., 2007) showed better recovery in bout 1 and 2 compared to 3 ( $p = 0.038$  and  $p = 0.036$ , respectively). LA clearance rate in bout 3 reached a negative association with LF/HF ratio post-competition ( $r = -0.661$ ;  $p = 0.027$ ). Discussion The results of our study suggest that analysis of HRV at rest may be a useful tool to detect a large-scale effort as a judo competition. Further work is needed to explore the possibilities of this tool for monitoring training in combat sports, where the quantification of training load is difficult. References Buchheit, M et al., (2007). Noninvasive assessment of cardiac parasympathetic function: postexercise heart rate recovery or heart rate variability? *American journal of physiology*. 293(1)

### COMPARISON IN HEART RATE AND OXYGEN UPTAKE ON BICYCLE ERGOMETER AND ARM ERGOMETER IN MAXIMAL EXERCISE

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Introduction Find out the effects of maximum oxygen uptake for different locomotory appendages and also bring out the effects of maximum oxygen uptake for locomotory appendages. Methods Six healthy men (age:  $21 \pm 2$  years) volunteered for this study. We got an informed consent from subjects. Subjects performed a bicycle ergometer and an arm ergometer in maximal exercise stress tests. Measurement items were oxygen uptake, heart rate (HR), blood pressure (systolic and diastolic blood pressure), ratings of perceived exertion (RPE) and grip strength. Results It was observed significant correlation between grip strength and HR max ( $p < 0.05$ ). HR max and  $VO_{2\text{Peak}}$  of a bicycle ergometer was significantly higher than those of arm ergometer. Changes in systolic and diastolic blood pressure between allout of a bicycle ergometer exercise and an arm ergometer exercise were no significant difference. However there were significant changes in systolic and diastolic blood pressure between before and after exercise. Discussion Based on the results, activity muscle mass using the bicycle ergometer exercise was bigger than an arm ergometer exercise. Oxygen uptake of arm ergometer was considered that the more upper limbs muscle strength, more. Changes in systolic and diastolic blood pressure between 2exercise in allout were no significant differences. However, there were significant differences in systolic and diastolic blood pressure measurements. It was considered that arm ergometer measurement site near locomotory appendages and blood pressure get higher than the bicycle ergometer. Conclusion It was observed change in HR and oxygen uptake from exercise for different locomotory appendages. References Vokac Z, Bell H, Bautz-holter E, Rodahl K. (1975). *Journal of Applied Physiology*, 39 (1), 54-59 Bigland-Ritchie B, Graichen H, Woods JJ. (1973). *Journal of Applied Physiology*, 35 (5), 739-740

### CHARACTERISTICS OF VARIABILITY OF HEART RHYTHM OF ELITE ATHLETES

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Introduction Vegetative nervous system (VNS) has an important role in regulation of adaptation to intensive physical load. One of the most informative methods of study of VNS is spectral analysis of variability of heart rhythm – VHR. Goal of the study was to investigate VHR of elite athletes and young male non-athletes. Methods Resting VHR study according to International Standard (1996) was conducted with

use of hard- and software complex VNS-Spectrum. Twenty-five judoists (experimental group) and fifteen healthy adult male non-athletes (control group) have been examined. Study protocol included a 5-minute registration of ECG and pneumogram, with determination of spectral power in each frequency ranges (High Frequency – HF, Low Frequency – LF and Very Low Frequency – VLF) and total power (TP) of the range. Vagal activity is a main element of the HF component, while the LF indicator describes the status of the sympathetic part of VNS. Results Average heart rate of athletes ( $60.0 \pm 2.1$  per min.) was significantly below the average HR in the control group ( $74.0 \pm 2.9$  per min.) ( $p < 0.05$ ). The control group demonstrated well-expressed waves of heart rate in all three frequency ranges (TP -  $2450 \pm 643$  ms<sup>2</sup>/Hz, VLF -  $851 \pm 164$  ms<sup>2</sup>/Hz, LF -  $702 \pm 199$  ms<sup>2</sup>/Hz and HF -  $896 \pm 355$  ms<sup>2</sup>/Hz), equilibrium of VNS sections defined as a ratio of LF/HF –  $0.78 \pm 0.16$ . No prevalence of VLF wave should be seen in the structure spectral power of VHR of healthy persons. Indicators of VHR spectral analysis were about twice higher in athletes as compared with non-athletes (TP -  $5189 \pm 806$  ms<sup>2</sup>/Hz, VLF -  $1469 \pm 190$  ms<sup>2</sup>/Hz, LF -  $1465 \pm 275$  ms<sup>2</sup>/Hz and HF -  $2254 \pm 458$  ms<sup>2</sup>/Hz). Ratio of low and high frequency powers in athletes (LF/HF –  $0.65 \pm 0.10$ ) evidences to prevalence parasympathetic regulation as compared with the control group. In the VHR structure of spectral power, the experimental group had less VLF waves and more HF waves as compared with the control group. LF waves share in the both groups was the same. Three athletes showed reduction of indicators of VHR spectral power, which evidences to insufficient adaptation to physical load in the given phase of training process. Conclusion Analysis and dynamics of VHR indicators allows more accurately assess the functional condition of athletes, adequacy of physical load for individual, condition of fatigue.

## HEART RATE AND VENTILATION RESPONSES TO ANTICIPATE EXHAUSTION IN SCUBA DIVING

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Introduction New technologies in diving equipment i.e. modern diving computers allow to measure heart rate (HR) and ventilation (VE) simultaneously online during SCUBA diving. The concept of ventilatory threshold can be adapted to field testing and a warning system based on these data can be developed to avoid incidents due to overload in free water diving with SCUBA. Methods 12 subjects (11 male, 1 female; age:  $28.8 \pm 4.6$  years; height:  $177 \pm 5$  cm; weight:  $77.6 \pm 15.3$  kg (mean  $\pm$  SD)) participated in a standardized incremental field test for SCUBA divers (fit2dive-test). The test consists of an incremental protocol that is performed in a pool or confined water space ( $< 5$  m depth). The underwater swim speed is increased stepwise by 0.2 m/s, starting with 0.4 m/s until subjective exhaustion. Swimming velocity is controlled by timing every 10 m. Test termination criteria include: a) exhaustion; b) failure to achieve the set swimming time on two consecutive instances. Subjects diving equipment consisted of a 10 l steel tank, ADV jacket, breathing regulator and the Uwatec® Galileo sol diving computer. This computer measures HR via a usual Polar® system (chest strap) adapted to the underwater environment, pressure changes in the SCUBA tank, depth and temperature. These pressure changes in the tank were used to calculate ventilation per minute with respect to the depth. The HR at disproportional increase of VE (HRin) was determined by linear regression. Results HRin were found in the range between 132 beats per minute (bpm) and 173 bpm with mean HRin = 151.3 bpm (SD = 13.1 bpm). Mean maximum HR (HRmax) was found at 173.8 bpm (SD = 13.8 bpm) with mean HRin at 87.1% (SD = 3.1%) of mean HRmax. The differences in HRin were not only related to individual fitness but also to diving equipment (e.g. fins) and swimming efficiency (e.g. kicking technique). Conclusion These results show that an individual HRin can be determined, probably indicating the onset of significant anaerobic metabolism in the specific conditions in SCUBA diving. Based on these data commercial diving computers can be personalized to provide an early warning in exhausting situations.

## COMPARISON OF HR AND BP RESPONSE DURING GRADUAL INCREASE AND DECREASE OF WORKLOAD EXERCISE BETWEEN EATING AND SKIPPING BREAKFAST

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Purpose: The purpose of the present study was to compare HR and BP response during gradual increase and decrease of workload exercise between eating and skipping breakfast. Method: Volunteering to participate in this study were 8 healthy Japanese males, who gave their informed consent prior to participation. Each subject performed cycling exercise for 32 min, recovered for 10 min in the supine position. They performed the exercise in two portions, a calibration test portion and gradual increase and decrease of workload exercise test portions. The calibration test consisted of three 4min bouts of exercise at 20, 60 and 40% of maximum oxygen uptake. The gradual increase and decrease of workload exercise test consisted of 4min bouts of gradual increase and decrease of workload exercise at between 20 and 60% of maximum oxygen uptake. The experimental conditions were fasting breakfast (C-condition) and eating breakfast (E-condition). C-condition comprised fasting for 12 hours prior to the experiments. E-condition comprised eating breakfast at 3 hours prior to the experiments. Both experimental conditions were performed at the same time in the morning (9-11 a.m.). HR, BP, oral temperature and cardiac ANS activity were measured in both experiments. Maximal and minimal HR values, amplitude and phase lags at workload top and bottom were measured in each gradual increase and decrease of workload exercise cycle. Results and Discussion: At rest, HR, SBP and oral temperature in E-condition were significantly higher than in C-condition. The ln HF, index of cardiac PNS modulation, in E-condition was significantly lower than in C-condition. During calibration exercise testing, HR at 20% and 40% in E-condition was significantly higher than in C-condition. At 60%, however, HR showed no significant difference in either condition. SBP at 20%, 60% and 40% in E-condition was significantly higher than in C-condition. During gradual increase and decrease of workload exercise, HR at top and bottom of workload exercise were no significant differences under both conditions. However, SBP in the E-condition was significantly higher than the C-condition at top and bottom of workload exercise. During recovery in the supine position, SBP in E-condition was significantly higher than in C-condition. These data suggest that eating breakfast might be followed a circadian rhythm. Also, during exercise and recovery BP responses might be conformed to exercise in the afternoon. In conclusion, SBP was increased by eating breakfast during exercise and recovery.

## HEART RATE RECOVERY FOLLOWING SUBMAXIMAL EXERCISE TESTING: ASSOCIATIONS WITH CENTRAL ADIPOSITY IN MIDDLE-AGED ADULTS.

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Introduction Heart rate recovery (HRR) following maximal and submaximal exertion, especially responses within the first minute (HRR60) are a simple, non-invasive measure of vagal reactivation. HRR is known to be more rapid in individuals of high cardiorespiratory fitness

(Imai et al. 1994), but delayed in obese individuals (Brinkworth et al. 2006). The aim of this study was to evaluate sex differences in the association between HRR and waist circumference in a healthy middle-aged cohort. Methods A retrospective analysis of 404 males and 200 females aged  $47.2 \pm 7.3$  and  $46.6 \pm 8.1$  years, respectively, and free of cardiovascular disease was undertaken. Obesity measures included body fat content (BF%) from whole-body bioelectrical impedance analysis and waist circumference (WC). Participants were separated into 3 groups based on recommended cut-off points for WC and BF% into distributional tertiles. Weekly frequency of moderate and vigorous physical activity was determined by questionnaire (Nuffield Health Wellbeing). A submaximal Bruce treadmill test was performed ( $91 \pm 5\%$  and  $89 \pm 3\%$  of age-predicted maximum heart rate (APMHR), males and females respectively). HRR was evaluated at one and two minute time points (HRR60 and HRR120) in a supine position. Correlations between HRR and obesity variables were assessed using Pearson correlation coefficients. Analysis of covariance (ANCOVA) was used to examine mean differences in HRR across tertiles of WC and between the sexes. Results In males and females, significant negative associations were observed between HRR60 and HRR120 with both adiposity measures (all  $P < 0.001$ ). However, WC and HRR120 showed the strongest associations in both sexes, especially in females ( $r = -0.38$  versus  $-0.31$ ; both  $P < 0.001$ ). ANCOVA (adjusting for age and %APMHR) showed HRR120 was significantly reduced in males ( $P = 0.009$ ) and higher tertiles of WC ( $P$  for trend  $= 0.001$ ). Following further covariate adjustment (for treadmill time and frequency of moderate and vigorous physical activity), HRR120 remained significantly reduced in males ( $P < 0.001$ ) and those with higher WC ( $P < 0.001$ ). Treadmill exercise time and vigorous physical activity were independently associated with HRR120 in this model. The differences between the mean HRR120 was only significant between the highest compared to lower tertiles of WC in both sexes (both  $p < 0.01$ ). Discussion Females showed a more rapid HRR and this may represent a cardio-protective effect. HRR120 appears to be most strongly associated with WC measures. These findings are suggestive that central adiposity is more closely linked with dampened HRR amongst middle-aged adults. References Imai K, et al (1994). JACC, 24, 1529-1535. Brinkworth GD, et al (2006). Am Heart J, 152, 693-696

### CARDIOVASCULAR REMODELING, PHYSICAL ACTIVITY LEVEL AND WALKING TRAINING IN POST-MENOPAUSE.

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Introduction Post-menopause is linked to an increase in Cardiovascular risk because of hormonal modifications. Although aerobic exercise has been shown to positively affect heart function and structure, few studies investigated their relationships with spontaneous physical activity. The aim of our study was to assess the role of daily physical activity level (PAL) on the left ventricle structure and the effect of aerobic training in post-menopause. Methods Thirty-eight post-menopausal ( $56.03 \pm 4.03$ ) healthy women without history of physical exercise were recruited after initial screening including medical history, echocardiography and electrical bioimpedance (BIA). To evaluate cardiovascular remodeling we measured the following echocardiographic-doppler parameters: left ventricle relative wall thickness (RWT), midwall fractional shortening (MFS) and elastance (LVE). Daily energy expenditure was measured by SenseWear Pro 3 Armband; basal metabolic rate was estimated by BIA. PAL was calculated by dividing daily energy expenditure by basal metabolic rate. Women walked at moderate intensity 4 days/week for 14 weeks. All the tests were executed also at the end of the training period. Results Cluster analysis on basal values of RWT, MFS and LVE showed the presence of two groups: Group- ( $n=16$ ) and Group+ ( $n=22$ ). Unlike, Group+, Group- had not favorable values regarding to RWT, MFS and LVE. The groups The groups differed significantly in plasma lipids, total cholesterol (TC) and triglycerides (TG) and PAL. Group+ values were better than those of Group-. Logistic regression performed with PAL, TC, TG, smoking habits and hypertensive treatment as independent variables, and sub-group membership as dependent variable, showed that PAL predicted sub-group membership ( $p=0.019$ ). RM-ANOVA showed that aerobic training modified MFS ( $p=0.022$ ) and LVE ( $p<0.001$ ) independently of sub-group membership, while RWT modification has been shown related to its basal values ( $p=0.006$ ). Discussion In post-menopause PAL, without aerobic exercise, has positive influences on both left ventricle function and structure. Walking training positively affects them even if the modification of the latter is related to its basal value.

## Poster presentations

### PP-PM45 Physiology: Repeat Sprints

#### ANALYSIS OF SPEED LOSS AND THE RELATION WITH ACCELERATION AND MAXIMUM SPEED PHASES IN SPRINT EVENTS

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Introduction The purpose of this study is improving knowledge about the different phases in a speed race (60 y 80 meters) and its relation with the values of force and power. This can be an useful tool to regulate the training loads of the sprinters during the competition period. Methods Twenty two high level sprinters (age  $23.1 \pm 4.4$  yr, body mass  $73.7 \pm 4.6$  kg, height  $177.6 \pm 5.9$  cm; body fat  $9.6 \pm 2.9\%$ ) took part in the study. They executed bouts of 40, 60 and 80 meters in different sessions at the maximal speed with complete recoveries (4 minutes, 6 minutes and 8 minutes for 40, 60 and 80m, respectively), registering the time with photoelectric cells. In each distance, the shuttle time in ten meters was registered. Before and after each sprint, every athlete executed three "Countermovement jump" (CMJ), measured with an infrared platform. Further an evaluation of force and power was made with measures of CMJ, CMJ with loads and Squat Jump (SJ), using for it a force platform, an infrared platform and a linear measurer of force. Results The loss of speed in 60 m and 80m is proportional and significantly higher in the final phase of the race (from 50m to 60m for the 60m distance and from 70 to 80m for the 80m distance), than in the acceleration phase (0 to 50 m and 0 to 70m). The performance decreases during repeated-series in short distances are sharper in the maximum speed phase within the run distance than in the acceleration phase. On the other hand, we do not observe this same tendency for the 40m distance, in which this loss of relative speed occurs only to a lesser extent in the final part (from 30m to 40m). Discussion This distribution has relation with the values of strength and power as the fatigue is greater when the available time to apply force is lower (Hakkinen, 1989), and this is what happens during the maximum speed phase, in which the available time to apply force is lower than in the acceleration phase. Therefore the percentual greatest loss of speed in the maximum speed phase could be by the fact of a lower contact time and the consequence in a greater RFD in this phase in relation to the acceleration phase. Nevertheless, are required more investigations in this line of work for the control of all the factors that play an important role to obtain the performance in

this kind of sprints events. References Hakkinen, K. (1989). Neuromuscular and hormonal adaptations during strength and power training. *J. Sports Med.* 29(1): 9-26.

### BLOOD LACTATE AND ACID-BASE BALANCE DURING TWO DIFFERENT LONG- SPRINT TRAINING REGIMENS

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**Introduction** Most studies on long-sprint have focused on interval training regimens with a ratio of 1:3 to 1:9 between sprints and recovery durations (recovery periods never exceed 4.5 min) and have described a progressive decrease in the intensity of the repeated sprint exercises [1] as well as a decrease in the anaerobic glycolytic contribution to the ATP resynthesis during the training session. Surprisingly, conventional textbooks on training [2] recommend interval sprint training with long recoveries (up to 20 minutes with an exercise/recovery ratio of 1:20) for the enhancement of long sprint performance. This study aimed to analyse two different long sprint training sessions of equal total work load, realized either with short (SR) or long recovery (LR) between sets and to compare the effects of 6 long-sprint training sessions on a 300-m performance. **Methods** Fourteen trained subjects performed three maximal sprints (50, 100 and 300-m). They were paired according to their 300-m performance and were randomly allocated to LR or SR training group. Blood pH, bicarbonate concentration, excess-base and lactate concentration were recorded during the third training session and the 300-m pre- and post-test. **Results** Compared to a similar SR training session, the LR training tends to induce a larger alteration of the acid-base balance: pH:  $7.09 \pm 0.08$  (LR) and  $7.14 \pm 0.05$  (SR), bicarbonate concentration;  $7.8 \pm 1.9$  (LR) and  $9.6 \pm 2.7$  (SR) and excess-base:  $-21.1 \pm 3.8$  (LR),  $-17.7 \pm 2.8$  (SR) ( $P=0.11$ ,  $0.04$  and  $0.12$ , respectively). Post-training, a significant improvement in the 300-m performance ( $41.52 \pm 2.45$  vs  $42.45 \pm 2.64$ ,  $p=0.009$ ) and significant decreases in pH ( $P<0.01$ ), excess-base ( $P<0.001$ ) and increase in lactate concentration ( $P<0.001$ ) have been observed compared to pre-training, with no difference between the two groups. **Discussion** Whatever the duration of the recovery, six sessions of a specific long sprint training program have been shown to be sufficient to obtain a significant improvement in the 300-m performance even in our trained subjects. Although muscle data are lacking, we can suggest that doubled recovery duration (12 min) is not sufficient to re-establish homeostasis after long sprint running exercises. Therefore, the repetition of such exercises separated by recovery duration of 4-5 or even 12 minutes is always performed with an incompletely restored homeostasis and could induce near similar adaptations. 1) Bangsbo J, et al. *J. Appl. Physiol.* 77(4): 1890-1895, 1994 2) Newsholme EA, et al. *The science of training and performance*. Chichester, England: John Wiley & Sons, Ltd, 1994

### METABOLIC ADAPTATIONS DURING INTENSE EXERCISE FOLLOWING LONG-SPRINT TRAINING OF SHORT DURATION

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INSEP

**METABOLIC ADAPTATIONS DURING INTENSE EXERCISE FOLLOWING LONG-SPRINT TRAINING OF SHORT DURATION** Claire THOMAS<sup>1,2</sup>, Olivier BERNARD<sup>3</sup>, Carina ENEA<sup>3</sup>, Chadi JALAB<sup>3</sup>, Christine HANON<sup>1</sup> 1 INSEP, Mission Recherche, Paris, France. 2 Université Evry Val d'Essonne, Département STAPS, France, 3 Université de Poitiers, Faculté des Sciences du Sport, EA 3813, Poitiers, France **Introduction** This study aimed to determine metabolic adaptations during intense exercise and improvement of long-sprint performance following six sessions of long-sprint training. **Methods** Nine subjects performed before and after training 1) a 300-m test, 2) an incremental exercise up to exhaustion to determine the velocity associated with maximal oxygen uptake ( $v\text{-VO}_{2\text{max}}$ ), 3) a 70-s constant exercise at intensity halfway between the  $v\text{-VO}_{2\text{max}}$  and the velocity performed during the 300-m test, followed by a 60-min passive recovery to determine an individual blood lactate recovery curve fitted to the bi-exponential time function:  $La(t) = La(0) + A1(1 - e^{-\gamma_1 t}) + A2(1 - e^{-\gamma_2 t})$ , and blood metabolic responses. The training program consisted of 3 to 6 repetitions of 150 to 250 m interspersed with rest periods with a duration ratio superior or equal to 1:10, 3 days a week, for 2 weeks. **Results** Whereas blood lactate concentration ( $La_{lb}$ ) did not change at the onset of recovery after training, significantly lower peak in  $La_{lb}$  was observed ( $P < 0.05$ ), which was related to a significant decrease in net amount of lactate released (NALR) ( $r = 0.78$ ,  $P < 0.05$ ). Furthermore, training also induced a significant decrease in the net lactate release rate (NLRR) at the beginning of recovery. Lastly, a significant improvement of the 300-m performance was observed after training, which was related to intra-individual alterations in blood lactate removal ( $\gamma_2$ ) ability. **Discussion** These results suggest that a lower amount of lactate was released from skeletal muscles after long-sprint training of short-duration, which results from rapid alterations in lactate exchange, and allowed long-sprint performance improvement. **References** Freund H, Gendry P (1978) Lactate kinetics after short strenuous exercise in man. *Eur J Appl Physiol Occup Physiol* 39, 123-35. Burgomaster KA, Cermak NM, Phillips SM, Benton CR, Bonen A, Gibala MJ (2007) Divergent response of metabolite transport proteins in human skeletal muscle after sprint interval training and detraining. *Am J Physiol Regul Integr Comp Physiol* 292, R1970-6.

### RELATIONSHIPS AMONG SPRINT ABILITY, AGILITY AND VERTICAL JUMP PERFORMANCE IN YOUNG SOCCER PLAYERS

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**RELATIONSHIPS AMONG SPRINT ABILITY, AGILITY AND VERTICAL JUMP PERFORMANCE IN YOUNG SOCCER PLAYERS** KOZ M\*.; KÖKLÜ Y\*\*.; ALEMDAROĞLU A\*\*.; ERSÖZ G\*. \*Ankara University, School of Physical Education and Sports, Ankara \*\*Pamukkale University, Schools of Sport Sciences and Technology, Denizli The capacity of soccer players to produce varied high-speed actions is known to impact soccer match performance (1-2). Although high-speed actions only contribute to ;11% of the total distance covered, they in fact constitute the more crucial moments of the game and contribute directly to winning possession of the ball and to scoring or to conceding of goals (1-3). The purpose of this study was to examine relationships among speed, agility and jump performance in young soccer players. Fifteen soccer players (height  $168.46 \pm 4.72$  cm; body mass  $62.60 \pm 7.74$  kg ; average age  $16.00 \pm 0.84$  years; training age  $6.0 \pm 2.03$  years ) participated in this study voluntarily. Sprint-ability of the soccer players was determined by 10-30 meter single-sprint, zig-zag test times (with ball and without ball) were used for the determination of agility (Newtest PowerTimer, Finland) (1), squat and counter movement jump was used for the determination of vertical jump (Newtest PowerTimer, Finland). Results of Pearson Product Moment correlation analysis indicated significant correlation between 10 meter sprint times and 30 meter sprint times ( $r=0.74$ ;  $p=0.01$ ), zig-zag without ball ( $r=0.56$ ;  $p=0.027$ ). Similarly 30 meter sprint times was significantly correlated with counter movement jump ( $r=-0.57$ ;  $p=0.027$ ), zig-zag without ball ( $r=0.76$ ;  $p=0.01$ ). Counter movement jump was significantly correlated with squat jump( $r=0.71$ ;  $p=0.03$ ), zig-zag without ball ( $r=-0.79$ ;  $p=0.00$ ). In addition to, squat jump was significantly correlated with zig-zag without ball ( $r=-0.73$ ;  $p=0.02$ ). Finally zig-zag without ball was significantly correlated with zig-zag with ball ( $r=0.57$ ;  $p=0.02$ ). As a conclusion, while the findings of the present study indicated significant

positive correlation between sprint ability and agility, the finding indicated significant negative correlation both vertical jump-sprint ability and vertical jump- zig-zag agility tests performance in soccer players. The findings suggest that specific testing and training procedures for each speed and jump component should be utilized when working with young soccer players. References : 1. LITTLE, T., and Williams, A.G. Specificity of acceleration, maximum speed, and agility in professional soccer players. *J. Strength Cond. Res.* 19(1):76–78. 2005 2. LUHTANEN, P. Biomechanical aspects. In: *Football (Soccer)*. B. Ekblom, ed. Oxford: Blackwell Scientific Publications, 1994. pp. 59–77. 3. REILLY, T., BANGSBO, J., and FRANKS A. Anthropometric and physiological predispositions for elite soccer. *J. Sports Sci.* 18: 669–683. 2000.

## RELATIONSHIPS BETWEEN STRENGTH QUALITIES BOTH IN RESISTED SPRINT AND VERTICAL JUMPS WITH 20-M SPRINT PERFORMANCE

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**Introduction:** The ability to optimise muscular power output is considered fundamental to successful performance of many athletic activities. Consequently, a great deal of research has investigated methods to improve power output and its transfer to athletic performance, i.e. resisted sprinting and/or loaded vertical jumps. One variable that is considered important in increasing power and performance in explosive tasks such sprinting is the training load that maximises the mechanical power output (PP) of muscle (Alcaraz et al., 2011). Other strength quality such rate of force development (RFD) may predict athletic performance too, however this issue is quite controversial (Cronin & Sleivert, 2005). In this sense, the aims of this study were to investigate the relationship between relative PP and RFD developed in unloaded and loaded vertical jumps (JRFD) with the RFD produced on resisted sprints (RRFD), and finally, correlate these variables with 20-m sprint performance. **Methods:** Thirteen men active competitive athletes specialized in sprinting were recruited for the study ( $18.7 \pm 3.4$  years,  $1.79 \pm 0.06$  m, and  $70.2 \pm 8.8$  kg). The participants, who had previously sled-towing training experience, performed two tests in two days. The first day, 10 countermovement jumps (CMJ) were performed (unloaded jumps and jumps with a weighed vest ranging from 5 to 20% of Body mass (Bm)) on a force plate. Absolute and relative PP (vertical force x instantaneous vertical velocity of the system's center of mass), and RFD (calculated using the following equation in a 0.002 s interval:  $RFD = \Delta F / \Delta t$ ). 48 hours after, four 20-m sprints (unloaded sprints and sprints pulling resistances of 10, 15 and 20% of Bm) from a crouched start were done. The participants were placed 1-m behind the starting line. The resisted sprint trials were performed using a weighted sled (4.7 kg) attached to each athlete by a 3.6-m cord and waist harness. The sprint times were recorded by photocells system placed at 0, and 20-m. A load cell was attached between waist harness and cord to assess changes in force production over the run. Maximum force production and RFD were recorded for each trial in the first stride. For both test, the trials' order was randomized for each participant, and an unlimited rest period was given between trials to minimize the effects of fatigue. **Results:** A Pearson's Product moment correlation showed that there was no significant association ( $p \leq 0.05$ ) between JRFD vs. RRFD. Only a significant correlation was found between RRFD and relative PP at 15% Bm ( $r = -0.666$ ). No significant correlations were found between these variables and 20-m time. In this sense, changes in these strength qualities are not necessarily representative of changes in sprint performance (Cronin & Sleivert, 2005). **Conclusion:** Neither measure analyzed (SRFD or JRFD) is representative of the acceleration phase of sprinting. **References:** 1. Alcaraz et al. (2011). Power-load curve in trained sprinters. A preliminary study. *J Strength Cond Res.* 2. Cronin & Sleivert (2005). *Sports Med*, 35, 213-234

## DIFFERENCES IN PERFORMANCE BETWEEN STARTERS AND SUBSTITUTES DURING SPECIFIC REACTION TEST IN YOUNG ELITE SOCCER-GOALKEEPERS

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**Introduction** In the last few years feasible specific diagnostics has gained more importance modern in high-level soccer. Up to now most of the soccer specific tests have been created for field players. Although even the FIFA World Championship 2010 has shown the necessity of having a strong goalkeeper (GK) in the team, there are still only a few useful tests evaluating the goalkeeper's abilities. In order to reduce this scientific gap we have designed a testing device that can provide information about the reaction and action velocity (RAV) of the soccer GK. **Methods** RAV is measured with the "Keepers Time Detector" ("KTD 4pro") testing device, consisting in a display panel which randomly lights up four LEDs (symbolizing the four corners of the goal) fixed on it, and four contact sensitive balls placed at each corner of the goal. The fourfold panel gives an initial signal for the GK, who has to deflect the determined balls. We analyze time and split time for single or complex diving actions of the GK. The RAV test was conducted with 21 junior GK of nine German 1st division teams, and one Polish "Młoda Ekstraklasa" Team (U19;  $18.8 \pm 0.8$  yrs;  $187 \pm 5$  cm;  $79.9 \pm 7.4$  kg). Moreover we tested 13 elite goalkeepers from DFB U14-talent spots ( $14.1 \pm 0.3$  yrs;  $176 \pm 8$  cm;  $63.0 \pm 10.8$  kg). **Results** RAV single action bottom U19 1st GK (left:  $1.25 \pm 0.07$ s; right:  $1.21 \pm 0.06$ s), substitutes (SB) (left:  $1.30 \pm 0.05$ s; right:  $1.24 \pm 0.06$ s), U14 (left:  $1.39 \pm 0.09$ s; right:  $1.39 \pm 0.12$ s). RAV single action top U19 1st GK (left:  $1.38 \pm 0.06$ s; right:  $1.38 \pm 0.04$ s), SB (left:  $1.44 \pm 0.08$ s; right:  $1.41 \pm 0.07$ s), U14 (left:  $1.59 \pm 0.13$ s; right:  $1.58 \pm 0.11$ s). RAV complex action U19 1st GK top-left/ bottom-right ( $4.30 \pm 0.27$ s), SB ( $4.48 \pm 0.23$ s), U14 ( $5.19 \pm 0.41$ s). RAV complex action U19 1st GK top-right/ bottom-left ( $4.25 \pm 0.30$ s), SB ( $4.38 \pm 0.09$ s), U14 ( $5.06 \pm 0.55$ s). **Discussion** The differences in reaction and action times between the 1st GKs and substitutes may be an indicator for a different degree of quality or expertise. The 1st GKs are faster in all action directions than the substitute keepers. Moreover the 1st GKs have a smaller time discrepancy between the left and the right side, which can imply a higher motoric skill level. The results of the tests can be a useful diagnostic tool for a coach to work specifically in detail on individual weaknesses of the athlete related to diving techniques.

## THE RELATIONSHIP BETWEEN REPEATED SPRINT PERFORMANCE AND MEASURES OF SPRINT AND JUMP PERFORMANCE IN YOUNG, WELL-TRAINED ELITE MALE SOCCER PLAYERS

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**Introduction:** There are two purposes for assessing athletic performance. First, and most common, is to quantitatively determine improvements made following a training cycle. This allows the athlete and sport performance professional to examine if a training stimulus was sufficient to cause a positive adaptation. This method does not, However, lead the professionals in the direction that they should focus the training on (1). Therefore, the purpose of this study was to examine the relationship between repeated sprint performance and measures of sprint and jump performance. **Methods:** Thirty young well-trained elite males' soccer players aged ( $\pm$  SD) ( $16.2 \pm 0.9$  years),

body mass ( $68.3 \pm 9.0$  kg) and stature ( $177.6 \pm 7.4$  cm) volunteered to participate in the present study. All participants and their parents gave their written voluntary informed consent and the local ethics committee at the Norwegian School of Sport Sciences approved the study. All participants were tested on 10x40 m repeated sprint, 40 m maximum sprint, CMJ. 0-20 m acceleration speed and 20-40 m maximum speed were measured at the same run as 40 m maximum sprint test. Results: The results showed a high and significant correlation ( $p < 0.01$ ) between 10x40 m mean repeated sprint time and measures of running speed over 40 m maximum sprint time, 0-20 m acceleration time and 20-40 m flying speed time of  $r = 0.961$  ( $r^2 = 92\%$ ),  $r = 0.925$  ( $r^2 = 86\%$ ), and  $r = 0.801$  ( $r^2 = 64\%$ ), respectively. Furthermore, the 40x10 m mean sprint time had a statistically significant relationship with all measures of jumping performance (for CMJ in absolute term the results was  $r = 0.667$  ( $r^2 = 44\%$ )  $p < 0.01$ , for peak power relative to body weight  $r = 0.590$  ( $r^2 = 35\%$ )  $p < 0.01$ , and for CMJ relative to body weight  $r = 0.423$  ( $r^2 = 18\%$ )  $p < 0.05$ ) except for peak power in absolute term  $r = 0.321$  ( $r^2 = 10\%$ ). Discussion: The significant correlations found between repeated sprint performance and measures of acceleration and maximum sprint indicate a large share of variance, which shows that any increase in 40 m performance whether in the acceleration phase or in maximum speed phase would affect the 40 m repeated sprint positively. Peak power and Jump height were found to correlate positively and significantly with repeated sprint performance except for jump height relative to body weight. However, jump measure explained just a little of the performance on repeated sprint. Generally, previously published data show that correlations between acceleration, sprint and jumping performance exist. How the repeated sprint ability correlates with these measures are, on the other hand, not well documented. References: 1. Brown, T.D., J.D. Vescovi, and J.L. VanHeest, Assessment of linear sprinting performance: A theoretical paradigm. *Journal of Sports Science and Medicine*, 3(4): 203- 210. 2004.

## PHYSIOLOGICAL AND NEUROMUSCULAR INDICES ASSOCIATED TO THE REPEATED SPRINT ABILITY IN COLLEGE SOCCER PLAYERS

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PHYSIOLOGICAL AND NEUROMUSCULAR INDICES ASSOCIATED TO THE REPEATED SPRINT ABILITY IN COLLEGE SOCCER PLAYERS Fernandes da Silva, J.I., Baldi, M.I., Floriano, L.T.I., Dittrich, N.I., Guglielmo, L.G.A.I. 1: UFSC (Florianópolis, Brazil) Introduction The performance of repeated sprint ability (RSA) is a multifactorial phenomenon, influenced not only by physiological aspects, but also by neuromuscular aspects (Billaut and Bishop, 2009). However, no studies were found that investigated the correlation of these indices with RSA of soccer players. Thus, the aim of this study was to investigate the association between physical indices of aerobic power ( $\text{VO}_{2\text{max}}$  and  $\text{vVO}_{2\text{max}}$ ), aerobic capacity ( $\text{vOBLA}$ ) and neuromuscular indices of muscle power: squat jump height (SJh), countermovement jump height (CMJh) and distance of the horizontal jump (HJdist) with RSA (fastest time (FT), mean time (MT), and the performance decrement (Pdec) in soccer players. Methods Twenty-six college soccer players (age:  $22.5 \pm 3.6$  years; height:  $177.5 \pm 6.3$ cm; weight:  $72 \pm 8.3$ kg) performed the following evaluations: a) vertical jump tests (SJ, CMJ); and horizontal jump (HJdist); b) maximal incremental treadmill test to determine: maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ), velocity at  $\text{VO}_{2\text{max}}$  ( $\text{vVO}_{2\text{max}}$ ) and onset of blood lactate accumulation (OBLA); c) RSA test (6 x 40 m (20+20m) interspersed with 20s of recovery) to identify the performance parameters FT, MT, Pdec. Pearson linear correlation was used to analyze the correlation between physiological and neuromuscular indices with RSA. Multiple regression (stepwise) was used to identify which indexes best predict the RSA performance ( $p < 0.05$ ). Results A significant correlation was found between  $\text{vOBLA}$  and the MT ( $r = -0.44$ ,  $p < 0.05$ ). No significant correlations were found between the physiological variables ( $\text{VO}_{2\text{max}}$ ,  $\text{vVO}_{2\text{max}}$ ) with RSA test scores (MT, FT, PD). Among the neuromuscular variables, there were very large and large significant correlations between the HJdist with the FT ( $r = -0.73$ ,  $p < 0.01$ ) and MT ( $r = -0.69$ ,  $p < 0.01$ ), respectively. Also, large correlations were found between CMJ and FT ( $r = -0.54$ ,  $p < 0.01$ ) and MT ( $r = -0.62$ ,  $p < 0.01$ ). The HJdist determined 54% of the variation in performance of the MT. HJdist and  $\text{vOBLA}$  explained 58% of MT. Discussion Based on the data obtained, it is possible observe that, among the physiological indices only OBLA and among the neuromuscular indices only the HJdist and CMJ explain the RSA performance. However, is possible to affirm that the RSA performance is determined primarily by neuromuscular indices (CMJ e HJdist) due to the use of elastic energy accumulated during the stretch-shortening cycle (SSC) (Bosco et al., 1982). References Billaut, F, Bishop, D. Muscle fatigue in males and females during multiple-sprint exercise (2009). *Sports Med*, 39, 257-278. Bosco C, Tarkka I, Komi PV. Effect of energy elastic and mioelectrical potentiation of triceps surae during stretch-shortening cycle exercise. (1982). *Int J Sports Med*, 3,137-40.

## EFFECT OF DIFFERENT TYPES OF STRETCHING ROUTINES ON SUBSEQUENT SPRINTING PERFORMANCE

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Introduction Stretching routines are generally recommended as part of a pre-exercise warm-up as a means of reducing injuries (Woods et al., 2007). However, evidence exists that stretching also impairs muscular performance (Rubini et al., 2007). Researchers have primarily investigated static stretching, usually held over long periods (Rubini et al., 2007). However, a more typical stretching routine would include a combination of static and dynamic stretching, usually lasting shorter periods. Therefore, the aim of the present study was to compare the effect of different stretching routines used in athletics training practice on subsequent sprinting performance. Methods Ten sprint and jump athletes (mean  $\pm$  SD: age,  $22.7 \pm 1.5$  yr; body mass,  $79.4 \pm 8.7$  kg), ranging from regional to international level, free from injuries and familiar with the procedures, performed a flying 20m sprint, following a standardised warm-up consisting of static stretching (SS; hip flexors, quadriceps, hamstrings, hip extensors, and gastrocnemius), dynamic stretching (DS; leg swings, walking lunges, walking floor sweeps and heel-toe walking), SS followed by DS (SDS), or no stretching (CON), with each exercise lasting 30 seconds. Performance variables measured (Optojump, Microgate S.R.L, Bolzano, Italy) were sprint time, stride length, stride frequency, contact time, and sprint-specific power. A 4 (stretching protocols) x 5 (performance variables) repeated measures MANOVA was used and the significance level was set at  $P < 0.05$ . Results Results showed no effect of the stretching routine ( $P = 0.686$ ) on any of the performance variables measured (sprint time  $P = 0.731$ , stride length  $P = 0.741$ , stride frequency  $P = 0.224$ , contact time  $P = 0.185$  and power  $P = 0.210$ ), indicating that performance was maintained, irrespective of the type of stretch used. Discussion Our findings indicate that static stretching, dynamic stretching and their combination do not affect performance. Our results are in disagreement with Fletcher and Jones (2004), who reported a decrease in 20m sprinting, following a bout of static stretching. The differences may be due to the stretching protocols and durations used. Future studies should examine whether stretching protocols that do not impair performance are sufficient to maintain reductions in injury likelihood. References Fletcher IM, Jones B. (2004). *J Strength Cond Research*, 18, 885-888. Rubini EC, Costa ALL, Gomes PSC. (2007). *Sports Med*, 37, 213-224. Woods K, Bishop p, Jones E. (2007). *Sports Med*, 37, 1089-1099.

**EFFECTS OF WELL-ROUNDED TRAINING ON WORKING WHEELCHAIR USERS**

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**Introduction** Reduction of muscle mass is associated with decreased functional performance and increased risk of disuse syndrome. Recent studies have shown that exercise training can improve muscle function, bone mineral density and quality of life in paraplegic persons using wheelchairs (Devillard et al., 2007). However, a lot of disabled persons can not participate in any exercise program, because they engage in normal work. Well-rounded training, composed of resistance training, aerobic training and flexibility exercise, has been shown to be beneficial for increasing the physical strength of the elderly (Harada et al., 2007). The purpose of this study was to investigate the intervention effects of well-rounded training on working wheelchair users. **Methods** Participants were four working wheelchair users (age  $43.5 \pm 6.6$  years). They performed 90-min well-rounded training after their working hours on a regular basis 1 day per week for 3 months. Additionally, we advised them to perform this training in their life style. Physical fitness (hand-grip strength test, muscle strength test of push and pull, shuttle run test, 20-m sprint test, and 5-minute distance test) and muscle mass in forearms, upper arms, lower legs, thighs and trunk were measured 2 times (first day session, 3 months after the initial session) of all participants. **Results** All subjects performed well-rounded training 2 times a week or more outside of the exercise class. Regarding physical fitness, the subjects had significant improvement in the shuttle run test (Pre:  $9.5 \pm 3.9$  times/30 sec., Post:  $10.5 \pm 3.9$  times/30 sec.,  $P < 0.05$ ). There were trends toward improvement in the 20-m sprint test and the muscle strength test of pull, although these changes were not statistically significant. In addition, the replies of almost participants to the following items of questionnaire were improved: "Are you confident in your present physical fitness?" On the other hand, there were no significant changes in the muscle mass of all regions. **Discussion** There is a practical issue for the working wheelchair users that almost of them cannot perform the exercise in their life because they have no time and no place to practice. This study showed that the well-rounded training has a beneficial effect for exercise adherence in working wheelchair users. Few studies reported similar results in the elderly (Harada et al., 2007). Moreover, the present study suggests that well-rounded training has some beneficial effects to improve or maintain the agility performance, the sprinting performance and the upper-extremity muscle strength in working wheelchair users. **References** Devillard X, Rimaud D, Roche F, Calmels P. (2007). *Ann Readapt Med Phys.* 50(6), 490-498. Harada N, Sakakibara H. (2007). *Nippon Koshu Eisei Zasshi.* 54(1), 15-24.

**Poster presentations****PP-PM46 Physiology: Muscle Physiology 1****EFFECT OF DELAYED-ONSET MUSCLE SORENESS ON MAXIMUM VOLUNTARY TORQUE, VOLUNTARY ACTIVATION, H REFLEXES AND TWITCH RESPONSES OF THE QUADRICEPS MUSCLE**

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**Introduction** Delayed-onset muscle soreness (DOMS) reduces voluntary force but impaired neural drive to the muscle may also contribute. Studies have shown that the impairments in the neuromuscular system after muscle damage may be different depending on the muscle and the protocol used to induce DOMS (Prasartwuth et al., 2005, Racinais et al., 2008). The present study investigated isometric maximum voluntary torque (iMVT), voluntary activation (VA), twitch responses and DOMS of the quadriceps muscle as well as maximal H reflexes (Hmax) and maximal M waves (Mmax) of vastus medialis (VM) before and after concentric-eccentric exercise. Data of six subjects have been analyzed so far. Further results including a larger number of persons will be presented at the congress. **Methods** Data were obtained before, immediately after (post), 24h, 48h, 72h and 7days after four bouts of 25 maximal voluntary concentric-eccentric contractions. Measurements were made on the quadriceps of the right leg. Transcutaneous femoral nerve stimulation (rectangular pulses, 1ms duration) was used to produce Hmax, Mmax and twitches. The persons had to perform 5 iMVTs. VA was assessed using the twitch interpolation technique (doublets, two rectangular pulses of 1ms duration, 10ms apart). VA was calculated with the formula:  $[1 - (\text{superimposed twitch}/\text{control twitch})] \times 100$ . Paired t-tests were used for statistical analyses ( $p = 0.05$ ). **Results** Hmax, Mmax and the Hmax/Mmax-ratio of VM did not change after the intervention, whereas twitch responses of the quadriceps muscle were significantly reduced at post, 24h, 48h and 72h. The iMVT was significantly impaired at post, 24h and 48h, while VA was only significantly decreased at post. DOMS assessment using the Likert scale, visual analogue scale and pressure pain threshold revealed significant impairments at 24h, 48h and 72h. **Discussion** While iMVT recovered after 48h, the resting twitch remained depressed until 72h. It has been suggested that changes in excitation-contraction coupling and the length-tension relation underlie the prolonged reduction of the twitch responses (Prasartwuth et al., 2005). Furthermore, it has been postulated that DOMS might impair VA (Racinais et al., 2008). DOMS occurred 24h, 48h and 72h after concentric-eccentric exercise. However, changes in VA did not follow this time course indicating that muscle pain does not change VA of the quadriceps. Data suggest that reduced VA contributes to the early force loss after concentric-eccentric exercise, but that it is not due to muscle soreness. **References** Prasartwuth O, Taylor JL, Gandevia SC (2005). *J Physiol*, 567, 337-48 Racinais S, Bringard A, Puchaux K, Noakes TD, Perrey S (2008). *Eur J Appl Physiol*, 102, 439-46

**THE EFFECTS OF VOLUNTARY WHEEL RUNNING AND NUTRITION ON SKELETAL MUSCLE IN THE SENESCENCE-ACCELERATED MOUSE .**

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**Introduction** The purpose of this study was to investigate the effects of aging in skeletal muscle exercise and nutrition. Muscle force decreases with the aging. It is reported with that factors of the muscle force decrease are atrophy of the fast muscle fiber and decrease in number of muscle fiber. In the neuromuscular junction which is a field of information transfer from the nerve, the denervation is observed. For the resistance of the aging of muscle force decrease and morphological change, it is reported that the exercise is effective. The sesame has an antioxidant, has been reported to inhibit aging. In this study, the effect of the exercise and sesame in the aging on the skeletal muscle function is examined by examining the contraction force. **Materials and methods** SAMP6 (senescence-accelerated mouse prone 6) and SAMR1 (senescence-accelerated mouse resistance 1) 56weeks old, body weight, 30-50 g) were used. This model is useful for studying the acceleration of the aging process in skeletal muscle of the SAM. All procedures in the animal experiments were per-



formed in accordance with the guidelines presented in the Guiding Principles for the Care and Use of Animals in the Field of Physiological Sciences, published by the Physiological Society of Japan. The SAMP6 were classified into 4 groups: SAM control (C), SAM control and sesame (S), voluntary wheel running (T), voluntary wheel running and sesame (TS). The training groups carried out the voluntary wheel running (made by APTEC Co.) from 24 weeks. Single muscle fibers were dissected from the EDL, SOL, PLA, GAS, TA muscles in 54 weeks. Single muscle fibers were dissected from the EDL muscles. The contraction characteristic demonstrated by the nerve stimulation. The morphological observation of muscle fiber by optical microscope used HE staining. Evaluation of the degree of senescence: It used a grading score system (Takeda et al.). Results In 54 weeks the Bodymass of the C and S groups were heavier than that of the Training groups. On the other hand Training groups showed the high value on muscle weight per body mass. And, the Training groups showed the high value in comparison with the C and S groups on the muscle contraction force. The grading score, C and S groups are the evaluation of aging, and training groups did not appear. This suggests that age-related muscle function and morphological changes in C and S group. In addition, voluntary wheel running is more beneficial for aged muscle hypertrophy. References Sakakima H, Yoshida Y, Suzuki S, Morimoto N. (2004). *J Gerontol A Biol Sci Med Sci*. Oct; 59(10):1015-21. Toshio takeda et al., (1981). Mechanisms of ageing and development.; 17:183-194

## **FORCE – VELOCITY RELATIONSHIP FOR UPPER AND LOWER LIMBS: A COMPARISON OF THE RESULTS OF ARM AND LEG FORCE – VELOCITY TESTS**

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**FORCE – VELOCITY RELATIONSHIP FOR UPPER AND LOWER LIMBS: A COMPARISON OF THE RESULTS OF ARM AND LEG FORCE – VELOCITY TESTS** Vodicka, P., Heller, J. Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic **Introduction** Maximal anaerobic power could be measured from the force-velocity (F–v) relationships on a friction loaded ergometer. In contrast with the hyperbolic F–v relationship of an isolated muscle or monoarticular exercise, the relationships between braking force and peak velocity seem to be linear both for arm as well as for leg exercise (Vandewalle et al. 1987). However, there is poor evidence on the differences in the F–v relationships for arm and leg exercise (Driss et al. 2002). Therefore, the aim of this study was to investigate the relationship of F–v characteristics between upper and lower limbs in the same participants, when they are measured in arm cranking and cycle ergometer tests, respectively. **Methods** A group of 17 male students of physical education (age  $25.2 \pm 3.7$  years, body mass  $74.2 \pm 9.8$  kg, height  $178.8 \pm 6.0$  cm, mean  $\pm$  standard deviation) realised arm cranking and cycle ergometer F–v tests in a randomised order. Both tests consisted from 5 short maximal sprints, with duration 7 s each one, against increasing breaking force, from 19.6 to 58.8 N for upper and 29.4 to 68.6 N for lower limbs. Individual linear regression relationship between breaking forces and pedalling frequencies were constructed to determine the theoretical values of maximal force (F0) and velocity (v0) indices for upper and lower limbs, the corresponding maximal anaerobic power (Pmax) and optimal braking force Fopt [% body mass] to elicit Pmax. Results Theoretical values of maximal force (F0) were higher for lower limbs than upper limbs ( $22.5 \pm 3.9$  vs.  $16.8 \pm 4.8$  kp,  $p < 0.01$ ), however maximal velocity (v0) for lower limbs and upper limbs was not significantly different ( $213.12 \pm 12.2$  vs.  $205.2 \pm 36.1$  rev.min<sup>-1</sup>, n.s.). Theoretical maximal anaerobic power (Pmax) for lower limbs ( $1148 \pm 167$  W,  $15.6 \pm 2.4$  W.kg<sup>-1</sup>) were higher ( $p < 0.01$ ) than for upper limbs ( $806 \pm 122$  W,  $11.0 \pm 1.8$  W.kg<sup>-1</sup>). Optimal braking force Fopt to elicit Pmax attained  $14.1 \pm 3.2$  % body mass and  $10.0 \pm 1.9$  % body mass, for lower and upper limbs, respectively. There were not found any significant correlation between the indices of lower and upper and lower limbs (F0:  $r = 0.085$ ; v0:  $r = -0.136$ ; Pmax [W]:  $r = 0.197$ ; Pmax [W.kg<sup>-1</sup>]:  $r = 0.385$ ; Fopt:  $r = -0.023$ , n.s.). **Discussion** The values found for the theoretical maximal force (F0), theoretical maximal velocity (v0), and maximal power output for upper and lower limbs were in agreement with the results of previous studies (Driss et al. 2007, Vandewalle et al. 1989) being attributable to differences in muscle mass and muscle fiber composition of lower and upper limbs. References Driss T, Vandewalle H, Le Chevalier J-M, Monod H (2007). *Can. J. Appl. Physiol.* 27 (3), 250-262. Vandewalle H, Peres G, Heller J, Panel J, Monod H (1987). *Eur. J. Appl. Physiol.* 56, 650-656.

## **MUSCLE OXYGENATION DURING FATIGUING CONTRACTIONS PERFORMED WITH DIFFERENT LOAD TYPES**

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**Muscle oxygenation during fatiguing contractions performed with different load types** Booghs C, Baudry S, Enoka RM, Duchateau J. Laboratory of Applied Biology, Université Libre de Bruxelles - Belgium **INTRODUCTION** Previous work has documented a briefer time to failure, which indicates greater fatigability, for tasks involving the support of an inertial load (high-compliance task) compared with exerting an equivalent torque against a rigid restraint (low-compliance task) (Enoka et al. 2010). The briefer time to failure for high-compliance tasks is accompanied with a faster increase in the amplitude of the electromyogram (EMG) for the active muscles (Klass et al. 2008). The purpose of the study was to determine if these differences in performance are influenced by metabolic and hemodynamic parameters. **METHODS** Eleven subjects (21-36 yrs) participated in two experimental sessions in which the two fatiguing contractions were performed for as long as possible. Subjects had to exert a constant torque (20% MVC) with the elbow flexor muscles either against a force transducer (low-compliance task) or while supporting an equivalent mass (high-compliance task). The elbow joint was kept at 90° during both tasks. The task was terminated when the subject was unable to maintain the required torque (low-compliance task) or joint angle (high-compliance task) within criterion values. The EMG was recorded for biceps brachii, brachioradialis and triceps brachii muscles. Spatial-resolved spectroscopy provided a measure of tissue oxygenation index (TOI), and the normalized hemoglobin concentration index (nTHI) indicated changes in local blood flow. **RESULTS** The time to failure was briefer ( $P = 0.02$ ) for the high-compliance task (411s) than for the low-compliance task (540s) despite a comparable decline in maximal torque at the end of both tasks (–24%). Moreover, the EMG activities increased to the same rate during the two tasks. TOI for biceps brachii was  $74.7 \pm 4.8\%$  and  $76.1 \pm 5.4\%$  at the start of the low- and high-compliance tasks, respectively, and decreased ( $P < 0.001$ ), to  $63.0 \pm 12.5\%$  and  $65.9 \pm 9.5\%$  at task failure (no difference between tasks;  $P > 0.05$ ). Moreover, nTHI for biceps brachii did not change during the two tasks ( $1.0 \pm 0.1$ , data collapsed across tasks). There was also no statistical difference in either TOI or nTHI for triceps brachii in either task. **DISCUSSION** These data indicate that there was an increase in oxygen consumption in the biceps brachii during the two fatiguing tasks and that local blood flow did not change during either contraction. Therefore, differences in muscle oxygenation and muscle blood flow did not appear to play a key role in the briefer time to failure observed for the high-compliance task. **ACKNOWLEDGEMENTS** This work was supported by the research council of the Université Libre de Bruxelles. **REFERENCES** Enoka et al. *J Electromyogr and Kinesiol* 21: 208-219, 2011 Klass et al., *J Neurophysiol* 99: 1096-1104, 2008

## RELATIONSHIP AMONG LOAD TRAINING, AEROBIC/ANAEROBIC PARAMETERS AND PERFORMANCE DURING 22-WEEKS OF SLALOM KAYAKERS TRAINING

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RELATIONSHIP AMONG LOAD TRAINING, AEROBIC/ANAEROBIC PARAMETERS AND PERFORMANCE DURING 22-WEEKS OF SLALOM KAYAKERS TRAINING VEIRA NA1, MESSIAS LHD1, TEREZANI D1, BORIN JP2, CUNHA SA2, OLIVEIRA RM1, MANCHADO-GOBATTO FB1 1:UNIMEP (Piracicaba, Brazil), 2: UNICAMP (Campinas, Brazil) Introduction The manipulation of intensity and volume training are important to the athletes training program (LAURSEN, 2010) and the intensity appears to be the most important for well trained athletes (IAIA, BANGSBO, 2010). The aim of the study was to verify the relationship among training load, aerobic/anaerobic capacity and performance in slalom kayakers during 22-weeks training program. Methods Six slalom kayakers (K1) (17±4yrs) were evaluated at three moments of the training program: linear base (T0), after 14-weeks (T1) and after 22-weeks (T2). The training was only monitored, without intervention of the researchers in the planning of the technical team. The intensity training was determined from the individual rating of perceived exertion (RPE) measured at the end of training session. The weekly training load (average) was determined using the product of duration session (min) by RPE session. The critical velocity model was used to estimate the aerobic and anaerobic capacities. The athletes were submitted to four maximal paddling exercises at 150,300,400 and 600-m with minimum 1hr recovery among them. The slope and y-intercept of linear mathematical model 'distance vs time' were CV (aerobic) and anaerobic paddling capacity (APC), respectively. The simulation competition of slalom kayak were used to evaluate the performance. There were registers of time race (s), distance travelled (m) and mean velocity (mv) using a GPS (Polar G3). For comparison among aerobic/anaerobic conditioning, performance and load training parameters among moments were used ANOVA One-Way. Correlation between training variables and others parameters were proceeded by a Person Correlation ( $P < 0.05$ ). Results Despite the oscillations among volume and intensity in several weeks during 22-weeks of training, there were not changes in weekly mean load, volume and intensity when two moments were compared. No differences were found in CV ( $6.8 \pm 0.1$ ;  $6.8 \pm 0.47$  and  $6.7 \pm 0.0$  Km/h, respectively) and APC ( $67.2 \pm 1.8$ ;  $60.7 \pm 2.1$  and  $64.1 \pm 3.4$  m) in T0, T1 and T2, respectively). The anaerobic parameter showed significant correlation in T0 and T1 ( $r = 0.91$ ) and at all moments, mv and CV were obtained in similar intensity. Discussion The maintenance of aerobic/anaerobic and performance parameters during the three moments seemed to be attributed to non-changes of the volume and intensity training. In this way, to improve significant modification in CV, APC and mv, the training parameters modifications is recommended. Supported by FAPESP and CNPq References IAIA, FM, BANGSBO J. (2010). Scand J Med Sci Sports, 20 (Suppl), 11-23. LAURSEN, PB, (2010). Scand J Med Sci Sports, 20 (Suppl. 2), 1-1

## THE EFFECT OF SKIN FRICTION, DIRECTLY ABOVE BICEPS BRACHII, ON RATE OF FORCE DEVELOPMENT DURING ELBOW FLEXION

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Introduction Rate of force development (RFD), which is obtained from the initial portion of a time-force curve during a muscle contraction, provides us with important information on neuromuscular function. Previously, we reported that RFD increases with skin cold stimulation (SCS) applied directly above agonist muscles during isometric knee extension, suggesting that cutaneous input improves neuromuscular function (Shimose R. et al, 2010). However, it is unclear whether RFD changes with different cutaneous input such as skin friction (SF). Therefore, the purpose of this study was to investigate the effect of SF and SCS on RFD. Methods Five healthy adults (35[9] yrs), who gave informed consent, participated in this study. Subjects sat in an adjustable chair with both their shoulder and elbow joints at 90 degrees flexion. Subjects performed maximal voluntary isometric elbow flexion three times. This procedure was done with SF, SCS or without any form of stimulation (CON). SF was applied to the front of the upper arm by moving a piece of fabric back and forth at a slow speed using an electrical shaking device. SCS (skin temperature 25 degrees) was applied on the same area using a cooled gel pad. Force and EMG of biceps brachii were measured simultaneously during elbow flexion. Peak force, RFD and root mean square EMG (rmsEMG) at periods 0-30, 0-50, 0-100, and 0-200msec were investigated in all the trials. Results There was not much difference between peak force among all trials. RFD of SF at 0-30-50 ms tended to increase by about 3-5%, and RFD of SCS tended to increase by about 7-12%. But there was not much difference in rmsEMG at every interval among the trials. Discussion RFD tended to increase with SF and SCS during isometric elbow flexion. The amount of increase in RFD was a little different between SF and SCS, suggesting different cutaneous input has a different effect on RFD. In comparison to our previous data from knee extension, there was a smaller increase in RFD with SCS during elbow flexion, most likely, because biceps brachii is more sensitive than quadriceps. These results suggest that RFD differs among limb muscles. Although further investigation will be needed to elucidate the effects of different cutaneous input on RFD, the present study suggests that skin friction improves initial force response in biceps brachii during elbow flexion. References Shimose R. et al (2010) ECSS Antalya 2010 congress proceedings, 582

## EFFECT OF HYDROTHERAPY, ACTIVE AND PASSIVE RECOVERY ON REPEATED MAXIMAL CLIMBING PERFORMANCE

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Introduction Hydrotherapy is commonly used in sport practice to enhance recovery from exercise (Wilcock et al., 2006). Cold water immersion and contrast water therapy are effective in minimising the physiological and functional deficits associated with delayed onset of muscle soreness. The effect on subsequent performance is not clear. To date, only three studies (Draper et al., 2006; Heyman et al., 2009; Watts et al., 2000) have investigated recovery in rock climbing. The aim of the study was to compare the effect of four recovery methods (PAS-passive, ACT - active, CW - cold water, CWW - cold and warm water) on repeated climbing performance. Methods Five advanced climbers (mean age 28.6,  $s = 4.0$  years) performed, in a random cross-over design, 4 sessions with 3 repeated climbing tests to exhaustion. The effect of the recovery methods on climbing performance (number of movements, climbing time), heart rate and grip strength was assessed by 4 x 3 RM ANOVA (recovery method x climbing test number). Results Significant interaction between recovery and the climbing test number for climbing performance was found (number of climbing movements:  $F_{6,32} = 2.23$ ;  $p = 0.65$ ;  $\eta^2 = 0.30$ ; climbing time  $F_{6,32} = 2.90$ ;  $p = 0.02$ ;  $\eta^2 = 0.35$ ). The decrease of performance between the 1st and 3rd test was after PAS 41%, CWW 24%, CW 0% and ACT 14% of the number of climbing movements. The average decrease in grip strength was 30% after climbing and was

significantly correlated with the number of climbing movements ( $r = 0.80$ ) and climbing time ( $r = 0.72$ ). Discussion There were two hydrotherapy methods used in the present study. While the CW immersion maintained the subsequent performance, there was a decrease of performance after the CWW immersion. The CW and ACT were the most efficient recovery methods in the current study confirming the results of Heyman et al. (2009). The ACT recovery was performed by walking at 65% of HRmax instead of the cycle ergometer used in the previous study. The recovery method did not have any effect on grip strength. References Draper, N., Bird, E. L., Coleman, I., & Hodgson, C. (2006). *Journal of Sports Science and Medicine*, 5(1), 97-105. Heyman, E., De Geus, B., Mertens, I., & Meeusen, R. (2009). *Medicine & Science in Sports & Exercise*, 41(6), 1303-1310. Watts, P. B., Daggett, M., Gallagher, B., & Wilkins, B. (2000). *International Journal of Sports Medicine*, 21, 185-190. Wilcock, I. M., Cronin, J. B., & Hing, W. A. (2006). *Sports Medicine*, 36(9), 747-765.

## RELATIONSHIP BETWEEN THE SILENT PERIOD AND THE AMPLITUDE OF V-WAVE DURING %MVC WITH SKIN COOLING

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**Introduction** We have demonstrated that the amplitude of H-reflex is unchanged and the amplitude of V-wave with skin cooling increases more than under normal skin temperature conditions in the latter half of the %MVC. However, there is no clear effect on central motor command with skin cooling. The purpose of this study was to investigate the effects on the magnitude of the descending motor drive with skin cooling by analysing V-wave and silent period. **Methods** Eleven healthy adults volunteered for this study. All measurements were taken from left leg muscles. The force of the isometric contraction and twitch of the triceps muscle of calf were established by a force transducer attached to a footplate apparatus. Electric signals were picked up by surface electrodes (10mm) on the belly of the SOL. This experiment was performed under two conditions that consisted of skin cooling (skin temp. 26 deg.; SC) and without skin cooling (skin temp. about 33 deg.; NSC). Under cooling conditions, the skin temperature was cooled to 26°C through application of a cooling pad, attached to the skin, for 3 minutes. 2 maximal voluntary isometric contractions (MVC) for 2 seconds were performed at the control temperature. The force of every 10%MVC was calculated using MVC under control temperature. H-reflexes, M-wave and V-wave were evoked in the soleus muscle by electrical stimulation of the posterior tibial nerve via a cathode ball electrode (5 mm in diameter) pressed into the popliteal fossa. H-reflex and Mmax were obtained under both conditions at rest. During sub-maximal contractions (10, 20, 30, 40, 50, 60, 70, 80, 90% of one MVC) and MVC performance, a supra-maximal stimulus was delivered at supra-maximal intensity, which allowed us to record the superimposed M-wave (Msup) and V-wave of the SOL. **Results and Discussion** There was no significant difference in Hmax, Mmax and H/M ratio under each condition. M-wave amplitude recorded during maximal voluntary plantar flexor contractions (Msup) was significantly greater than that recorded at rest (Mmax) in each condition. However, there was no significant difference between SC and NSC. There was an interrelation between the amplitude of V-wave and silent period in SC and NSC. The amplitude of V-wave increased gradually with increased %MVC under both conditions. With skin cooling the amplitude of V-wave increased in the latter half of the %MVC more than control. The polynomial relation indicated with skin cooling was higher than that without skin cooling over 80%MVC ( $p < 0.05$ ). On the other hand, the silent period decreased gradually with increased %MVC under both conditions. However, there was no significant difference between SC and NSC. However, there was no significant difference between SC and NSC. These results suggest that the increase in V-wave response with skin cooling are related to the elevated motoneuron excitability, however, skin cooling has less effect on the magnitude of the descending motor drive (silent period) than on the spinal cord.

## Poster presentations

### PP-PM47 Physiology: Exercise Training 1

#### CHANGES IN TOTAL DAILY ENERGY EXPENDITURE AND ITS COMPONENTS DURING HIGH- AND LOW-VOLUME TRAINING PERIODS IN MALE ENDURANCE ATHLETES

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**Changes in total daily energy expenditure and its components during high- and low-volume training periods in male endurance athletes.** Drenowatz C., Eisenmann JC. Human Energy Research Laboratory, Michigan State University (USA) **Introduction** Various studies have examined total daily energy expenditure (TDEE) or exercise energy expenditure (EEE) in endurance athletes. There is, however, limited research on the contribution of various components contributing to TDEE and the specifics of EEE during different training periods. The purpose of this study was to examine changes in TDEE and its components, specifically EEE, non-exercise activity energy expenditure (NEAT), and resting metabolic rate (RMR), in male endurance trained athletes during high- and low-volume training periods. **Methods** Energy expenditure was measured in 15 male endurance athletes (age  $23.6 \pm 2.4$ ) during 2 non-consecutive weeks – one week with about 13 hours of training (high volume) and another week with about 6 hours of training (low volume). Anthropometric measurements including %fat via BodPod were taken according to standard procedures at the beginning and end of each week of data collection. RMR was measured in the middle of each week using indirect calorimetry. The SenseWear Pro 3 Armband was used to measure NEAT and EEE was assessed via heart rate using individual regression equations established during a VO2max test performed at the beginning of each week. **Results** There was no difference in body weight ( $73.4 \pm 9.7$ ) or %fat ( $10.8 \pm 3.8$ ) between the two weeks of training. TDEE and EEE were significantly higher during the high volume week ( $4824 \pm 773$  vs.  $4080 \pm 637$  and  $1285 \pm 269$  vs.  $639 \pm 267$  kcal/day, respectively), but there was no difference in training intensity. While there was no difference in NEAT ( $1262 \pm 350$  vs.  $1291 \pm 285$  kcal/day), a trend towards higher RMR was observed ( $2276 \pm 383$  vs.  $2150 \pm 240$  kcal/day) ( $p = 0.08$ ). Time spent in sedentary activity was significantly reduced during the high volume week ( $1051 \pm 91$  vs.  $1108 \pm 89$  min/day), but there were no differences in light, moderate, or vigorous activity. NEAT was also inversely correlated with time spent sedentary ( $r = -0.8$ ), while a positive relationship between NEAT and time spent in light and moderate activity was observed ( $r = 0.7$ ). Further, RMR was positively correlated with time spent in vigorous activity ( $r = 0.5$ ). **Discussion** These endurance athletes did not show a compensatory behavior in response to high volume training – that is, there was no decrease in NEAT during the high volume training. The difference in TDEE was greater than what could be attributed to differences in TEE and the present data suggests an increase in RMR during high volume training. In addition increased training time did not reduce light and moderate activity, but rather reduced sedentary time in trained endurance athletes. Results of this study also support the importance of time spent in light and moderate activity concerning NEAT and TDEE.

## TRAINING LOAD IN A ULTRATRAIL PREPARATION MACROCYCLE

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**TRAINING LOAD IN A ULTRATRAIL PREPARATION MACROCYCLE** Blanco, A., Ensenyat, A., Serra, N. INEFC (Lleida, Spain) **Introduction** Ultra Trail events are competitions of mountain running on various terrain trails that exceed 6 h in duration. Due to its prevailing aerobic demands, from a physiological point of view, Ultra Trail is considered an ultra-endurance effort. During the training process, it is essential to determine and evaluate the training load in order to quantify the magnitude of the effort done, and to control the degree of fatigue of the athlete. Quantification of the load, by means of rating of perceived exertion (RPE), can be done easily using RPE of each session (session RPE method) and microcycle (fatigue index). The aim of this study was twofold; (a) to determine the training load in a 13 weeks macrocycle for the preparation of two Ultra Trail competitions, and (b) to relate the session and microcycle training load with the volume (time and distance) and the physical intensity (mean speed) of training. **Methods** An experienced amateur athlete (36 years, 172 cm of height, 80 kg of weight), with a best performance of 7 h 26 min in 100 km road running. Along a 13 weeks macrocycle, distance covered and time expended in each training session were measured using a GPS Garmin Forerunner 301. Session and microcycle training load were registered by means of session RPE method and fatigue index, respectively (Foster, 1998; Foster et al., 2001). **Results** The athlete did 78 training sessions and two Ultra Trail competitions. He devoted 124 h 55 min to cover 1921.2 km running with a mean speed of 15.4 (SD 1.8) km.h<sup>-1</sup>. Training volume and training intensity decrease along the 13 microcycles of macrocycle. The mean training load was 298.4 (SD 91.1) arbitrary units (AU), ranking from 298 to 454 AU. Monotonia ranked between 0.91 and 4.06. The mean of fatigue index was of 3976.4 (SD 1907.9) AU, ranking from 403 to 6082 AU. Ultra Trail competitions (112 and 96 km) were covered in 28 h 48 min and 13 h 51 min, with a global ascent of 9700 m and 5950 m, respectively. **Discussion** The fatigue index of each microcycle correlates significantly with distance ( $r = 0.76$ ) and time ( $r = 0.77$ ) but not with the mean speed ( $r = -0.34$ ) and monotonia ( $r = 0.47$ ). Correlation was not significant for training volume (distance or time) and microcycle mean speed. The findings suggest that to assess the physical strain of the training load, fatigue index, is more sensitive to microcycles training volume, than to the mean speed. This may allow controlling the dynamics of the training process of the athlete. **References** Foster C. (1998). Monitoring training in athletes with reference to overtraining syndrome. *Med & Sci in Sports & Exercise*, 30(7), 1164-1168. Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, Doleshall P, Dodge C. (2001). A new approach to monitoring exercise training. *J Strength & Co Research*, 15(1), 109-115.

## THE EFFECT OF 5 WEEK OF HIGH- INTENSITY TRAINING ON AEROBIC AND ANAEROBIC FIELD TEST PERFORMANCE IN YOUNG FEMALE SOCCER PLAYERS

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**Introduction** Previous studies has shown that high- intensity training (HIT) such as repeated sprint and interval training is important for soccer players (Bradley, et al., 2009), and it has been suggested that HIT can improve physical soccer performance (Bravo, et al., 2008; McMillan, et al., 2005). Also, HIT has proven to better test results in a test of repeated sprint ability (RSA) and Yo-Yo IR1. However, little research on the effect of this type exercise training on young female soccer players exists. Therefore, the aim of this study was to investigate the effect of HIT on RSA and Yo-Yo IR1 in young female soccer players. **Methods** 23 young female soccer players (age 15.7  $\pm$  1.2 y) participated in this study. Pre- and post- tests included a Yo-Yo IR1 test, a test of 6\*25m RSA and 10m and 25m sprint. Further, players were randomly assigned to either the HIT group (TG, n=11) or the control group (CG, n=12) based on their Yo-Yo IR1 performances. TG did 20min of HIT (3x6x25m repeated sprint or 4x3.5min intervals in a soccer specific "dribbling track") twice during their six weekly soccer team practices, while CG continued to do their regular soccer activities. We applied paired t-tests to compare the pre and post test within the groups, while the independent samples t-test were used to evaluate possible differences between groups. Differences were considered significant at  $p < 0.05$  and results are presently expressed as mean  $\pm$  standard deviations (SD). **Results** TG showed significant ( $p < 0.05$ ) improvement in Yo-Yo IR1 (+77.3  $\pm$  37.7m,  $p = 0.03$ ), 10m mean (-0.093  $\pm$  0.006s,  $p = 0.02$ ) and 10m total (-0.464  $\pm$  0.086s,  $p = 0.02$ ) RSA time, and 0-10m sprint time (-0.076  $\pm$  0.001s,  $p = 0.002$ ). CG experienced a significant ( $p < 0.05$ ) decreased performance in 0-10m sprint time (0.211  $\pm$  0.06s,  $p = 0.00$ ). No further significant changes were observed. **Discussion** Present results indicates that 5 weeks of HIT twice weekly cause significant effect on Yo-Yo IR1, 10m mean and 10m total RSA time, and 0-10m sprint time, while not leading to any changes in 25m mean or total RSA time. Changes in 10m performances could be due to an increased amount of high speed acceleration during training compared to previous soccer practices. Based on previous research, these improvements could also indicate an improved ability to perform high- intensity running in soccer matches for the present group of young female soccer players. **References** Bradley, P. S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P., & Krustup, P. (2009). *J Sports Sci*, 27(2), 159-168. Ferrari Bravo, D., Impellizzeri, F. M., Rampinini, E., Castagna, C., Bishop, D., & Wisloff, U. (2008). *Int J Sports Med*, 29(8), 668-674. McMillan, K., Helgerud, J., Macdonald, R., & Hoff, J. (2005). *Br J Sports Med*, 39(5), 273-277.

## DELAY EFFECT BETWEEN STRENGTH AND ENDURANCE SEQUENCES DURING A 7-WEEKS CONCURRENT TRAINING.

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**Delay effect between strength and endurance sequences during a 7-weeks concurrent training.** Robineau, J.I, Piscione, J.I, Lacome, M.I, Bigard, X.2, Babault, N.3 1: FFR (Marcoussis, France), 2: CRSSA (Grenoble, France), 3: CEP (Dijon, France) **Introduction** Previous studies emphasised an impairment of strength development following concurrent resistance and endurance training, in comparison to resistance training alone (Hickson, 1980). Because the recovery time between sessions could be a limiting factor of the expected responses to physical training, we aimed to examine the role played by the delay between strength and endurance training sessions on performance (0, 6 and 24h). Therefore, the aim of this research was to identify a training model to optimise strength adaptations induced by concurrent training. **Methods** Twenty five amateur rugby players volunteered for the experiment. Subjects mean ( $\pm$ SD) age, height and mass were 26.4  $\pm$  4.1 yrs, 180.3  $\pm$  7.2 cm and 87.9  $\pm$  11.0 kg, respectively. They were shared out three 7-weeks concurrent training groups with strength performed first and followed immediately (0h), 6h or 24h by endurance training. Strength training consisted in 3-4 sets of 3-10 RM for bench press (BP), bench row (BR), half-squat (HS) and leg press exercises. Endurance training aimed to develop aerobic maximal power using intermittent running exercises (15/15s). Training sessions were performed twice a week. Muscular strength was evaluated before (pre) and after (post) each 7-weeks training period. The 1RM was evaluated on BP, BR and HS exercises. Power of the lower limb was determined during counter movement jumps (CMJ) using an Optojump system (Microgate, Italy). Muscular endurance has been evalu-

ated through 20 maximal isometric knee extensions, (75°, 5s contraction and 15s recovery) on an isokinetic dynamometer (Contrex, Switzerland). Results Significant increases were observed, between pre and post training ( $p < 0.05$ ), for BP ( $10.7 \pm 7.2\%$ ), BR ( $11.8 \pm 7.7\%$ ), HS ( $25.2 \pm 18.2\%$ ) and CMJ ( $7.8 \pm 9.1\%$ ). No significant difference was found for muscular endurance between pre and post training. However, there was no significant effect of the time recovery on responses to physical training. Discussion Our study highlighted strength gains of both lower and upper-limb, following the 7-week period, independently of the delay between strength and endurance sessions. In contrast, muscular endurance failed to be improved after the 3 concurrent training models. In conclusion, the between-sessions delay (0, 6 and 24h) did not seem to markedly affect the neuromuscular responses to concurrent training. References Hickson RC. (1980). Eur J Appl Physiol, 45, 255-63.

## WALKING TRAINING PROGRAM AND ITS INFLUENCE ON AEROBIC FITNESS AND BODY COMPOSITION IN SENIOR WOMEN

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**WALKING TRAINING PROGRAM AND ITS INFLUENCE ON AEROBIC FITNESS AND BODY COMPOSITION IN SENIOR WOMEN** Bunc, V., Štilec, M. UK FTVS (Prague, Czech Republic) Introduction An effect of physical exercise may be assessed by level of aerobic fitness (AF) and body composition (BC). Dynamic work of cyclic character like walking or running requires the large muscle masses and thus the changes of actual state could be the biggest. The walking is probably the most easily accessible, and often underestimated as a general way to increase a subject's level of AF and improvement of BC. The aim of this study was to verify the moving programme based on walking for influence AF, and BC in women seniors. Method The exercise intensity (minimally of 90% was walking) at a level of 50 to 70% VO<sub>2</sub>max (HR ranged from 65 to 85 % of HRmax) was used in a group healthy senior women ( $n=53$ , age= $68.7 \pm 5.0$  years, BM= $69.9 \pm 7.9$  kg, height= $161.0 \pm 2.8$  cm, %BF= $37.5 \pm 5.1\%$ , VO<sub>2</sub>max.kg<sup>-1</sup>= $25.9 \pm 4.3$  ml.kg<sup>-1</sup>.min<sup>-1</sup>). The time of exercise session ranged from 20 to 50 min, and exercise was performed 3-5 times a week. The time spent by exercise per week ranged between 90-250 min (mean  $156.8 \pm 48.9$  min). Walking time ranged between 82-233 min (mean  $142.8 \pm 45.7$  min). Results The energy output of exercise ranged from 650 kcal (2675 kJ) to 1780 kcal (7740 kJ) (mean  $950 \pm 230$  kcal -  $3970 \pm 960$  kJ) per week. After 6 months of training, non-significant BM increase (mean  $0.8 \pm 1.7$  kg), %BF decrease ( $0.6 \pm 1.5\%$ ;  $1.6 \pm 2.2\%$ ; NS), and BCM increase ( $2.3 \pm 1.7$  kg;  $10.0 \pm 2.3\%$ ;  $p < 0.01$ ) was found. VO<sub>2</sub>max increased significantly by  $2.1 \pm 1.2$  ml.kg<sup>-1</sup>.min<sup>-1</sup>;  $8.0 \pm 3.3\%$ ; ( $p < 0.01$ ) of initial value. Similarly was increased the v<sub>max</sub> of walking by  $0.5 \pm 0.3$  km.h<sup>-1</sup>;  $7.8 \pm 1.5\%$ ; ( $p < 0.01$ ) of starting value. Discussion Major advantage with walking over running is that it has a lower frequency of injuries and that in a group of patients the probability of exceeding of security level is lower than in running. FFM is significantly lower in elderly women than in younger women, and it is estimated that FFM decreases 3kg per decade, on average, in middle-aged to elderly sedentary healthy adults. This loss is almost 1-1/2 times as great in men as women, because men were found to lose FFM at the rate of 0.34 kg.year<sup>-1</sup> whereas women lost FFM at the rate of 0.22 kg.year<sup>-1</sup>. Between 40 and 80 years of age, men lose FFM at the rate of 5% each decade, whereas women lose about 2.5% FFM each decade. At these rates, men and women lose approximately 20% and 10% of total FFM, respectively, between ages 40 and 80 years. After the 6 months of aerobic training the values of AF were significantly better than Czech population standards, and data of BC non-significantly were improved. Conclusions We may conclude that physical exercise realized mainly by walking lasting 6 months with total energy content of 950 kcal (3970 kJ) during a week is enough for significant improvement of AF and BC in senior women. The study was supported by grant of Czech Ministry of Education MSM 0021620864

## COMPARISON OF THE EFFECTS OF ISOKINETIC VS ISOTONIC ECCENTRIC TRAINING ON MUSCLE STRENGTH AND MASS.

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**Introduction** Eccentric(ECC) training has been shown to induce higher improvements than concentric training on muscle strength and mass (Roig, 2009).The majority of the studies have used isokinetic (ISOK) dynamometers for investigating the acute and chronic effects of ECC training. However, isotonic (ISOT) devices are more commonly available in real sport setting. Aim of the study was to compare ISOK to ISOT ECC training by assessing the effects on muscle strength and mass. **Methods** Forty-nine healthy sport science students were randomly divided in 3 groups: isokinetic eccentric training (ISOK,  $n=14$ ), isotonic eccentric training (ISOT,  $n=17$ ) and control group (CON,  $n=18$ ).Both training groups performed 50 ECC repetitions of knee extension at 120% of their maximal strength measured in concentric modality (1RM for ISOT and peak concentric torque for ISOK), for a total of 14 times in 6 weeks. Isometric maximal voluntary contraction (MVC), concentric and eccentric strength at 60 °/s, 1RM, and muscle mass (using DEXA) were measured pre and post training. All dependent variables were analyzed after log transformation using ANCOVA,entering the baseline values as covariate and factor "group" as independent variable. **Results** Compare to CON,the ISOK group showed higher 1RM (12%, CI95% 6 to 19%), concentric (15%, 8 to 22%), eccentric (35%, 25 to 45%) and isometric (25%, 18 to 34%) maximal strength ( $P < 0.001$ ). Compare to CON, ISOT showed higher 1RM (14%, 9 to 20%), concentric (17%, 11 to 24%), eccentric (25%, 16 to 34%) and isometric (22%, 15 to 29%) maximal strength ( $P < 0.001$ ). No differences between ISOK and ISOT were found in 1RM (2%, -3 to 7%), concentric (-2%, -4 to 8%) and isometric (-3%, -8 to 3%) maximal strength. Only eccentric strength was higher in the ISOK compare to the ISOT group (8%, 1to 14%). No differences between groups were found in muscle mass( $0.419 < P < 0.769$ ). **Discussion** This study showed that ECC training using both ISOK and ISOT improved maximal strength in physically active people. The lack of muscle mass changes suggests that the increase in muscle strength was mainly due to neural adaptations (Hortobagyi, 1996).ISOK showed higher improvement in ECC strength measured on the isokinetic dynamometer but this may be due to similarity between testing and training conditions. Nevertheless, considering ISOT devices are more easily available, this training modality seems to be a good alternative to ECC training using isokinetic dynamometers. References Roig et al., 2009, Br J Sports Med 43(8): 556-68. Hortobágyi et al.,J Appl Physiol. 1996 Oct;81(4):1677-82.

## EFFECT OF HIGH-INTENSITY SPRINT TRAINING WITH ACTIVE RECOVERY ON AEROBIC ENERGY SYSTEM AND PERFORMANCE DURING EXERCISE

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[Introduction] Active recovery (AR) after high-intensity exercise enhances blood lactate removal (Bonen and Belcastro 1976; Gisolfi et al. 1966). However, no study has examined the efficacy of AR during high-intensity exercise training. In this study, we investigated training

effects with respect to the presence or absence of AR during high-intensity exercise training. [Methods] We divided 12 college soccer players into 2 groups: a group in which AR at an intensity of 80% lactate threshold (LT) was continued for 20 minutes after sprinting at 130 to 150% VO<sub>2</sub>peak (n=6, AR group), and a group in which subjects rested in a seated position for 20 minutes after a similar sprint (n=6, passive recovery (PR) group). Such sprint training was conducted 5 times a week for 6 weeks. The VO<sub>2</sub>peak, LT and OBLA running velocity were measured before and after training. The subjects were also instructed to sprint at an intensity of 130 to 150% VO<sub>2</sub>peak until they become exhausted before and after training. We measured the duration of exercise and total oxygen consumption during sprinting. [Results] In the two groups, the duration of exercise significantly increased after training (PR group: from 130.0±18.0 to 145.8±20.0 seconds, AR group: from 130.0±30.6 to 156.7±37.8 seconds, p<0.05). At this time, the rate of increase in the duration of exercise was greater in the AR group (p=0.06). Similarly, the total oxygen consumption during sprinting significantly increased after training in the two groups. However, the increase was more marked in the AR group (p=0.07). Both the LT and OBLA velocity in the AR group significantly increased after training (p<0.05), but there were no changes in the LT or OBLA velocity in the PR group. [Discussion] The rate of increase in performance after training was larger in the AR group. At this time, the AR group showed a more marked increase in the total oxygen consumption during sprinting. Therefore, in this group, the aerobic energy system during sprinting may have been greater than in the PR group. In the AR group, the LT and OBLA velocity increased after training. Therefore, improvement in the oxidation capacity of lactate and pyruvate may have contributed to the increase in the total oxygen consumption during sprinting in the AR group (Bergman et al., 1999; Burgomaster et al., 2006). These results suggest that sprint training with AR improves the aerobic energy system and performance during exercise in comparison with AR-free training. [References] Bonen A and Belcastro AN (1976). *Med Sci Sports*, 8, 176–178. Gisolfi C, et al (1966). *J Appl Physiol*, 21, 1767–1772. Burgomaster KA, et al (2006). *J Appl Physiol*, 100, 2041–2047. Bergman BC, et al (1999). *J Appl Physiol*, 87, 1684–1696.

### THE EXECUTION OF WUSHU FORMS MEETS THE INTENSITY RECOMMENDATIONS FOR THE DEVELOPMENT OF AEROBIC FITNESS

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**Objective** The wushu practice basically involves fighting (sanshou) and the execution of forms (taolus), both handsfree and with the use of implements. Being the wushu increasingly practiced, and given the high rates of physical inactivity among the population, this modality, specifically taolu, may be an interesting strategy to engage people in the appropriate amount of exercise (Haskell et al., 2007). Thus, the purpose of this study was to verify whether the practice of the taolus – with and without weapons – result in heart rate values (HR) compatible with the recommendation of the ACSM (2006). **Methods** The sample included six subjects (male and female), all members of the Brazilian taolu team (age: 22.3±4.3 years, body mass: 61.5±10.6 kg, height: 163.3±7.6 cm; VO<sub>2</sub>peak: 48.8±7.5 ml/kg/min, years of experience: 9.1±5.1, practice time per week: 15±5 h; HRmax: 191±8 bpm). The participants underwent a maximal graded test with a gas analyzer (Aerograph VO2000), in a motorized treadmill (ATL Inbrasport) and performed two taolus, handsfree (HF) and with short weapons (SW). The taolus were performed in different days, but at the same time of the day, and at the subject's regular practice place. The HR was monitored by heart rate monitor (Polar s610). The conditions were compared using a Student t test for paired data. **Results** The values (mean and standard deviation) of HR (bpm) in the taolus were: HF – 174±9.65 and SW – 171.5±13.59. As a percentage of HRmax, these figures represented: HF – 91.78±2.52 and SW – 90.71±3.85. No significant differences were found between both absolute and relative values (p> 0.05). **Discussion** It was noted that all athletes have reached the heart rate values recommended by the ACSM (2006) for improving aerobic fitness in both taolus. Therefore, according to the data from the sample in question, regardless of the use of short weapons, the practice of taolu can contribute to the improvement or maintenance of cardiorespiratory fitness. Similar results were found in studies cited by Tsang et al. (2008), who analyzed the performance of the mode's specific techniques. **References** American College of Sports Medicine (ACSM) (2006). *Guidelines for Exercise Testing and Prescription*, 141-142. Lippincott Williams & Wilkins, Philadelphia. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, Bauman A. (2007) *Circulation* 39: 1423-34. Tsang TW, Kohn M, Chow CM, Singh MF. (2008) *J Sports Sci*. 26(12): 1249-67.

## Poster presentations

### PP-PM48 Rehabilitation 1

#### A NOVEL SHOULDERS TRAINING/REHABILITATION DEVICE BASED ON THE CONCEPT OF PERCENT OF MUSCULAR ACTIVATION

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**Introduction** For most training/rehabilitation devices, the external load is calculated on the basis of the "one repetition maximal" (1 RM). Recently, a new concept has been tested using electromyogram signal (EMG) that activate a motor unit in order to assist the participant during four different shoulder movements: flexion, extension, abduction and adduction. The assistance begins when a predetermine percent of the maximal muscle activation (PMA) of the shoulder is reach. The EMG is used as a monitoring system to ensure that the participant works within the prescribed workload. That is, when the participant's muscular efforts surpass a certain threshold, the system will automatically and progressively reduce the load to bring the deployed effort back into the desired zone. To do so, each training session must begin by determining the EMG level corresponding to the participant's maximum effort assessed during a maximal isometric contraction for each of the four movements. Depending on the goal of training, a participant may be prescribed to work at a given percentage of is maximum values. The system will monitor the EMG signal during normal exercise, and when it surpasses the limit, the desired weight will be decreased. When the EMG signal is below the prescribed threshold, the operation of the system continues normally. **Methods** 8 healthy active adults (4 men and 4 women, mean age 34.8.1±17.2 years old) were trained 3 times a week for a period of 8 weeks. Each training session last 45 minutes during which, four exercises have been realize. The maximal isometric contractions (kg) were measured for each training session for the shoulder flexion and abduction. During this process, percent of maximal muscle activation was recorded via the EMG and the percent of workload fixed at 80% of the PMA. **Results** After 8 weeks of training, a significant strength gain of 11.8% and 26.3% respectively for right and left shoulder flexion and 14.0% and 25.5% respectively for right and left shoul-

der abduction. Likewise, the assistance of the motor unit dropped by an average of  $\approx 15.0\%$  by the end of the 8 weeks training. Discussion The EMG feedback system seems to be an attractive procedure to modulate strength muscular training. The present results are particularly interesting because all participants were trained persons. The impressive gains on the left shoulder (weakest one), as much as for flexion as for abduction, suggest that injured patients could find a particular benefit by using that device. The drop of the motor assistance was also an objective measurement of strength improvement. Conclusions The EMG feedback system appears to be an innovative and effective way to train healthy or injured shoulders.

### PREDICTORS OF RISKY REHABILITATION BEHAVIORS AMONG US COLLEGIATE ATHLETES

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Competitive athletes may risk their health and well-being in an attempt to return to sport following injury (Charlesworth, & Young, 2004). The purpose of this study was to examine whether impression management concerns and a high athletic identity were associated with risky rehabilitation behaviors (e.g., overdoing rehabilitation) and a willingness to make a premature return to sport. Sixty-seven (32 males and 35 females) NCAA Division I, II and III collegiate athletes from the United States completed measures assessing impression management concerns, athletic identity, risky rehabilitation behaviors and beliefs, and a willingness to make a premature return to sport. Impression management concerns about appearing athletically untalented (AAU,  $\alpha = .93$ ), physical appearance (PA,  $\alpha = .73$ ), fatigued/lacking in energy (FLE,  $\alpha = .97$ ), and mental composure inadequacies (MCI,  $\alpha = .88$ ) were assessed using the Self-Presentation in Sport Questionnaire (SPSQ). Athletic Identity was measured using the Athletic Identity Measurement Scale (AIMS;  $\alpha = .84$ ). Injury risk behaviors were measured using the Rehabilitation Behaviors and Beliefs Questionnaire (RBBQ) and a modified version of the Injury Psychological Readiness to Return to Sport Scale (I-PPRS;  $\alpha = .88$ ). As the RBBQ was a novel instrument, an exploratory factor analysis (EFA) was conducted. EFA results indicated two distinct interpretable factors with eigenvalues exceeding 1.0—Ignoring Medical Recommendations (RBBQ-IMR,  $\alpha = .93$ ) and Attempting an Expedited Rehabilitation (RBBQ-AER,  $\alpha = .75$ ). Subsequent correlational analysis revealed significant correlations between PA ( $r = .50$ ,  $p < .01$ ), FLE ( $r = .38$ ,  $p < .01$ ), MCI ( $r = .40$ ,  $p < .01$ ), AIMS ( $r = .27$ ,  $p < .05$ ) and the IMR factor. In addition, PA was positively correlated with risking a premature return (I-PPRS;  $r = .25$ ,  $p < .01$ ). Finally, linear multiple regression analyses indicated that PA predicted 29.2% (23.4 % adjusted) of the variance in risky rehabilitation behaviors and beliefs (RBBQ-IMR;  $\beta = .328$ ,  $p < .05$ ). These findings suggest that athletes with impression management concerns and a high athletic identity may be more likely to ignore medical recommendations such as avoiding specific activities/exercises and by hiding pain. A focus on diminishing physical appearance concerns and mental composure inadequacies may be useful in minimizing engagement in risky rehabilitation behaviors. To this end, medical practitioners may wish to employ confidence building techniques such as relaxation, imagery, and goal-setting. Charlesworth, H., & Young, K. (2004). Why English female university athletes play with pain: motivations and rationalizations. In K. Young (Ed.), *Sporting bodies, damaged selves: Sociological studies of sports-related injury* (pp. 163-180). Oxford, UK: Elsevier.

### THE EFFECT OF A PROGRAMME OF SWISS BALL EXERCISES ON SOME OF PHYSICAL FITNESS ELEMENTS AS A TRAINING STYLE OF PHYSICAL PREPARATION FOR EGYPTIAN FENCERS.

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THE EFFECT OF A PROGRAMME OF SWISS BALL EXERCISES ON SOME OF PHYSICAL FITNESS ELEMENTS AS A TRAINING STYLE OF PHYSICAL PREPARATION FOR EGYPTIAN FENCERS. Heba Abu El-Maaty, Lecturer in Sports Training Dept. Faculty of Physical Education /Tanta University (Tanta, Egypt). Introduction Exercise is considered to be one of the most important factors of developing the body's vital systems, especially the neuromuscular system along with the circulatory and respiratory systems, which lead to improving functional performance (Elhagrsy, 2004; Saad Eldin, 2001). Swiss balls are one of today's top fitness tools. Since the Swiss ball is unstable, balance need to be adjusted constantly, this in turn improves proprioception and flexibility. Using the Swiss balls during fencing training in regular basis will develop many of the physical qualities such as muscular strength and endurance, agility, balance and coordination. Moreover, it aid in improving the fencers' psychological state and temperament (Mousa, 2006). Despite the significance of using Swiss balls during fencing training, there has been no any publication or assessment to date of its effect on the physical and psychological fitness of Egyptian fencers. Therefore, this study was undertaken. Methods Of the 12 Egyptian fencers from Muslim Youth Club team in Tanta (Egypt), 8 fencers were included in performing the experiment. The Restameter was used for measuring the body's total height in centimetres, standardised medical scales for measuring weight in kilogrammes, a stopwatch for measuring time to the closest 1/100 second, 10 Swiss balls were enough to suit the study sample. T test was used to measure the element of physical fitness. Results The arms' muscular strength variable in the pre-training was 3.74 times while in post-training was 5.52 times whereas the legs' muscular strength in the pre was 60.55 cm and in the post was 75.00 cm. Coordination in the pre was 6.20 degrees and in the post was 9.00 degrees. Abdominal muscles endurance variable in the pre was 5.18 counts and was 8.88 counts in the post, while back muscles endurance in the pre was 3.80 counts and 6.96 counts in the post. Static balance in the pre was 4.14 second and was 8.33 second in the post. Agility in the pre was 3.78 degrees and 5.52 degrees in the post. Discussion This study found that exercise program using Swiss balls has significant effect in improving some of the element of physical fitness as (arms' muscular strength – legs' muscular strength – muscular endurance of abdomen muscles – muscular endurance of back muscles – balance –agility) of Egyptian fencers. It also has significant effect in improving Egyptian fencers' physical performance during training and competitions. References Elhagrsy S, (2004). *Swiss Ball: for Strength, Tone and Posture*. Future Publishing Company, Cairo. Mousa S, (2006). *Swiss Ball for Total Fitness*, 24 –3. Helwan University Press, Cairo. Saad Eldin M, (2001), *Swiss Ball versus Office Chair: Comparison of Muscle Activation*. Elmaarf Press, Alexandria.

### EFFECTS OF ENDURANCE AND STRENGTH TRAINING IN REHABILITATION OF WOMEN WHO HAVE FINISHED TREATMENT FOR GYNAECOLOGICAL CANCER, - A RANDOMIZED TRIAL.

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Introduction Previous studies have shown that participation in physical training and educational and counseling groups may have positive effects on quality of life and coping for women treated for gynaecological cancer. However, as far as we know no RCT has measured and compared the effects of both physical training groups with those of educational and counseling groups for women's self reported

quality of life and coping. In this study there are two interventions. In the following the intervention physical training in groups will be presented. The purpose of this study intervention is to evaluate the effect of endurance and strength training in group for women treated for gynaecological cancer. Methods: Subjects: Women who completed curative treatment for gynaecological cancer at Kvinneklínikken, Haukeland University Hospital, Bergen, between January 2007 and June 2011. This study has a randomized controlled design: 1) Physical training in group, 2) Education and counseling groups, 3) Controlled group. The participants completed measurement three times, at pre-intervention, post-intervention and after one year. All the participants were measured for VO<sub>2</sub>peak by a walking treadmill test in addition to measurements of maximal strength; leg press, leg extension and chest press. Oxygen consumption was measured using a Jaeger Oxycon Pro in mixing chamber mode (Jaeger, Germany). The physical training group had two sessions a week (90 min) for 16 weeks. The group training was carried out in a gym to music as follows; warmup (15 min), endurance training (25 min) moderate to hard intensity, strength training (25 min) and finally stretching and relaxation with focus on body awareness (25 min). The strength training was performed using simple tools such as elastic ropes and weights. Other outcome variables: quality of life (global and health related), coping, fatigue, sexuality, anxiety and depression. Results: Preliminary data will be presented. Conclusion: Of about 300 women that were invited to participate in the study, 50 women volunteered. So far, three groups have concluded the physical training program and a 4th group has just started in Bergen. To include sufficient participants as estimated in power analysis, the study has just been extended to become a multicenter study. It now includes two other health regions in Norway; Stavanger and Kristiansand besides Bergen.

### INTENSITY/DURATION OF GAIT TRAINING & PRACTICE DURING INPATIENT REHABILITATION OF STROKE SURVIVORS

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Intensity/duration of gait training & practice during inpatient rehabilitation of stroke survivors K.H.L. Gerrits(a), M. van Nunen(a), E. Pijpers(b), and L.H.V. van der Woude(b) a) Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam; b) Center for Human Movement Sciences, Center for Rehabilitation, University Medical Center Groningen, the Netherlands Introduction. An important goal of stroke rehabilitation is improving/restoring walking ability. It has been suggested that stroke rehabilitation should be intensive and task specific to reach optimal outcomes of activities of daily living (ADL) including gait (1). Yet, it is unclear how intense, in terms of duration and cardio-metabolic intensity, stroke survivors practice their walking ability during therapy and daily life of inpatient rehabilitation (in the Netherlands). Therefore, the present study describes the duration and intensity of walking during gait training and during daily activities of the clinical rehabilitation in stroke patients and investigates whether these relate to functional ability. Methods. The local ethical committee approved this study, which included a convenience sample of patients with stroke (n=17), who were inpatients of Reade (Amsterdam, the Netherlands). During the day (8 hours) and for an observation period of 4 consecutive days, the amount of time spent on walking activities was monitored with an activity monitor (activPAL, PAL Technologies Ltd). In the same time period, and during one session of gait training, heart rate was monitored (Polar) and used to 1) determine % heart rate reserve (%HRR) and 2) calculate the % of time in which HRR exceeded 40%HRR (%T>40). Because of possible confounding effects, data were analyzed for patients that did (B+, n=6) or did not (B-, n=11) use beta-blocking medication. Results. The mean time spent on walking activities in B+ (38±34 min.day<sup>-1</sup>) was not different from B- (61±55 min.day<sup>-1</sup>). Across groups, high and significant correlations were found between duration of walking and functional ability (r=0.59-0.91, P<0.05). Intensity of walking was significantly (P<0.05) higher in B- compared to B+ across a 4-day period (37±12% versus 21±7% HRR, respectively) as well as during the gait training session (40±13% HRR versus 23±8% HRR, respectively, P<0.05). Intensity of walking was not related to functional activities. Finally, the %T>40 during 4 days of monitoring was significantly higher in B- (9±10%) compared to B+ (0.2±0.4%). Conclusion. These results indicate that although patients practice walking for on average 0.5-1 hour.day<sup>-1</sup>, at a sufficiently high intensity (>40% HRR, AHA guidelines for stroke survivors), the total amount of time in which intensity exceeds the appropriate training intensity is very limited. Current rehabilitation programs should therefore increase the time spent on gait training/practice and stimulate an active lifestyle. 1) Kwakkel G. et al. Stroke. 2004 Nov;35(11):2529-39.

### THE EFFECT OF LOW-VOLUME ENDURANCE AND STRENGTH TRAINING ON MUSCLE PHOSPHOCREATINE RECOVERY AND PERFUSION DURING 3-WEEK UPPER LIMB IMMOBILIZATION

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Introduction During a 3-week upper limb immobilization (3W-IMM), muscle phosphocreatine (PCr) recovery after submaximal exercise (SubEx) was delayed (Kitahara et al, 2003; Homma et al, 2009) and the brachial artery peak blood flow (BF) was decreased (Ohmori et al, 2010). However, it is unclear whether the delayed PCr recovery is due to a blunted BF response. Therefore, we examined the relationship between the delayed PCr recovery and muscle perfusion and the effect of exercise training on PCr and BF. Methods Twenty-one male volunteers participated in the experiment after having been approved by the institutional ethical committee and obtained a written informed consent. They were divided into three groups (Immobilization, IMM-G (n=7); IMM with endurance and strength training of twice weekly, TR-G (n=7); and control, CNT (n=7)). Strength training consisted of intermittent isometric (2 sec on / 2 sec off) contractions (70% of maximum voluntary contraction (MVC), 10 times), whilst exhaustive exercise (EEx) training consisted of contractions with one repetition per 1 sec. at 30% MVC. Non-dominant arm was immobilized with a cast for 3 weeks. Exercise training was performed during 3W-IMM once weekly. SubEx test at a frequency of one contraction every 4 s at the 40% MVC, EEx test and MVC measurement were performed before and after 3W-IMM. The time constant for PCr recovery (PCrTc) was examined using <sup>31</sup>-phosphorus magnetic resonance spectroscopy after SubEx with no pH drop. The blood velocity and vessel diameter (D) of the brachial artery were measured using ultrasound Doppler and B-mode methods at rest and immediately after SubEx test. BF was calculated from the blood velocity and D. Results In the TR-G, the training was effective for preventing the decrease in MVC. EEx performance showed no significant interaction between the groups. A significant delay was found in PCrTc in the IMM-G (p < 0.05) and a protective effect in the TR-G. No significant IMM interaction was found for BF after SubEx between the groups. Discussion The delay of PCr recovery induced by the 3W-IMM was not associated with muscle perfusion, but presumably related to intrinsic factors such as attenuated muscle oxidative capacity. The endurance and strength training used in this study was effective for preventing delayed PCr recovery. References Kitahara et al. (2003). Med Sci Sports Exerc, 35, 1697-702. Homma et al. (2009). Acta Physiol, 197, 313-320. Ohmori et al. (2010). Eur J Appl Physiol, 110, 845-851.



## DOSE-RESPONSE EVALUATION OF EXERCISE PROGRAMS IN THE EARLY REHABILITATION PHASE FOLLOWING KNEE AND HIP ARTHROPLASTY

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**Introduction** Rehabilitation programs following knee and hip arthroplasty predominantly focus on strengthening and functional exercises. However, although exercise programs are generally considered essential for regaining joint stability and mobility in daily living, the dose-response relationship between exercise load and functional improvements remains questionable. In this study, we evaluated the dose-response relationship of exercise programs in the early rehabilitation phase following knee and hip arthroplasty. **Methods** 65 patients with elective total hip or total knee replacement were included in this cohort study. All participants underwent a postoperative rehabilitation program in the same setting. Functional outcomes were assessed at the first as well as at the last day of the exercise intervention program. Additionally, type, intensity (Borg scale 6-20), duration and frequency of exercise interventions were recorded by using rehabilitation and training diaries. The primary outcome was physical function (Western Ontario and McMaster Universities Arthritis Index = WOMAC). Secondary outcomes were the SF36 and the hip or knee range of motion. Linear regression analysis with multiple independent variables (e.g. intensity, frequency) was performed to assess the dose-response relationship between the intervention dosage and changes in the primary and secondary outcomes. **Results** The mean duration of the exercise program was  $18.9 \pm 3$  days for hip and  $14.7 \pm 2.4$  days for knee patients with a frequency of 6 days per week and an intensity of Borg  $11 \pm 1$  (hip) or  $12 \pm 1$  (knee). Participants performed strength, functional, mobility and flexibility exercises in group or individual training sessions. The physical function (hip:  $14.1 \pm 31.8\%$ , knee:  $19.8 \pm 8.0\%$ ) and range of motion ( $11.1 \pm 10.7\%$ ,  $6.7 \pm 12.1\%$ ) improved significantly ( $p < 0.05$ ) in both patient groups. Multiple regression analysis revealed that there was no association between changes in these outcomes and duration, intensity, frequency or type of exercise. **Conclusions** Although the participants improved their physical function and range of motion throughout the early rehabilitation phase, no association was found between changes in these outcomes and the intervention dose. This implies that the postoperative exercise therapy had little impact on the changes in function or mobility. However, these findings should be viewed cautiously as the overall exercise intensity might have been too small for training-induced structural or functional adaptations. In future, randomized controlled trials are needed to establish dose-response effects of exercise programs after knee and hip arthroplasty.

## THE EFFECT OF SELF-PACED WALKING ON PSYCHOLOGICAL AND PERFORMANCE MARKERS IN PHASE II AND III CARDIAC REHABILITATION PATIENTS WITH MODERATE TO HIGH LEVELS OF ANXIETY

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**Introduction** Greater attention is necessary to detect and treat anxiety with cardiac rehabilitation (CR) patients (Lavie & Milani, 2004). The purpose of this study was to assess whether a short-term, self-paced walking programme reduces anxiety, improves self-confidence and elicits physiological and perceptual benefits to phase II and III CR patients. **Methods** As a pre-requisite for recruitment, all participants experienced moderate to high levels of anxiety, according to the modified Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), when considering the prospect of walking. Twenty-two CR patients completed a HADS, exercise self-efficacy (ESE) questionnaire and two walking tests (Incremental shuttle walking test [ISWT]; 1.6 km assessment walk) during a baseline assessment. Participants were randomized to either standard CR care (cycle exercise; control group [CG];  $n = 11$ ) or a walking programme (WP;  $n = 11$ ). The WP involved a 1.6 km self-paced walk on a variable topographic course, twice a week for 6 weeks. Post-intervention assessments replicated the baseline assessment. A series of repeated measures ANOVAs (Condition [CG, WP] x Test [Baseline, post-intervention]) were used to analyse the data. **Results** A Condition by Test interaction for anxiety revealed a significantly greater reduction in anxiety from the baseline to the post-intervention assessment for WP ( $7.9 \pm 1.5$  v  $3.9 \pm 1.9$ ) compared to CG ( $8.1 \pm 1.9$  v  $6.8 \pm 2.7$ ) ( $P < .01$ ). A similar interaction was observed for ESE, with significant improvements in walking confidence observed for WP ( $78.1 \pm 22.8\%$  v  $84.7 \pm 21.7\%$ ) but not for CG ( $76.1 \pm 22.8\%$  v  $69.7 \pm 21.7\%$ ) ( $P < .01$ ). There were, however, no statistical differences in heart rate, ratings of perceived exertion (RPE), and exercise duration for the ISWT between conditions ( $P > .05$ ). Nevertheless, participants randomised to the WP not only reduced the time to complete the 1.6 km assessment walk from the baseline to post-intervention assessment (19 min 32 s v 18 min 16 s, respectively;  $P < .01$ ), they also significantly reduced their RPE ( $11.5 \pm 1.4$  v  $10.9 \pm 1.3$ , respectively;  $P < .01$ ). Such findings were not observed for CG. **Discussion** This study provides evidence that a 6-week self-paced walking programme can reduce anxiety and improve self-confidence in phase II and III cardiac rehabilitation patients. The study also demonstrates that patients can complete a set amount of work (1.6 km walk) at a higher relative intensity without inducing increases in the perception of exertion following a 6-week walking programme. **References** Lavie C, Milani, R. (2004). The American Journal of Cardiology, 93, 336-339. Zigmond AS, Snaith RP. (1983). Acta Psychiatrica Scandinavica, 67, 361-370.

## BETTER CARE THROUGH PHYSICAL ACTIVITY? – EFFECTS OF AN EXERCISE INTERVENTION FOR PATIENTS WITH CHD WITHIN A DISEASE MANAGEMENT PROGRAM

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**Introduction** Disease management programs (DMPs) have been established in Germany in 2002 with the goal to meet the growing requirements for an efficient health care for chronic patients. So far DMPs exist for the indications coronary heart disease (CHD), diabetes mellitus type-1/2, asthma, chronic obstructive pulmonary disease and breast cancer. Exercise interventions don't rate among the main treatment methods used in DMPs up to now, although the evidence of physical activity as a therapeutic mean is given (Capewell et al., 2010). Therefore this analysis deals with the effects of a behaviour-oriented exercise intervention within the framework of a DMP for CHD. **Methods** A total of  $n=98$  (age:  $65.2 \pm 6.6$ ; BMI:  $32.89 \pm 4.03$ ) adults participated in the controlled intervention study (IG=75; CG=23). The exercise program took place once a week (á 90 min.) for a period of 10 weeks. With a pre- (t1) and posttest (t2) data of health related quality of life (HRQoL) (Bullinger&Kirchberger, 1998), of physical activity levels (Frey et al., 1999) and of exercise self-efficacy (Lippke et al., 2005) has been assessed through questionnaires. Additionally the BMI and the endurance capacity through a 2km Walktest were documented. **Results** 86 completed data sheets (t1-t2) could be included in the analysis. The following results have been found: • Significant improvements ( $p < .001$ ) could be found by measuring the HRQoL in the subscale 'physical functioning' and 'pain' in the IG ( $n=66$ ). • The participants in the IG increased their health related activity level (leisure time) statistical significant and practical relevant ( $p < .05$ ;  $d=0.35$ ) over the time, the CG showed no changes. • The IG showed significant improvements in the 2km Walktest ( $p < .001$ ), whereas the CG

remained inconspicuous. Discussion The results proof that a multi-dimensional exercise intervention within a DMP for CHD has a positive impact on the endurance capacity, the physical activity level and the HRQoL. The revealed effects are first indicators, that the integration of exercise interventions into DMPs provide an important contribution to improve the health care quality. Further research with a larger sample is needed to proof these results as well as the verification of the longterm effects of such a program. References Bullinger M & Kirchberger I (1998). SF-36, Fragebogen zum Gesundheitszustand. Göttingen: Hogrefe. Capewell S, Ford ES, Croft JB, Critchley JA, Greenlund KJ, Labarthe DR (2010). Bulletin of the World Health Organization, 88 (2), 120–130. Frey I, Berg A, Grathwol D, Keul J (1999). Sozial- und Präventivmedizin, 44 (2), 55–64. Lippke S, Ziegelmann JP, Schwarzer R (2005). Psychology of Sports and Exercise 6, 585–603. (The study was funded by a grant of the DAK Health Insurance.)

### INTELLIGENT PHYSICAL EXERCISE AT WORK: EFFECT OF SUPERVISION ON MOTIVATION AND REDUCTION IN NECK-SHOULDER PAIN? RESULT FROM VIMS-STUDY.

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Introduction It is well known that sedentary occupation with computer work is associated with development of pain in neck and shoulder. Studies have shown that physical exercise at work is effective in managing musculoskeletal pain (1,2). However, the effect of supervision during training sessions in workplace interventions needs to be clarified. Thus, the aim of this study was to evaluate the effect of different amount of supervision on training motivation and neck/shoulder pain during a worksite physical exercise intervention. Method The study was conducted as a cluster randomized controlled trial in Denmark; study design is previously published (3). The participants were office workers and recruited from 12 different work units in Denmark. Three hundred and six participants were randomized in 3 groups; 2 exercise groups performing specific strength training 3 x 20 min a week, with supervision half of the sessions throughout the training period (WS) or supervision only initially for 2 sessions to learn the exercises correctly (MS), respectively, and 1 reference group who did not exercise (REF). The intervention period was 12 weeks. Structured e-mail based on questionnaires was sent to the participants every week. The intensity of pain was registered on scale 0-9. Results One hundred and ninety women and 116 men participated in the study. Replies were collapsed from week 1 and 2 and week 11 and 12, respectively, and the response rate was: WS: 47%, MS: 29%, and REF: 49%. ANOVAs showed significant reduction in neck pain in WS compared to REF;  $\Delta -1.3 \pm 1.8$  (SD),  $p < 0.05$  but not in MS compared to REF;  $\Delta -0.8 \pm 1.5$  (SD)  $p = 0.54$ . There were no significant changes in shoulder pain. Looking at pre vs. post data (paired t-test) in the exercise groups shoulder pain reduced significantly in both groups but not the REF group. Between the two exercise groups motivation to training did not change. In both groups motivation decreased significantly in the interventions period: WS:  $-0.5 \pm 1.7$ , MS:  $-1.1 \pm 1.1$ . Discussion A continuously supervision gave significant reduction in pain compare to reference group. Pain did not significantly change in the group only with start-up/minimal supervision. These results indicate that supervision has positive effect on neck pain outcome. But low response rate makes it difficult to conclude on supervision in general. References 1. Proper KI et al. Clin J Sport Med 2003;13:106-117. 2. Coury HJ et al. Rev Bras Fisioter 2009; 13:461-479 3. Andersen et al. BMC musculoskeletal disorders 2010;11:173

### MIXED EXERCISE PROGRAM AND AEROBIC CAPACITY IN LOWER LIMB OSTEOARTHRITIS

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1: Facultad de Ciencias del Deporte. AFIDES Research Group, Universidad de Extremadura (Caceres, Spain) Introduction The reduced aerobic capacity of patients with lower limb osteoarthritis affects their independence in performing everyday activities. The purpose of this review was to summarize evidence for the effectiveness and structure of mixed exercise programs on functional aerobic capacity in patients with lower limb osteoarthritis. Methods A computerized search was made of the most important databases. Effect sizes (ES) and 95% confidence intervals (CI) were calculated. The criteria for inclusion were the following: (i) adults diagnosed with lower limb OA according to the criteria of the ACR; quasi-experimental or experimental studies; (iii) type of intervention: mixed exercise program; (iv) minimum duration of program: 4 weeks; and (v) assessment of aerobic capacity using the 6-minute walk test. Results The eight studies (see references) that satisfied the inclusion criteria were selected for analysis. The functional aerobic capacity improved in mixed exercise programs (ES=0.47; 95% CI, 0.32 to 0.62). Their content was based on developing aerobic endurance, strength, and flexibility. On the other hand, the structure of the programs, the duration ranged between four and 72 weeks. The weekly frequency was two or three sessions. The session durations were between 60 and 90 minutes. Discussion Numerous studies have investigated the effects of different types of exercise programs, but these programs consisted almost exclusively of aerobic, resistance, or flexibility exercises, with some containing a mixture of two types of exercises. The study that gave the best results (Aglamis et al., 2008) employed an individual manually applied treatment, which allowed the therapist to focus treatment on the specific structures that caused pain and limited function for each patient. It is interesting to note that this program uses purely unloaded aerobic work on a static bicycle. However, other studies in this group obtained similar improvements (Deyle et al., 2000; Hughes et al., 2004). The main conclusion was the structure of the mixed exercise programs was very heterogeneous but this program was effective to improve the aerobic capacity in patients with lower limb osteoarthritis. References Aglamis B et al. (2008). J Back Musculoskelet Rehabil 2008; 21:121-128. Callahan LF et al. (2008). Arthritis Rheum 2008; 59:92-101. Deyle GD et al. (2000). Ann Intern Med 2000; 132:173-181. Focht BC et al. (2005). Arthritis Rheum 2005; 53:659-665. Hughes et al. (2004). Gerontologist 2004; 44:217-228. Hughes et al. (2006). Gerontologist 2006; 46:801-814. Messier SP et al. (2004). Arthritis Rheum 2004; 50:1501-1510. Peloquin L et al. (1999). J Clin Rheumatol 1999; 5:126-136. Acknowledgments This presentation of this study was partially funded by European Social Funds (FEDER Funds) and the Autonomous Government of Extremadura (Junta de Extremadura) (GR10171).

### RESISTANCE TRAINING AND DIETARY SUPPLEMENTS AS INTERVENTION FOR REGAINING MUSCLE MASS FOLLOWING RADIOTHERAPY IN HEAD AND NECK CANCER PATIENTS.

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Resistance training and dietary supplements as intervention for regaining muscle mass following radiotherapy in head and neck cancer patients. Lønbro, S. 1,2; Overgaard, K. 2; Primdahl, H. 3 & Overgaard, J. 1, Dept. of Experimental Clinical Oncology, Aarhus University Hospital 2, Inst. of Sports Science, Aarhus University, 3 Dept. of Oncology, Aarhus University Hospital Background: In patients with head

and neck cancer (HNC), a loss of body mass of around 10 % is seen - mainly due to loss of muscle mass [1]. Since muscle mass reduction is an independent mortality predictor and lowers muscle strength and functional capacity, interventions to regain muscle mass are warranted. Progressive Resistance Training (PRT) has been shown most effective in regaining these parameters among young and elderly healthy individuals and various groups of patients (e.g., breast-, prostate cancer). HNC patients could benefit from this as well. In addition, a timed dietary supplement of protein and creatine can enhance the positive effects induced by PRT as shown in healthy individuals. Objectives: The aims are to: 1) investigate whether PRT +/- protein and creatine ingestion is tolerable among HNC patients following curative radiotherapy, 2) determine the effects on body composition, muscle strength and functional capacity of a PRT intervention with or without supplementation with protein and creatine. Methods: 30 HNC patients are randomly assigned into two groups. During the first week Group 1 completes an oral creatine loading regime, whereas Group 2 ingests placebo. In the following 12 weeks, Group 1 completes a PRT protocol combined with a timed protein and creatine supplement, whereas Group 2 completes the same PRT protocol with placebo supplement. Pre and post radiotherapy treatment, total body weight (BW) is recorded. Before the first week and pre and post the 12 weeks of PRT, lean body mass (LBM, DXA scans), maximal muscle strength (isometric dynamometry), functional capacity (e.g. 30 s arm curl test, 30 s sit-to-stand test) are measured. Preliminary results: At abstract deadline 21 subjects were randomized (ongoing). 8 dropped out - 7 due to causes unrelated to the training and supplementation intervention, 9 are ongoing and 4 completed the protocol. Preliminary analyses show a mean loss of BW of 14.7 (12.5-17.9) % following radiotherapy. In the 4 patients who completed the PRT BW increased 1.6 (-2.1-4.4) %, LBM increased 7.1 (4.6-11.5) %, Fat Mass decreased 8.3 (-3.1-45.3) %, isometric knee extension and flexion increased 26 (9-52) % and 16 (6-27) %, respectively. Arm curl and sit-to-stand performance increased by 15.9 (0-42.3) % and 25.5 (0-50) %. Conclusions: Despite a large total dropout rate from the study, the PRT seems to be well tolerated among the participants who received training. The preliminary results from completers indicate a positive effect on LBM, muscle strength and functional capacity. References: 1. Silver HJ et al. (2007), Changes in body mass, energy balance, physical function....., Head and Neck 29: 893-900.

## Poster presentations

### PP-PM49 Children and Physical Activity 2

#### COMPARATIVE EVALUATION OF BODY POSTURE FUNCTIONAL STATUS IN CHILDREN AGED 8-11, 12-14 AND 15-16

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COMPARATIVE EVALUATION OF BODY POSTURE FUNCTIONAL STATUS IN CHILDREN AGED 8-11, 12-14 AND 15-16 A. SHKLYARENKO, T. KOVALENKO, D. ULYANOV, YA. YAHNIK, A. SUHORUCHKO. Volgograd State University Slavenskiy-on-Kuban Pedagogical State Institute, Russia Introduction. Body posture was treated like a dynamic stereotype obtained in the process of individual development, upbringing and training. Methods. With the use of special tests we evaluated the functional state of children posture in the upright and seated positions. Power and endurance rates, muscle contractility were measured; these indicators assure locomotorium stability. Results. Girls and boys, aged 8-1, kept the preset position during 6,2 and 7,0 minutes. We observed no statistically significant differences between gender groups ( $p>0,1$ ). During the growth spurt (12-14 years) temporal testing characteristics in various genders varied considerably, correspondingly 12,8 and 9,4 minutes. ( $p<0,05$ ). The results were clearly different in adolescences aged of 14. The test results of females aged 15-16 showed that the improvement reduced while males of the same age had gradually continued positive dynamics. Females had a lower endurance rate in keeping the preset seated position (without relaxing back and abdominal tight muscles) than male of the similar age. Furthermore, the girls' task performance time increased by 23 percent on the average; the boys' indicator was slightly below 19 percent. As for the 12-16 age range the polar opposite results were observed (correspondingly 17% and 29%). Duration of test exercise to determine power endurance of back and adnominal muscles among girls of 12-14 year old was substantially lower than that of similar aged boys. Isometric index of rectus abdominal and back straightening muscles of boys is 88 и 111 s., that of girls is 66 and 81 s. Positive spine stability indicator among boys aged 12-16 is high endurance rate of abdominal and back straightening muscles. Conclusion. Comparing the data obtained from representatives of both sexes of different age we observed that their body posture functional status differs considerably. We assume that risk reduction of growing body posture fault is connected with prevention and correction of functional static abnormalities in muscle function.

#### PHYSICAL ACTIVITY PATTERNS AND FATNESS IN SPANISH CHILDREN: THE EUROPEAN YOUTH HEART STUDY

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Introduction Spain has one of the highest rates of childhood overweight and obesity in Europe [1]. The majority of Spanish children do not engage in enough physical activity (PA) to be beneficial for health [2, 3]. Recommendations for healthy levels of PA for children have been established [4] but there is a need for objective and accurate assessment of the proportion of overweight/obese vs non overweight/obese children meeting the PA guidelines. Moreover, assessing time spent in moderate to vigorous PA (MVPA) both between days (during weekdays and weekend days) and within days is of interest to improve our understanding to provide more efficient intervention programs. The aim of this study was to examine the patterns of MVPA in Spanish school children measured by accelerometers and determine if there were differences between overweight/obese vs non overweight/obese children. Methods A total of 665 children (438 9 year old [214 boys, 224 girls] and 227 15 year old [101 girls and 126 boys]) from private and state schools in Madrid, Spain participated in the study. The variables measured were: anthropometric characteristics (height, weight, body mass index (BMI), waist circumference and sum of 4 skinfold thickness). PA was measured during 4 consecutive days using the GT1M accelerometer. Fatness was estimated from BMI and dichotomized using cut-points of International Obesity Task Force (IOTF). Results We found that 72.4% 9 year old boys and 49.6% 9 year old girls, and 39.7% and 29.7% 15 year old boys and girls respectively, achieved the level of MVPA recommended for health. Non-overweight children (both 9 and 15 year old) achieved significantly ( $p<0.01$ ) more MVPA and less sedentary time than overweight/obese children. Non-overweight 9 year old children were significantly ( $p<0.01$ ) more active than non-overweight 15 year old. No differences in MVPA were found in overweight/obesity children by age groups. Non-overweight 9 year old boys and girls achieved significantly ( $p<0.05$ ) more MVPA during weekdays than their overweight/obese counterparts respectively. In the 15 year old group, there were no significant differences in MVPA between no-overweight and overweight/obese boys and girls respectively. Conclusion Few children achieved the level of MVPA recommended for health: at particular risk were all 15 yr old children and overweight and obese 9 yr old

children. More effort needs to be devoted to promoting appropriate opportunities for Spanish overweight and obese children across the day and to promoting PA during weekends for all children.

## A PRELIMINARY INVESTIGATION OF RELATIVE AGE EFFECT IN GAELIC GAMES

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**Introduction** Annual age-grouping is a regular organisational strategy in sport; however, such a strategy appears to promote a relative age effect (RAE) (Mujika et al., 2009). Relative age effect occurs as a result of chronological age and associated physical, emotional and psychological differences due to an asymmetrical distribution of birth date, favouring subjects born earlier in an annual competitive cycle (Cobley et al., 2009). The aim of the current study was to identify if a similar pattern exists at the representative (inter-county) level in Gaelic football and hurling (Gaelic games). **Method** Gaelic games player (n = 604) data was collected for under-14, under-15, under-16, under-17, under-18, under-21 and adult representative selections for the 2010 season. Players were grouped into one of four yearly quartiles according to their month of birth. The Chi-square and Kruskal Wallis statistic was used to examine differences between observed birth date distributions. Results From the total sample obtained, the percentage of players born in Q1, Q2, Q3 and Q4 were 33%, 29%, 21% and 18% respectively. A chi-square analyses revealed that the birth date distribution of the group of players differed significantly from that of the theoretical distribution ( $\chi^2 (3) = 34.795, P < 0.001$ ). The results indicates a RAE exists within the sample of representative players. When juvenile (U14 to U18) players (n = 485) were taken in isolation, the birth date distributions differed significantly from that of the theoretical distribution ( $\chi^2 (3) = 46.885, P < 0.001$ ). Within the sample, 64% of those juvenile players were born in the first half of the calendar year, indicating RAE inequalities are pronounced at juvenile level and continue into adult representative levels. **Discussion** The findings of the current study are consistent with that of Cobley et al. (2009), who also identified that juvenile players at representative levels (U14 to U18) appear to be at a higher risk of RAE inequalities. Researchers can assist national governing bodies (NGB), players, sport coaches, teachers and parents by providing suggestions regarding the origins of RAE, its implications in player development and drop-out from sport, and how NGB can address the RAE in their own context specific manner (Cobley et al., 2009). The current findings provide a platform for further research in the areas of talent identification and player development within the Gaelic games. **References** Cobley S., Baker J., Wattie N., McKenna, J. (2009). *J Sports Med*, 39(3), 235-256. Mujika I., Vaeyens R., Matthys S., Santisteban J., Goiriena J., Philippaerts R. (2009). *J Sports Sci*, 27(11), 1153-1158.

## EVALUATION OF AEROBIC ENDURANCE CHARACTERISTICS IN ADOLESCENT AND YOUNG ROAD CYCLISTS

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**Introduction** There is a close correlation between the aerobic capacity and the results in endurance sports in adult athletes (Shave, Franco, 2006). An endurance of adolescent road cyclists depends on an aerobic capacity and a process of growth. An aim of our investigation is to compare 14 – 15, 16 – 17 and 18 – 21 years old road cyclists' endurance characteristics. **Methods** Thirty-eight road cyclists participated in the investigation. They are divided into three age groups: 14–15 (N=11), 16–17 (N=13) and 18–21 (N=14) years old. Every road cyclist performed incremental load test to exhaustion on a mechanical bicycle ergometer (Monark, Sweden). An initial load intensity was 27 W, then it increased step by step for 12 W every two minutes. A cardiopulmonary diagnostic equipment „Oxygen Mobile Via Sys“ (Via Sys Healthcare GMBH, Germany) is used during the test to register an electrocardiogram and respiratory characteristics. A lactic acid concentration in the capillary blood is detected by special lactate analysers „Biosen 5030“ (EKG – diagnostic, Germany) every two minutes. **Results and discussion** The mean weight of 16–17 years old cyclists ( $71 \pm 6$  kg) is significantly greater than in 14 – 15 years old ( $66 \pm 7$  kg),  $p < 0.007$ . Growth of the weight with age is none significant in 18–21 years old cyclists ( $73 \pm 4$ ) in comparison with 16–17 years old,  $p > 0.05$ . The absolute workload and oxygen uptake significantly increases in every older age group of cyclists. The correlations between the body weight and workload and between the body weight and oxygen uptake are significant positive in 14 – 15 and 16 – 17 years old cyclists ( $p < 0.02$ ), but in the 18–21 years old cyclists these correlations disappear. The relative workload is the same in the age groups of 14–15 and 16–17 years, but in the oldest cyclists it is significantly greater,  $p < 0.003$ . It means that the oxygen uptake in adolescent cyclists (14–17 years) depends mostly on the weight increase process in this age, but in the age of 18 years and older it depends on training in endurance sports. The relative oxygen uptake does not differ significantly in 14–15 and 16–17 years old cyclists at different intensities of load ( $p > 0.05$ ). In 14 – 15 years old cyclists correlations between the relative oxygen uptake and workload are none significant ( $p > 0.05$ ). The relative oxygen uptake in 18–21 years old cyclists is significantly greater than in younger cyclists ( $p < 0.0002$ ). In 16–17 and 18-21 years old cyclists the correlations between the relative oxygen uptake and workload on bicycle ergometer at aerobic, anaerobic thresholds and maximal aerobic load are significant positive ( $p < 0.04$ ). **References** Shave R, Franco A (2006) The physiology of endurance training. In: Whyte G (ed) *The Physiology of Training*. Churchill Livingstone, Elsevier, UK

## IMPROVING 1000M RUNNING TIME IN 14 YEAR-OLD SCHOOL CHILDREN

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**INTRODUCTION:** The 1000m personal best time is commonly used in German schools to test endurance performance. The aim of the study was to examine the effect of two different 5-week training strategies (high intensity vs. high volume) on 1000m- running performance (T1000m), maximal oxygen uptake ( $\dot{V}O_{2max}$ ), velocity at lactate threshold (VLT) and running economy (RE; oxygen uptake at 3.2 m/s). **METHODS:** 20 boys (means  $\pm$  SD: age  $13.5 \pm 2.8$  yrs; height  $160.4 \pm 6.8$  cm; body mass  $50.9 \pm 9.7$  kg) participated in the present study. They were divided into two training groups who either mainly focused on high intensity intervals (HIIT, n=10) or continuous loads of endurance training (HVT, N=10). Heart rate was monitored during all sessions, HIIT were performed at 90-95%, HVT at 50-70% of individual maximal heart rate. Total exercise time of HIIT- sessions did not exceed 30min (including warm up and rest); HVT- sessions lasted up to 60 min. Before and after the training-phase (5 weeks in total) the subjects performed an incremental step test on the treadmill (2.4 m/s; increase 0.5 m/s every 5 min) and a 1000m run. **RESULTS:** RE improved significantly in both training groups (HIIT: pre  $47.8 \pm 5.6$  post  $40.7 \pm 4.8$  ml/min/kg,  $p < 0.01$ ; HVT: pre  $47.7 \pm 7.0$  post  $43.0 \pm 5.6$  ml/min/kg,  $p < 0.01$ ).  $\dot{V}O_{2max}$  increased significantly only in the HIIT- group (pre  $55.0 \pm 5.2$  post  $58.7 \pm 4.9$  ml/min/kg,  $p < 0.01$ ; HVT: pre  $55.3 \pm 4.3$  post  $56.4 \pm 4.7$  ml/min/kg,  $p = 0.24$ ). Similar results were found regarding VLT (HIIT: pre  $3.2 \pm 0.2$  post  $3.4 \pm 0.3$  m/s,  $p < 0.01$ ; HVT: pre  $3.3 \pm 0.3$  post  $3.4 \pm 0.2$  m/s,  $p = 0.85$ ). and T1000m (HIIT: pre  $3:56.6 \pm 10.7$  post  $3:46.8 \pm 12.9$  min,  $p < 0.01$ ; HVT: pre  $3:55.3 \pm 12.8$  post  $3:50.7 \pm 17.3$  min,  $p = 0.10$ ). **DISCUSSION:** In five weeks of HIIT, with 3

training sessions per week 1000m running time decreased significantly in (pre) pubertal boys. This was associated with improvements in VO<sub>2</sub>max, velocity at lactate threshold and running economy. These findings are supported by literature where comparable improvements are described (McMillan et al. 2005). Exercise time, especially for endurance training is limited in school sports as well as in most team sports due to other school or recreational activities and sport-specific training. Thus, time saving strategies are necessary to enhance physical fitness. The present study suggests that HIIT performed 3 times per week (in total 1.5 hours/week) over a period of 5 weeks leads to a significant improvement of endurance performance in 14-year old children.

## RESULTS OF A PROGRAMME FOR IMPROVING JUMPING ABILITY IN TWO CHILDREN'S VOLLEYBALL TRAINING GROUPS

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**Introduction** The subjects of the study were children who practiced volleyball regularly in two training groups. The first group consisted of 6 boys and 6 girls aged 16-17 years, the second group of 6 boys and 4 girls aged 8-13 years; in total 22 young volleyballers. **Methods** In both groups, in addition to regular practice, a special programme for improving jumping ability was applied. The programme had been compiled by the Moscow Institute of Physical Culture (Beljaev, Bulõkina 2004). According to the programme, the children were taught to do certain exercises daily for 19 days. In the next two periods (both 19 days) more difficult exercises with great intensity were done over the day. During the training days, the exercises were done under the supervision of the coach. At the beginning and end of the programme, volleyballers were measured anthropometrically – height, weight, upper and lower circumference of lower leg, waist circumference and the height of the arm. Height of standing jump (SJ), running jump (RJ) and block jump (BJ) were measured. Running speed was tested by the shuttle run test. **Results** At the beginning of the study the mean height of the boys in the older group was 185.6 cm and at the end of it 185.6 cm. Their weight was 71.3 and 71.5 kg respectively. The height of the girls in the same group was 167.5 and 167.6, and their weight 61.1 and 60.3 kg respectively. The height of boys in the younger group was 161.9 cm at the beginning of the study and 163.0 cm at the end; their weight was 49.0 and 49.7 kg respectively. The height of the girls of the same group was 161.3 and 161.6 cm, and their weight 52.0 and 51.3 kg. Jumping tests results and running speed improved in both groups. Thus, in the older group the height of SJ increased by 7.83 cm on average in boys and by 6.17 cm in girls. The height of RJ in this group increased by 7.33 and 6.83 cm respectively. In the younger group the height of SJ increased by 5.0 cm in both boys and girls. The height of RJ increased by 8.33 cm in boys and by 3.50 cm in girls. In the older group, the height of BJ increased by 6.0 in boys and by 4.5 cm in girls; in the younger group the respective changes were 5.5 and 3.25 cm. The speed of shuttle run improved by 0.9 and 1.1 sec in the older group and by 0.7 and 1.0 sec in the younger group. **Discussion** Correlations between the anthropometric data and tests results at the beginning and end of the study were found. All the data were in statistically significant correlation, and there was also a significant correlation with age. For conclusion we can say that the programme for improving jumping ability (Beljaev, Bulõkina 2004) is suitable for the younger (8-13 years) and older (16-17 years) volleyballers. **References** Beljaev A.V, Bulõkina L.V. (2004) Theory and Practice of physical education, 3, 37-38.

## A STUDY ON CARDIOPULMONARY FUNCTION AND EXERCISE CAPACITY OF ADOLESCENTS SUFFERED FROM KAWASAKI DISEASE IN CHILDHOOD

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**Introduction** Kawasaki Disease (KD) is an acute systemic vasculitis which was first found in 1967 in Japan. The diagnosis of typical or incomplete KD is based on clinical criteria. The clinical features, especially cardiac complications are the leading causes of childhood acquired heart disease (Wang et al, 2004). There were only a small number of reviews related to exercise performance on KD (Paridon et al.,1990). Therefore, cardiopulmonary function and exercise capacity in adolescents post-KD were evaluated through this study. **Methods** Maximal anaerobic capacity as well as factors of restrictive exercise capacity were evaluated in the study. A cardiopulmonary exercise stress assessment (Wang et al., 2008) was performed upon 13 adolescents post-KD among the experimental group along with 13 healthy adolescents in the control group. **Results** Based on the finding, no significant differences were found in VO<sub>2</sub> max, maximal systolic blood pressure and maximum heart rate. Pulmonary function tests also showed no significant differences in forced vital capacity (FVC), forced vital capacity second (FEV<sub>1</sub>), ventilation (MVV), nor FEV<sub>1</sub>/FVC. **Discussion** In the presented study, adolescents post-KD showed normal cardiopulmonary function (Paridon et al.,1995) and exercise capacity comparing to those from the healthy group; no limitations in exercise were observed additionally. Thus keep average exercise to maintain quality of life was suggested. **References** Paridon SM, Galioto FM, Vincent JA, Tomassoni TL, Sullivan NM, Bricker JT. (1995). J Am Coll Cardiol, 25(6), 1425-1427. Paridon SM, Ross RD, Kuhns LR, Pinsky WW. (1990). J Pediatr, 116(1), 52-56. Wang L, Lin Y, Su YZ, Wang Y, Zhao D, Wu TJ. (2004). Zhonghua Er Ke Za Zhi, 42(8), 609-612. Wang YL, Yang AL, Wang JL, Yang CH, Hoe ZY, Huang CM, Lin KL. (2008). Tw J Phys Med Rehabil, 36(4), 209-215.

## COMPARISON OF MUSCLE AND JOINT FLEXIBILITY BETWEEN PRIMARY SCHOOL AND LOWER SECONDARY SCHOOL IN JAPANESE SOCCER PLAYERS

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**Introduction** The efficiency of skill acquisition is high at 10-14 years old (adolescence in males) on the sports field. It is accompanied by a second growth spurt at this age. However, this is also a time when the occurrence of sports injury among adolescent sports players increases. It is, therefore, important to understand the physiological characteristics of sports players at this age. The purpose of the present study is to compare the physiological characteristics of lower secondary school soccer players with those of primary school soccer players. **Methods** We divided one hundred and sixteen subjects volunteered to participate in this study into two groups. The first group was primary school soccer players (9-11 years old). This group included 55 soccer players. Another group was lower secondary school soccer players (13-14 years old). This group included 61 soccer players. The physiological characteristics measured were height, weight, and joint laxity. We also evaluated muscle flexibility in the lower extremities (e.g., iliopsoas, hip external rotators, quadriceps femoris, hamstrings, gastrocnemius and soleus). **Results** The lower secondary school soccer players exhibited significantly lower joint laxity than the primary school soccer players. The lower secondary school soccer players also had significantly less muscle flexibility of the iliopsoas, quadriceps femoris, hamstrings and gastrocnemius on the kicking leg side, and the iliopsoas and gastrocnemius on the support leg side. No other differences were found in terms of muscle flexibility. **Discussion** We found that the lower secondary school soccer players

had less joint laxity than the primary school soccer players, and concluded that the flexibility of the joint of the lower secondary school soccer players was lower than those of the primary school soccer players. The lower secondary school soccer players also had significantly lower flexibility in many of the lower extremity muscles compared to the primary school soccer players. We supposed that the kicking leg would have lower muscle flexibility than the support leg, since the load of the kicking leg's muscles was larger than the support leg's muscles in soccer. These data suggested that the lower secondary school soccer player's muscle flexibility was low in order to accomplish a second growth spurt and repeat the kicking ball. Therefore, to prevent sports injury among lower secondary school soccer players, the flexibility of the soft tissues needs to be maintained by conditioning such as active stretching and mobilization, starting at primary school.

## PHYSICAL ACTIVITY CHANGES FROM ADOLESCENCE TO ADULTHOOD FOUR YEARS OF LONGITUDINAL APPROACH

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PHYSICAL ACTIVITY CHANGES FROM ADOLESCENCE TO ADULTHOOD? FOUR YEARS OF LONGITUDINAL APPROACH Fábio L. Ceschini, Ms1, Aylton J. Figueira Junior, PhD1, Victor K.R. Matsudo, MD2. - 1São Judas Tadeu University, Faculty of Health and Biological Sciences São Paulo, Brazil and 2 Physical Fitness Research Center - CELAFISCS, São Paulo, Brazil. Email: flceschini@yahoo.com.br Introduction: The physical activity daily is an important factor to promote health in adolescence. This paper longitudinally evaluated the physical activity level in both sex subjects from adolescence to adulthood living at an urban area of São Paulo City. Methods: During four years (2006-2010) it was followed 344 adolescents of the both sex (184 boys and 160 girls). The boys mean of age was 16.8±1.2 (2006) and 20.4±1.1 years old (2010); and the girls group were 16.4±1.0 years old (2006) and 20.1±1.0 years old (2010). Daily physical activity level (PAL) was assessed through International Physical Activity Questionnaire (IPAQ short version) that allows to classify the physical activity level in insufficiently active (when subject reports less than 300 minutes of moderate to vigorous physical activities per week) and physically active (when subject reports more than 300 minutes of moderate to vigorous physical activities per week). It was evaluated the body dimensions [body weight (Kg); stature (cm); body mass index (BMI= Kg/m<sup>2</sup>) and waist circumference (WC-cm)]. The statistical analysis issue was the Chi Square test (X<sup>2</sup>) and Paired Student's t Test to compare 2006-2010 data. The level of significance was p<.05 for all statistics analysis. Results: Physical activity longitudinal comparison from 2006 to 2010 presented for both sex significant physical activity decrease (18.9%) from adolescence to adulthood between 2006 and 2010 (p<.05). Boys became more physically inactive (28.7%) than girls (11.4%), suggesting different impact over time in the PAL, probably cultural and gender behaviors. Body dimensions presented in general stability no significant changes on WC (p=.07). However it was observed that both sex presented little increase in WC (boys: 2.34 cm; girls: 2.02 cm), suggesting that the increase of abdominal area must be controlled in the close future to do not increase the metabolic diseases. BMI data did not present significant changes (p=.09) in both sex. Boys presented 2.89 (kg/m<sup>2</sup>) and girls 2.89 (kg/m<sup>2</sup>). Conclusion: The transition from adolescence to adulthood presented higher impact on PAL than in body dimensions variables. Also, our data allow us to suggest that health professionals, family and teachers must advice the risk of sedentary behavior and body composition changes in lifespan. References World Health Organization (2010). Global Recommendations on physical activity for health. Geneva. Van Der Horst K, Chin MJ (2007). Paw A. et al. Brief review on correlates of physical activity and sedentariness in youth. Med Sci Sports Exercise. 39(8): 1241-50.

## PHYSICAL FITNESS AND PHYSICAL ACTIVITY AS DETERMINANTS OF HEALTH DEVELOPMENT OF CHILDREN AND ADOLESCENTS - THE MOMO-LONGITUDINAL SECTION STUDY

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Starting Point: The MoMo-Cross-sectional Study At present, the health of German children and adolescents has not been sufficiently studied. In order to remedy this situation, the cross-sectional and nationwide-representative "German Health Interview and Examination Survey for Children and Adolescents" (KiGGS, www.kiggs.de; N=18.000; age: 0 to 17 years) was administered by the Robert Koch-Institute (RKI, Berlin) from 2003 to 2006. KiGGS is constructed modularly. The aim of the Motorik-Modul (MoMo; www.motorik-modul.de; N=4.529; age: 4 to 17 years), which was carried out simultaneously by the University of Karlsruhe in cooperation with the RKI, was a baseline-assessment of the physical fitness and physical activity status of German children and adolescents. The results of this assessment have been published in a comprehensive research report (see Bös, Worth, Oppen, Oberger & Woll, 2009). Current Research: The MoMo-Longitudinal Section Study The MoMo-Cross-sectional study will continue longitudinally in 2009 as a joint project between the University of Konstanz, the Karlsruhe Institute of Technology and the University of Education Schwäbisch Gmünd with the continuing cooperation of the RKI. The objectives of this follow-up study are to analyse the development of physical fitness and physical activity as well as the complex interrelations between physical fitness, physical activity and health and a continuous reporting on the physical fitness and physical activity status of German children and adolescents. In this context, the following research-questions are of particular interest: How does the development of physical fitness and physical activity proceed in childhood and adolescence? Which relationships exist between the development of physical fitness, physical activity and health in childhood and adolescence? Which historical trends can be identified in the stage of development of physical fitness and physical activity in childhood and adolescence? Data will initially be collected in two waves (2009-2011; 2012-2014) using motor tests, physical activity and health questionnaires as well as medical examinations. First results are expected to be published in the second half of 2012. References Bös K, Worth A, Oppen E, Oberger J, Woll A (Eds.) (2009). Das Motorik-Modul: Motorische Leistungsfähigkeit und körperlich-sportliche Aktivität von Kindern und Jugendlichen in Deutschland. [The Motorik-Modul: Motor fitness and physical activity of children and adolescents in Germany]. Nomos Verlag: Baden-Baden.

## 'BICYCLE-CLASS': A SCHOOL-BASED EXERCISE INTERVENTION TO SUPPORT PHYSICAL ACTIVITY AND HEALTH

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UNIVERSITY OF VIENNA

Introduction Juvenile obesity and sedentary lifestyle in children are increasing worldwide [1]. One way to counteract this could be the increased use of school-based physical activity additionally to the regular physical education curriculum. The aim of this study was to increase physical performance and to decrease metabolic risk factors in 12-y-old schoolchildren by using bicycle ergometers during the normal school lessons. Methods Before and after an exercise intervention period of 5 months, the intervention group (IG) (10 girls, 13 boys; age (y): 11.7 ± 0.42; height (cm): 151.7 ± 6.9; weight (kg): 40.4 ± 6.8) performed an incremental graded exercise test (GXT) on an electro-

magnetically braked ergometer to determine maximal oxygen uptake (VO<sub>2</sub>max), ventilatory threshold (VT), respiratory compensation point (RCP) and relative and absolute maximal Power (rPmax; Pmax). Fasting blood samples were taken before and after the training period to determine metabolic risk factors (blood glucose, cholesterol, triglycerides and insulin). Each member of the IG performed 3 trainings sessions per week (à 50 min) during ordinary teaching. Therefore, six bicycle ergometers were placed in the back part of a classroom and five teachers supported the study by allowing the IG to exercise during their lessons. The IG was instructed to cycle as long and as intense as possible during the 50 minute lesson without losing attention or disturbing the teaching. The matched control group (CG) (10 girls, 11 boys; age: 11.8 ± 0.28; height: 153.8 ± 7.0; weight: 43.8 ± 10.7) was examined in the same way without participating in the additional exercise intervention. Results A significant improvement during the GXT was observed in VT (Watt) (IG: 58.6 ± 11.5 to 66.5 ± 12.5; CG: 65.4 ± 16.6 to 65.0 ± 20.2; p<0.001), rPmax (Watt/kg) (IG: 3.45 ± 0.62 to 3.56 ± 0.60; CG: 3.38 ± 0.66 to 3.30 ± 0.76; p<0.05) and Pmax (Watt) (IG: 136.6 ± 19.9 to 151.1 ± 21.6; CG: 143.6 ± 23.1 to 149.0 ± 27.5; p<0.05) when IG was compared with CG. Changes in VO<sub>2</sub>max and RCP were not sig. different. Blood glucose values (IG: 89.6 ± 4.8 to 86.1 ± 3.7; CG: 91.2 ± 6.3 to 91.6 ± 4.6; p < 0.05) and triglyceride values (IG: 74.4 ± 40.3 to 63.5 ± 26.0; CG: 72.9 ± 43.5 to 89.5 ± 76.4; p < 0.05) decrease significantly for IG compared with CG. No differences were found in cholesterol and insulin values. Discussion The results of the current study suggest that a 5 month school-based bicycle ergometer intervention can significantly improve some indices of endurance measures (VT, Pmax, rPmax) and metabolic risk factors (blood glucose, triglycerides) in comparison to a control group. Therefore, this form of intervention could be an appropriate method to enhance physical activity and physiological performance and to reduce risk factors in school children. References [1] Lobstein T, Baur L, Uauy R. (2004). Obesity in children and young people: a crisis in public health. *Obes Rev* 5:4-104

### THE CHANGE! PROJECT: GROUP AND GENDER DIFFERENCES IN BODY COMPOSITION, CARDIORESPIRATORY FITNESS, AND CARDIOMETABOLIC VARIABLES AT BASELINE

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Introduction: The CHANGE! Project is a cluster randomised intervention which aims to educate children about leading a healthy lifestyle through a 20 week school based PSHE curriculum. The aim of this paper is to describe the differences in groups at baseline. Method: Participants (n=317) were recruited from 12 primary schools (mean age =10.6 ± 0.3 years) in Wigan. Six schools were randomly assigned to an intervention group with the other six schools acting as controls. A subsample of children (n=60), were randomly selected to take part in further measurements. Anthropometrics (height, sitting height, weight, waist [WC] and hip circumference [HC]), resting blood pressure, cardiorespiratory fitness (CRF) (20 m multi-stage shuttle runs test) and habitual physical activity (PA) (7 day accelerometry) were measured in the whole cohort. Additional measurements completed for the subsample included fasting capillary blood total cholesterol (TC), high density lipoprotein cholesterol (HDL-C) and glucose; body composition (DEXA); CRF (VO<sub>2</sub>peak) left ventricular diastolic filling (E/A Ratio); septal myocardial tissue velocities (E'/A'), and left ventricular mass (LV mass). LV mass index was calculated to account for body size. Group differences were examined using ANCOVA controlling for somatic maturation and gender. Gender differences were also assessed at baseline controlling for somatic maturation. Results: There were no significant differences between the participants in the subsample and whole cohort. There was a significant difference between groups (control and intervention) for the whole cohort for CRF (20m shuttles) (f(1,299)=4.2, p=0.041), and in the subsample for HDL-C (f(1,26)=5.114, p=0.032). There were no other significant group differences. In the subsample there were significant gender differences when controlling for somatic maturation in the following variables; height (f(1,19)=27.194, p<0.001); sitting height (f(1,19)=28.90, p<0.001); weight (f(1,19)=19.3, p<0.001); WC (f(1,19)=6.27, p=0.022); HC (f(1,19)=6.02, p=0.024); Moderate to Vigorous PA (f(1,19)=4.812, p=0.041); and E'/A' (f(1,19)=4.67, p=0.04) In the whole cohort there were also significant gender differences in CRF (20m shuttles)(f(1,310)=21.38, p<0.001). Discussion: There were few group differences at baseline; this suggests the intervention and control groups were well matched at baseline. To account for the observed gender differences all future analyses will control for gender, and maturation, as well as baseline measurements.

## Poster presentations

### PP-PM50 Training and Testing: Jumping Performance

#### ENDURANCE, STRENGTH AND JUMPING ABILITIES OF NORWEGIAN POLICE ACADEMY STUDENTS

JENSSEN, O., NYGÅRD, Ø., INGEBRIGTSEN, J.

UNIVERSITY OF NORDLAND

Introduction Police officers typical work involve long periods of relatively low activity or even inactivity, but is often punctuated by periods of unpredictable bursts of potentially life threatening activities and high intensity that is experienced as stressful (Kales, S. N., Tsismenakis, A. J., Zhang, C., & Soteriades, E. S., 2009). Hence, to cope with the daily demands of the profession you need to hold certain levels of physical fitness. Therefore, physical tests, and requirements, is a major part of the selection of Police academy students overall (Kales et al., 2009), as well as in Norway. Hence, the aim of this project was to establish and identify endurance, strength and jumping performance of first year students in the Norwegian police academy 2010. Secondly we wanted to compare endurance and strength performances with graduate students from year 2000 (as shown in Lagestad, 2006). Methods Participants went through testing of 3000m running, bench press, pull ups, squat jump and counter movement jump, as well as standard anthropometric measures. All statistical analysis was carried out with SPSS 14.0 (SPSS Inc., Chicago). Results are reported as mean ± standard deviations of the mean (SD). Results 91 male (age 22.7±2.3yrs, body mass 80.7±10.8kg, stature 180.3±7.5cm, BMI 24.8±2.6) and 48 female (age 22.0±1.7yrs, body mass 65.2±5.9kg, stature 168.8±5.6cm, BMI 23.0±2.5) police students performed 3000m running on 13:19 (±1:48) min and 15:16 (±1:44) min respectively. In bench press and hang ups male students on average lifted 88.7 (±13.9) kg and 8.5 (±4.3) repetitions, while female lifted 48.5 (±8.7) kg and did 9.8 (±5.1) repetitions respectively. Considering counter movement jumping abilities we found male participants to jump on average 39.3 (±5.1) cm while female participants jumped 29.3 (±3.8) cm. Discussion We aimed to establish normative data from Norwegian first year police academy students, and to compare current performances to graduate students in year 2000. Results among male students reveal on average 1:40min slower, 14 kg and 3 repetitions less in 3000m running, bench press and hang ups respectively. Within female students, performances were 9kg less in bench press, 1:10min slower 3000m running time and 6.5 repetitions less hang ups compared to year 2000 graduate students. Jumping abilities previously not been investigated among Norwegian police students. Refe-

rences Lagestad, P. (2006). PHS-skriftserie 2006 (1). Kales, S. N., Tsismenakis, A. J., Zhang, C., & Soteriades, E. S. (2009). Am J Hypertens, 22(1),11-20.

### CORRELATION BETWEEN VERTICAL JUMP VS REPETIBLY SPRINT ABILITY IN YOUNG SOCCER PLAYERS

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UNIVERSITY OF CAGLIARI

Correlation between vertical jump vs repetibly sprint ability in young soccer players Attene G, Ibba G, Sorci A, Cava C, Pittorru G, Melis S, Pinna M, Degortes N 1 Corso di Laurea Specialistica in Scienze e Tecnica dello Sport, Università degli Studi di Cagliari 2 Scuola Regionale dello Sport della Sardegna, Italian Regional Olympic Committee, Sardinia Italy Aim The goal of this study was to investigate how the neuromuscular ability assessed during the performance of different types of vertical jump test can affect the performance of Repeated Sprint Ability (RSA) in a group of young players. Materials and Methods The experiment was conducted on a group of 16 male subjects practicing football (age  $18 \pm 0.8$  years, height  $173.6 \pm 4.9$  cm, weight  $63.4 \pm 7.6$  kg), participants in the FIGC championship Juniors class. In the first test session the following tests of neuromuscular jump ability were evaluated: Squat Jump (SJ) and the Counter Movement Jump (CMJ) (platform in conductance, TTSport, Galazzano-Republic of San Marino). During the second session the RSA test was conducted (6 reps for 40m sprint with a change of direction to 20 m, 20 s of passive recovery between the tests). Travel times were measured with a photocell timing system (MICROTAC, TTSport, Galazzano-Republic of San Marino). For the measurement of blood lactate (LA) at the end of the test, the tool Lactate Scout (SensLab GmbH, Leipzig, Germany) was used. The index of fatigue (IFF) for the RSA was calculated according to Fitzsimons et al. (1993). The relationship between variables was evaluated using the Pearson correlation coefficient. The significance level was set equal to 5% [ $p < 0.05$ ]. Results The results obtained are as follows: SJ  $35.3 (\pm 5.1)$  cm, CMJ  $42.2 (\pm 4.9)$  cm, best time over 20m (20m BT)  $3.30 (\pm 0.15)$  s, 6 total sprint time (TT)  $43.98 (\pm 1.71)$  s, IFF  $5.31 (\pm 1.58)\%$ , the one-minute post-test RSA  $9.6 (\pm 1.7)$  mmol / l, LA to three minutes post-test RSA  $9.7 (\pm 1.6)$  mmol / l. Statistical analysis has revealed statistically significant correlations between the IFF and the SJ (P value: 0.0181,  $r^2$  0.2770; the IFF and the CMJ (P value: 0.0041,  $r^2$  0.4041); the IFF and the BT 20m (P value: 0.0130,  $r^2$  0.3065), the IFF and the TT (P value: 0.0033,  $r^2$  0.4201), the IFF and the variation of lactate the first and third minute ( $\Delta$  LA1'-LA3', P value: 0.0279,  $r^2$  0.2370) and the SJ BT 20m (P value: 0.0028,  $r^2$  0.3617), the CMJ and the BT about 20m (P value: 0.0069,  $r^2$  0.4316). Conclusions Our results show that the height of jump, the power index of the extensor muscles of the lower extremities positively affects the RSA in young players. In addition, the contribution for the provision of the RSA system in anaerobic metabolism is essential. 1. Rampinini E, Bishop D, Marcora SM, Ferrari Bravo D, Sassi R, Impellizzeri FM. Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. Int J Sports Med 2007; 28: 228-235.

### THE EFFECT OF PLYOMETRIC TRAINING ON AGILITY, LEG POWER, AND FLEXIBILITY OF HIP JOINT OF BADMINTON PLAYERS

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The effect of plyometric training on agility, leg power, and flexibility of hip joint of Badminton players Safari zanjani, F1.Karbasi, S2. Tarassi, Z1. 1: Department of Physical Education and Sport Sciences, Islamic Azad University- zanzan Branch[IRAN] 2: General administration education and training of province of zanzan[IRAN] Introduction Plyometric training helps train explosive strength by shortening the time taken to switch from an eccentric action to the concentric action. Athletes are basically training the muscle fibers and motor neurons to work more quickly and in synchronization with each other. The purpose of this study was to investigate the effects of the plyometric training on improvements of total agility, leg power, and flexibility of hip joint of young male Badminton players (17-19 years old). Methods 40 young male Badminton players who took part province competition, in order to participate in country is school championship were selected randomly. The subjects then were divided into the two groups. The experimental group consisted of 20 Badminton players with the average height who performed plyometric training (one hour per session) for a period of 8 weeks. Control group involved of 20 Badminton players with the average height who merely performed general badminton training programs. Pre- Tests were taken from each group subjects, which involved 4\*9m for Total Agility (TA) measurement, Vertical Jump (VJ) test for leg power measurement, and lateral R.O.M (LROM) of hip joint for flexibility measurement. Post-Test were taken of both groups after 8th week. Results After recording the datum, statistical analysis was used by using method of t-test. The results have shown that the TA, VJ, and LROM significantly improved in experimental group [ $p < 0.01$ ] but these improves were not significantly in control group. Discussion Using a variety of plyometric exercise can improve motor performance. While the majority of studies have focused on untrained subjects, trained athletes such as badminton players have improved their performance with plyometric trainings. References: 1- JSCR 23[2009]. [2] P 495-506 2- Matavuli, D. et al [2001]. J Sports Med Phys Fitness. Jun: 41[2]:159-164 3- Physical training for badminton [1999], By I.B.F [Page 59-108].

### CHANGES OF JUMPING SKILL IN FEMALE VOLLEYBALL PLAYERS

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Introduction Changes of the maximal muscle torques and the lower extremities power are indicative of the athlete's training level and effects of applied training loads. Volleyball players' fitness relies on their strength, power output and jumping ability (Buško, 2009; Smith et al., 1992). The aim of the study was to follow the changes of the maximal power and height of jump measured in spike jump and counter movement jump in female volleyball players during training. Methods Twelve female volleyball players took part in the study. Their mean ( $\pm$ SD) age, body height, body mass and duration of training practising amounted  $21.6 \pm 1.6$  years,  $176.7 \pm 6.1$  cm,  $74.1 \pm 6.6$  kg and  $8.9 \pm 3.3$  years, respectively. The maximal power output of lower extremities and the height of rise of the body mass center during vertical jumps were measured on a force platform for counter-movement jumps (CMJ) and spike jumps (SPJ). Three measurements were carried out: before the preparatory period (I), after the preparatory period (II) and after the end of first competitive season (III). The results were statistically processed using analysis of variance (ANOVA) with repeated measures (post-hoc Tukey test). Results The values of CMJ relative maximal power output increased from  $21.62 \pm 2.9$  W/kg before the preparatory period (I) to  $22.68 \pm 3.3$  W/kg after the end of preparatory period (II) and  $24.21 \pm 3.07$  W/kg after the end of first competitive season (III,  $p < 0.05$ ) while the height of rise of the body mass center were  $0.336 \pm 0.043$  m,  $0.336 \pm 0.038$  m and  $0.349 \pm 0.040$  m, respectively. The relative maximal power output values of SPJ changed from  $34.26 \pm 6.0$  W/kg (I) to  $33.22 \pm 7.11$  W/kg (II) and  $37.53 \pm 7.6$  W/kg (III,  $p < 0.05$ ). The height of jump were  $0.410 \pm 0.049$  m,  $0.429 \pm 0.054$  m and  $0.460 \pm 0.064$  m ( $p < 0.05$ ), respectively. Discussion The preparatory training period is usually devoted to the training of motor skills,



while the competitive season focuses primarily the improvement of volleyball technique and tactics (Häkkinen, 1993). In our study, in female volleyball players insignificant increases occurred in the maximal power output and the height of jump measured in CMJ and SPJ during the preparatory period. Significant increases of the maximal power output and the height of jump in both jumps were noted during first competitive season. The results obtained in this study are in good agreement with the results of the paper of Häkkinen (1993) and Buško (2009). Acknowledgements The study was supported by Ministry of Science and Higher Education (Grant No. AWF - Ds.-150). References Buško K. (2009). Human Movement, 10(2), 149-152. Häkkinen K. (1993). Sports Med Phys Fitness, 33, 323-332. Smith DJ, Roberts D, Watson B. (1992). Sports Sci, 10(2), 131-138.

## RELATIONSHIPS AMONG JUMP TEST PERFORMANCES AND SPEED OF CONTINUOUSLY CYCLICAL STEPS DURING ACCELERATION PHASE OF SPRINTING

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**Introduction** The sprint performance during acceleration and maximal speed phase relate to several jump performances (Morin and Belli, 2003; Maulder et al., 2006; Kale et al., 2009). Previous studies investigated the relationships among jump performances and the performance in each wide partition during sprint running. Then, the purpose of this study was to investigate the relationships among the jump test performances and continuously cyclical steps during acceleration phase of maximal sprint running. **Methods** Nineteen male sprinters (age  $20.1 \pm 1.2$  yr, height  $1.75 \pm 0.04$  m, weight  $66.1 \pm 4.0$  kg and the best time of 100m race  $11.19 \pm 0.34$  s) participated in this study. The subjects performed the 60m sprint running with maximal effort started by crouching style as used in 100m race. The running motion was recorded by six high-speed cameras (300Hz). The step times were counted with recorded videos and the coordinates of toe at each support phase were obtained by digitizing. After the sprinting test, subject performed several jump tests (Standing Long Jump: SLJ, Standing Five Jump: SFJ, Counter Movement Jump without arm action: CMJ, Rebounding continuous Jump without arm action: RJ, rebounding continuous Ankle Jump without arm action: AJ). The AJ is our original jumping test which is performed by only plantar flexion of ankle joint without any other joint movement. The measures of SLJ, SFJ and CMJ were the distance and height (m). On the other hand, the measure of RJ and AJ was the jump index that is the ratio of jumping height (m) divided by the contact time (s). Correlation coefficients among the jump performances and the each running speed were calculated. **Results and Discussion** There was no significant relationship among running speeds and SLJ & RJ. The significant relationships were showed among running speeds and CMJ during initial acceleration until the 4th cyclical steps. From the 4th to the 8th cyclical steps, there were significant relationships among running speeds and SFJ. The AJ showed significant relationships against each running speed in whole acceleration phase, and correlation coefficient became high in the 2nd half of acceleration phase. Thus, we concluded that there is different demand of jump performance for obtain of high running speed during each acceleration phase of sprinting. **References** Morin, J.B. & Belli, A. (2003) Mechanical factors of 100m sprint performance in trained athletes. *Sci. Sports*, 18, 161-163. Maulder, P.S. et al. (2006) Jump kinetic determinations of sprint acceleration performance from starting blocks in male. *J Sports Sci. Med.*, 5, 359-366. Kale, M. et al. (2009) Relationships among jumping performances and sprint parameters during maximum speed phase in sprinters. *J Strength Cond. Res.*, 23, 2272-2279.

## STIFFNESS AND VERTICAL JUMP HEIGHT ARE AFFECTED BY THE PREVIOUS COUNTER MOVEMENT

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**Introduction** A greater insight into the influence of the counter movement phase of a jump on the vertical stiffness can help to assess whether the vertical path during the counter movement is optimal to achieve the greatest possible jump height. It could also allow to rank athletes from different populations, based on the vertical stiffness levels measured during the counter movement phase. We aimed to assess the effect of vertical jumps (CMJ) performed with different magnitudes of counter movement on peak mechanical power and vertical stiffness during the push off phase. **Methods** Seventeen young subjects ( $21.1 \pm 3.1$  years), 9 women and 8 men, volunteered for the study. They performed 6 CMJs, 3 trials each, with different levels of knee flexion on a force plate (Quattro Jump, Kistler, Switzerland). The levels of knee flexion were classified as (1) Very low flexion ( $70-78^\circ$ ), (2) Low flexion ( $80-88^\circ$ ), (3)  $90^\circ$  of knee flexion, (4) Free, (5) High flexion ( $100-108^\circ$ ) and (6) Deep flexion ( $>110^\circ$ ). **Results** Jump height in the Free condition ( $27.3 \pm 6.6$  cm;  $15.8 \pm 3.6\%$  of standing height) was significantly greater ( $P < 0.05$ ) than those observed in the other conditions, followed by the one measured at  $90^\circ$  of knee flexion ( $26.3 \pm 6.1$  cm;  $15.3 \pm 3.3\%$  of standing height). Jump height in the Free condition was a 10% higher than the one at the Very low flexion condition. When comparing Free condition with each of the other levels there were significant differences ( $P < 0.05$ ) in all the variables. Peak power in the Very low flexion condition was significantly higher than the one found in Free ( $46.5 \pm 7.9$  W/kg vs.  $44.0 \pm 7.6$  W/kg,  $P < 0.01$ ). Vertical stiffness was gradually decreasing from the Very low flexion condition to the Deep flexion condition, with a plateau of similar values in the Free and  $90^\circ$  conditions. Vertical stiffness in Free and  $90^\circ$  were greater than the one measured in the Deep flexion condition ( $P < 0.001$ ), and the stiffness value measured in the Very low flexion condition was greater than the one measured in the other conditions ( $P < 0.001$ ). **Discussion** The greatest jump heights were achieved when the participants freely chose the magnitude of the counter movement. This should be taken into account during the jump protocol design, because the differences between the highest and lowest jumps were the 10% of jump height. The greatest power was measured in the jump with very low flexion. The highest jump heights were found in a plateau of the stiffness values, which could be utilized as a reference to study the optimal counter movement level during the push off phase.

## COMPARISON OF THE FREE FALLING DISPLACEMENT OF THE CENTER OF GRAVITY WITH THE HEIGHT OF THE PLATFORM

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**INTRODUCTION** One problem in the evaluation of the stretch-shortening cycle through the drop jump technique, is to consider the height of the drop platform as the FFDCG, which can result in calculating jump heights with 4.2% error (SD 9.6%) (Baca, 1999). Moreover, the increment intervals on the drop platform are normally 20 cm (Sale, 1991). Therefore, the aim of this study was to analyze the difference between the height of the drop platform and FFDCG, as well as the differences among the FFDCG obtained from four heights of the drop platform using intervals of 10 cm. **METHODS** Through the impulse method with one force plate the FFDCG were determined. The subjects were 22 young physical active males who were familiarized with the DJ technique (Age  $21.4$  years SD  $2.2$ ) (BW  $74$  kg SD  $9.2$ ) (BH  $1.72$  m SD  $0.11$ ) (BMI  $23.6$  SD  $2.1$ ). Two perfect jumps were performed from each height of the drop platform (20, 30, 40, 50 cm) with 3 minutes rest

period between jumps. The jumps were performed in a random order. Before each jump the following command was given systematically: "With your hands on your hips, try to fall from the height that you were in, using the minimum contact time and maximum jump effort". For the FFDCG variable the mean and SD were obtained from values of the subject's two jumps mean. For the statistical analysis the t test and one way ANOVA were used. RESULTS The FFDCG was different from the height of the respective drop platform ( $p < 0.0001$  for every drop platform). Each FFDCG of the four drop platform were different among each other ( $p < 0.001$ ). DISCUSSION This result supports Bobbert et al. (1987), who found FFDCG values smaller than drop platform heights, increasing the difference as the height of the drop platform increased, indicating a possible protection mechanism against increasing impacts (Schmidtbleicher, 1992; Leukel et al., 2008). Therefore, we can categorically reaffirm that using the impulse method, the utilization of the height of the drop platform as the value of FFDCG to calculate jump height in DJ will result in non confident values of jump height (Baca, 1999). Moreover, differences were observed among FFDCG for each drop platform, indicating that the utilization of 10 cm increment intervals are more adequate than 20 cm or more as generally used in studies with DJ (Sale, 1991). REFERENCES Baca A. (1999). *Med Sci Sports Exerc*, 31, 427-442. Leukel C, Taube W, Gruber M, Hodapp M, Gollhofer A. (2008). *Acta Physiol*, 192, 569-576. Sale DG. In: MacDougall J, Wenger H, Green H. Ed. Champaign: Human Kinetics, (1991). 21-106. Schmidtbleicher D. (1992) In: Komi P. ed: Oxford: Blackwell Scientific Publications, 381-395.

## INFLUENCE OF MODIFIED BOSCO REBOUND JUMP TEST FOR EVALUATING PHYSICAL STRENGTH FACTORS IN ALPINE SKIERS DURING THE COMPETITION SEASON

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**Introduction** In the present study, this test was performed for 90 seconds, and the power output characteristics were added to the jump height as test parameters. Subsequently, in order to analyze the physical conditioning of Alpine skiers during the season on the basis of these parameters, measurements were conducted at two different times, during the physical training period prior to the competition season and the during the competition season. The objective of this study was to investigate the suitability of a modified version of Bosco et al.'s rebound jump test (BRJ) for evaluating the physical conditioning of competitive Alpine skiers. In the modified Bosco rebound jump test (call for BRJ), the duration of the test has been prolonged to 90 seconds. The physical conditioning of the subjects is then evaluated on the basis of the data generated in the modified BRJ for the jump height, power output and power components. **Methods** A total of 26 Alpine skiers, 15 men and 11 women, performed the modified BRJ test. Measurements of the test parameters, i.e., the jump height and power output characteristics, were conducted twice, during training (September) and during the competition season (January). The changes in the test parameter values were then analyzed. During the BRJ test, performed on a ground reaction force (Ex-Jumper; DKH Co., Ltd.), the subject jumped as high as possible on the rebound from a squatting position, repeating this for 90 seconds. The jump height and power output characteristics were determined on the basis of the time from vertical ground reaction force until landing, in accordance with the methods developed by Bosco et al. Results and discussion BRJ test was devised for evaluating the physical conditioning of competitive Alpine skiers during the competition season. The suitability of the modified BRJ test for this evaluation was also assessed. The mean test parameter data between the training-season and the competition season were compared for male and female skiers. The results show that the maximum jump height of the male skiers increased by 5%, from 39 cm to 41 cm, between training season and the competition season. The mean peak power of the male skiers also increased, from 52.51 watts/kg to 53.38 watts/kg. For the female skiers, the mean maximum jump height increased from 29 cm to 33 cm between the training season and the competition season. The mean peak power of female skiers also increased, from 43.16 watts/kg to 48.08 watts/kg. **Conclusion** To evaluate these factors, we devised a modified version of the BRJ test, in which the duration of the exercise was extended to 90 seconds. We then had Alpine skiers perform the modified test at two different times, during the physical training period and during the competition season. For both male and female skiers, the test parameter data were found to have improved during the training season and the competition season. In consideration of these test findings, the BRJ test may be a suitable method for evaluating the physical conditioning of Alpine skiers.

## TRAINING LOAD'S CONTROL BY THE CMJ TEST IN SPRINT EVENTS AND JUMPS TO OPTIMIZE SPORT'S PERFORMANCE IN ATHLETICS

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**Introduction** The study of training load's dose always has provoked controversies and there is not solved which is the optimal training load to achieve the highest performance (Cronin and Sleivert, 2005). Most studies analyse the training's immediate effects without a scientific evidence exists, in many cases, on the most suitable loads and their effects in performance. Our aim was to obtain a more complete and actual information on training process' effects, verifying the evolution in time of these variables and their relationship to athletic performance. **Methods** Twenty four high level sprinters (age  $25.4 \pm 4.5$  yr, body mass  $75.5 \pm 7.3$  kg, height  $179.9 \pm 5.6$  cm; body fat  $9.9 \pm 2.3\%$ ) took part in the study. Over seventy-one training's week, subjects' physical condition was weekly tracked using "Counter-movement Jump" (CMJ) and by collecting other data of weekly training load athletes performed, strength and power measurements and the results in competition. **Results** We analyse the value in CMJ's evolution in the four weeks previous to a competition at best and worst performance peaks, at best performance peaks there is a tendency to an increase in vertical jump height upto approximately the 100% of the best value achieved during all the period studied (71 weeks). The variables measured to monitor specific performance were always taken at times closer to competitions. In relation to training load's evolution during the four weeks previous to competition, we highlight that maximum values of weekly training load no higher than 40-45% of the maximum weekly load conducted by the subject, tends to produce the best results in competition. **Discussion** Control of CMJ during the competition week could be a good indicator of the subject's performance during that same week on short-term events in which the performance depends largely on strength and ability to produce force. The information gathered in CMJ weekly should be used to control the specific performance's evolution. The results from the test enable us to introduce suitable changes in training load so as to control the performance tendency in cases where the latter is not satisfactory. **In conclusion**, if there is realized an exhaustive training load's control and its relationship to physical performance and athletic performance, it would allow to adjust training loads adequately and it would also provide valuable information for a rational training planning. **References** Cronin, J., and Sleivert, G. (2005). Challenges in understanding the influence of maximal power training on improving athletic performance. *Sport Med.* 35(3): 213-234.

## EFFECTIVENESS OF A MODIFIED BOSCO REBOUND JUMP TEST FOR EVALUATING PHYSICAL STRENGTH IN ALPINE SKIERS

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**Introduction** The purpose of this study was to investigate the suitability of a modified version of the Bosco Rebound Jump test (mBRJ) for evaluating the physical conditioning of competitive Alpine skiers. In the mBRJ, the duration of the test has been prolonged to 90 seconds. The physical conditioning of the subjects is then evaluated on the basis of the data generated in the mBRJ for the jump height, power output and power components. **Methods** A total of 26 Alpine skiers, 15 men and 11 women, performed the mBRJ. Measurements of the test parameters, i.e., the jump height and power output characteristics, were conducted twice, during pre-season training (September) and during the competition season (January). The changes in the test parameter values were then analyzed. During the mBRJ test, performed on a ground reaction force (Ex-Jumper; DKH Co., Ltd.), the subject jumped as high as possible on the rebound from a squatting position, repeating this for 90 seconds. The jump height and power output characteristics were determined on the basis of the time from the vertical ground reaction force until landing, in accordance with the methods developed by Bosco et al. **Results and discussion** The original BRJ was devised for evaluating the physical conditioning of Alpine skiers during the competition season. The suitability of the mBRJ for this evaluation was also assessed. The mean test parameter data between pre-season training and the competition season were compared for male and female skiers. The results show that the maximum jump height of the male skiers increased by 5%, from 39 cm to 41 cm, during the competition season. The mean peak power of the male skiers also increased, from 52.51 W/kg to 53.38 W/kg. For the female skiers, the mean maximum jump height increased from a pre-season training 29 cm to 33 cm during the competition season. The mean peak power of female skiers also increased, from 43.16 W/kg to 48.08 W/kg. **Conclusion** The speed endurance capacity and the ability to perform the stretch-shortening cycle exercise have been the focus as factors related to physical strength for Alpine skiers during the competition season. To evaluate these factors, we devised a modified version of the Bosco Rebound Jump test (mBRJ), in which the duration of the exercise was extended to 90 seconds. We then had Alpine skiers perform the mBRJ at two different times, during pre-season physical training and during the competition season. For both male and female skiers, the test parameter data were found to have improved between pre-season training and the competition season. In consideration of these test findings, the mBRJ may be a suitable method for evaluating the physical conditioning of Alpine skiers. **Reference** Bosco C., SCIENCE AND SKIING (1997) Bosco C., et al., Eur. J. Appl. physiol (1983)

## EFFECTS OF PASSIVE STRETCHING IN THE VERTICAL JUMP OF BALLET DANCERS

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1: LAPEB-ESEF (UNIDIAÍ-BRAZIL) 2: FACULDADES ANHANGUERA (UNIDIAÍ-BRAZIL)

**Introduction:** Studies point out that strength and flexibility are competitive in relation to the mechanics of movement, therefore flexibility exercises can cause a temporary reduction in strength and performance. Ballet dancers intensively use their flexibility and strength capacity in order to assure the extent of movement and perfect execution of classical dance techniques. **Objective:** To verify the relationship between exercises of stretching and vertical jump among ballet dancers. **Methodology:** Fourteen dancers of both genders (21.21±2.72 years old) were studied. They performed successive jumps for 20s. two times: (S1) only vertical jump and (S2) vertical jump immediately after flexibility training. The variables related to jump were measured with the jump mat 'Jump System 1.0 Fit Cefise®'. The flexibility section had eight static stretching exercises, lasting for 20 seconds each. In line with statistic procedures, the t test (p <5%) was applied. **Results:** The amount of jumps in the S1 (30.7 ± 4.9) was lower than in S2 (32.0 ± 3.5). The average jump height was 22.4 ± 4.9cm and 22.0 ± 6.3cm respectively, however, no significant difference was found. **Discussion:** Previous studies showed that prior flexibility exercises can reduce the capacity of vertical jump and therefore it can cause deficit in the strength for up to one hour after the passive stretching (FIELD et al 2008). Furthermore, Cramer et al, (2004) verified that applying the maximum torque condition during the isokinetic extension of the inferior limbs, after one active exercise and three passive exercises of stretching, decreased strength. In the present study it was observed that the passive stretching did not affect the performance of vertical jump. In the same way it did not present negative effects in the explosive strength during the performance of jumps in controlled conditions (NOGUEIRA et al 2010). In this way it is suggested that the dancers were used to a routine of intensive stretching presenting chronic morphophysiological adaptation recurrent from constant flexibility training, and the section of passive flexibility of 20 seconds was probably not enough to influence the capacity of vertical jumps. It can be concluded that the prior passive stretching did not interfere in the performance of vertical jump of ballet dancers. **Bibliography** Cramer JT, Housh TJ, Johnson GO, Miller JM, Coburn JW, Beck TW. The acute effects of static stretching on peak torque in women. J Strength Cond Res 2004;18:236-41. Field KB, Burnworth, CM, Delaney M. Atletas devem se alongar antes do exercício?. GSSI; 2008 [access em 01 jun 2010]. Available: [http://www.gssi.com.br/Nogueira\\_CJ\\_Galdino\\_LAS\\_Vale\\_RGS\\_Dantas\\_EHM\\_Efeito\\_agudo\\_do\\_alongamento\\_estatico\\_sobre\\_o\\_desempenho\\_no\\_salto\\_Motriz\\_2010\\_16\(1\):10-6](http://www.gssi.com.br/Nogueira_CJ_Galdino_LAS_Vale_RGS_Dantas_EHM_Efeito_agudo_do_alongamento_estatico_sobre_o_desempenho_no_salto_Motriz_2010_16(1):10-6).

## EFFECT OF JUMPING DIRECTION ON JOINT KINETICS DURING REBOUND-TYPE JUMPS: DIFFERENCES BETWEEN DOUBLE- AND SINGLE-LEG TAKEOFF

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**Introduction** Rebound-type jump (RJ) in the horizontal direction is widely used to enhance high power output, e.g., plyometric training. Many studies have investigated RJ in the vertical direction and double-leg takeoff jumps as experimental tasks (Bobbert, 1990; Markovic and Mikulic, 2010), while only few studies have examined joint kinetics in the horizontal direction. Joint kinetics of the takeoff leg should be studied to understand the training load and training objectives. This study aimed to clarify the effects of jumping direction on joint kinetics during RJ, with focus on the differences between double- and a single-leg takeoff. **Methods** Twelve male track and field athletes (age, 22.0 ± 2.2 years; height, 175.0 ± 6.1 cm; and weight, 65.8 ± 4.0 kg) performed repeated RJs with double-leg takeoff (vertical double [VD], 50% horizontal double [HD], and HD) and single-leg takeoff involving alternate left- and right-leg contacts (vertical single [VS], 50% horizontal single [HS], and HS). In 50%HD and 50%HS, they performed RJs in the horizontal direction at equal intervals of half the jump distance measured from HD and HS, respectively. Kinematics and kinetics data were recorded using a high-speed video camera (300 Hz) and force platforms (1000 Hz). The joint torque and torque power of the takeoff leg were calculated by inverse dynamics. The takeoff phase was divided into the eccentric phase (ECC; from the point at touchdown to the lowest point of the body's center of gravity [CG]) and the concentric phase (CON; from the lowest point of CG to toe-off). **Results and Discussions** With a change in jumping direction from

vertical to horizontal, the force and joint kinetics also changed: some changes were common (A) while others differed (B) between double- and single-leg RJs. (A) There was an increase in the braking and propulsive impulses of horizontal ground reaction force; the negative torque power at the knee joint; and the extension torque during ECC and positive torque power at the hip joint. (B) At the ankle joint: the extension torque during ECC and negative torque power decreased, but the extension torque during CON and positive torque power increased in single-leg RJ; no change in these parameters was noted in double-leg RJ. At the knee joint: the extension torque during CON and the positive torque power increased in single-leg RJ; these parameters decreased in double-leg RJ. At the hip joint: the increase in the maximum torque during ECC was greater in single-leg RJ than in double-leg RJ. Our results show that the torque and torque power outputs change with jumping direction, and these differ between double- and single-leg takeoff. References Bobbert, M. F. (1990) Sports Med., 9, 7-22. Markovic, G. and Mikulic, P. (2010) Sports Med., 40, 859-895.

## Poster presentations

### PP-PM51 Body Composition

#### CHANGES IN BODY MASS AND WAIST CIRCUMFERENCE OF CONSCRIPTS WITHIN DIFFERENT HEALTH GROUPS AND THEIR EFFECT ON THE CONSCRIPTS' PERFORMANCE ON THE EXAMPLE OF A UNIT IN THE ESTONIAN ARMY

ANTSON, H., MÄRK, H.

TALLINN UNIVERSITY

**Introduction** Estonian National Defence is based on a non-professional army with conscripts and reservists. Depending on health status the conscripts are divided into the categories Healthy and Healthy with Restrictions. Several studies indicate that the conscripts' body weight and waist circumference might shift upwards during a few weeks after start of military service and such an orientation might impose an unwanted influence on their operational effectiveness and health status. The current follow-up study continues the recent research among conscripts. The paper aims at eliciting influences of comparative body mass and waist circumference (described by body mass index (BMI) and waist circumference index (WCI) respectively) on conscripts' physical performance, wherein the health status of conscripts is taken into consideration. **Methods** 656 male conscripts at the start of service in 2009 (mean age 22) participated in the study of the training cycle in years 2009-2010. Individual APFT (army physical fitness test - 3 simple sports tests in three stages during the service period) results as well as their medical data and body measurement records were collected and stored in the data base and analyzed. **Results** The current study revealed the fact that both the body mass and the waist circumference of many conscripts varied distinguishably in two general stages – firstly, after entering the service and secondly, after the end of the basic training course (BTC). Division of health categories of freshmen who were engaged into the unit was 75% Healthy and 25% Healthy with restrictions. Diseases of the musculoskeletal system (M-type diseases) are considered to be a rather common health problem among freshmen (in current study 49% of all diseases). These are followed by mental and behavioral disorders (F-type diseases 16%), diseases of the eye (H-type 5.4%) and congenital malformations (Q-type 5%). **Discussion** Conscripts within health category Healthy with restrictions significantly performed at lower level in their physical abilities than conscripts within category Healthy. The most negative effect of the rise of conscripts' comparative BMI as well as comparative WCI (the results of APFT did not improve) was strongly correlated to the soldiers with F-type diseases within health group Healthy with restrictions. There is an indirect evidence that the rise of body mass, which is commensurately growing along with fat mass (described by WCI) is linked to the mental and behavioral stress. References Antson H, Märks H. Changes in BMI and its cohesiveness to physical performance and health condition of soldiers during their conscript time. ECSS Antalya 2010, Turkey

#### THE INFLUENCE OF BODY WEIGHT REDUCTION ON THE PARAMETERS OF BODY COMPOSITION IN JUDOISTS

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**Introduction** In judo and other sports which have weight categories, it became customary to reduce weight of athletes just before the tournament. It is done by significant restriction of fluid intake, exercises for dehydration and sweating. In this way of the reduction it will not reduce only the total body water, but also the body fat, together with lean body mass (Forbes, 1987; Proteau, 2006). This body weight reduction has serious consequences. The aim of this study was to find differences in the particular parameters of body composition influence of body weight reduction in elite judoists. Monitoring these changes is important especially to avoid the negative impact of body weight reduction. **Methods** We measured the basic anthropometric parameters (body height, body weight, circumferences and transverse diameters and somatotype by Heath & Carter - 1967) and the thickness of the skinfolds by Best's caliper. For the measurement of body composition was used multifrequent bioimpedance analyzer BIA 2000 - M. **Results** The results of our study show that body weight reduction in judoists is greatly influenced by the individual variability and reflected in varying degrees in all parameters of body composition. Average of body weight reduction was 3.8 kg (i.e. 4.7%). The major changes in the parameters of body composition occurred in extracellular water (average difference 13,8%) and body fat (average difference 13,2%). Average decrease of lean body mass was 4,2%. Measured mean somatotype was 1,5: 5,7: 2,1, equivalent to a somatotype balanced mesomorph. In assessing the changes of parameters due to body weight reduction were found materially and statistically significant differences in all parameters, except intracellular water and body cell mass. **Discussion** As we expected major part of weight loss was composed of body water loss. We found large individual differences in fluid distribution between intracellular and extracellular water. It could be caused by redistribution of body fluid from intracellular to extracellular space or other way round, it is very individual and influenced by many factors. Even though there was a rapid body weight reduction lasting only a few days, we recorded a decrease of body fat. We also measured a decrease of lean body mass in most of the probands, what is undesirable. References Forbes, G. B. (1987). Human body composition. Springer Verlag, New York. Heath, B. H., Carter, J. E. L. (1967). A modified somatotype method. American Journal of Physical Anthropology, 27, 57-74. Proteau, S., Pelle, A., Collomp, K., Benhamou, L., Courteix, D. (2006). Bone Density in Elite Judoists and Effects of Weight Cycling on Bone Metabolic Balance. Med. Sci. Sports Exerc.

## BODY IMAGE, OBESITY INDICES AND PHYSICAL FITNESS OF CYPRUS ELEMENTARY SCHOOL CHILDREN AGED 6 TO 12 YEARS OLD

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**Introduction** Body image, a psychological variable enhanced by physical activity and subsequently influence weight control attitudes and behaviour, is defined as the interaction between the perceptive component and cognitive evaluation of body size (Baker & Brownell, 2000). However, when children participate in exercise programs, they experience feelings of satisfaction and success leading to the improvement of self-esteem and body image. Among children and adolescents, body image dissatisfaction is based on age, pubertal status, gender, body mass index and family relationship (Gilliland et al., 2005). The aim of the present study was to assess the correlations among body image, obesity indices and physical fitness level of elementary school children in Cyprus aged 6 to 12 years old. **Methods** A cohort of 816 healthy pupils, aged  $10.3 \pm 1.8$  yrs, participated in the study and were divided according to their gender (391 boys, 425 girls) and their obesity level (normal, overweight, obese) as defined by IOTF criteria (Cole et al., 2000). A self-report body image questionnaire was composed of thirty-six questions about body shape and overall physical appearance and anthropometrical (BMI, body composition, abdominal circumference) and physical fitness (flexibility, muscle strength, isometric strength, jumping ability, cardio-respiratory endurance) measurements were obtained. **Results** From the PCA analysis, seven components were extracted, with eigenvalue above 1, explaining 60.46% of the total variance, and were labelled in the following order: 1-Satisfaction (14.79%), 2-Appearance (13.34%), 3-Insecurity (10.49%), 4-Low Self-Esteem (7.59%), 5- Self-assurance (5.39%), 6-Sociability (4.71%) and 7-Positive attitude (4.13%). The data analysis showed that boys presented better values in the satisfaction of their body image ( $p < .01$ ) as compared to girls. Significant differences were also observed between obese and normal body mass children in 1-Satisfaction ( $p < .01$ ), 2-Appearance ( $p < .001$ ), 4-Low self-esteem ( $p < .01$ ) and 5-Self-assurance ( $p < .05$ ). Pearson correlation coefficient showed statistically significant association of BMI, waist circumference and body fat respectively with 1-Satisfaction ( $r = -.195$ ,  $r = -.240$ ,  $r = .253$ ,  $p < .01$ ), 2-Appearance ( $r = -.295$ ,  $r = -.284$ ,  $r = -.344$ ,  $p < .001$ ) and 4-Low self-esteem ( $r = .161$ ,  $r = .146$ ,  $r = .134$ ,  $p < .05$ ). Muscle strength and cardio-respiratory endurance correlated significant with 1-Satisfaction ( $r = .233$ ,  $r = .252$ ,  $p < .001$ ) and 2-Appearance ( $r = -.204$ ,  $r = -.192$ ,  $p < .001$ ). **Discussion** The above data revealed that girls, as well obese children, reported greater body image dissatisfaction than boys (Hausenblas et al., 2002) and a greater desire for thinness (Collins, 1991). Generally, boys had greater participation in physical activity than girls, were more active and presented better values of physical fitness and strength and overall self-esteem for their body image.

## RELATIONSHIP BETWEEN EXPENDITURE TIME, MENTAL HEALTH AND BMI IN SECONDARY SCHOOL PUPILS IN ALBANIA.

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UNIVERSITY OF SPORTS OF TIRANA

Çanaj ,F.1, Ikonimi E. 1, Qeleshi, A.1. 1: UNIVERSITY OF SPORT OF TIRANA **Introduction:** It is well know that activity habits are established at young age; studies show that those people, who can most readily be persuaded to take up more activity, are those who, as children, were physically active at school and during their leisure (1). There is such a thing as mental health just as there is physical health and the two are intertwined (2). The WHO has now tentatively recommended the use of BMI – for age as indicator of overweight or obesity (3). and high BMI in adolescence is predictive of adult mortality (4). But is the correlation between time expenditure, mental health and BMI in secondary school pupils in Albania? **Objectives:** To objectively investigate the relationship between mental health, time expenditure and BMI in secondary school pupils in Albania. **Subjects:** This study included the biggest city in Albania ,Tirana , Shkodra and Fieri ( 5, 6, 7, 8 grade), 950 children-boys and girls from 11 to 14 years old in public school. **Methodology:** Objective measurements of height, weight and waist circumference were obtained. BMI is measured by measuring Weight and Height at 9:00- 10:00 morning time Questionnaires of time expenditure (based on EPAQ2, Source: Wareham et al. IJE 2002) and mental health (Rate yourself from Poul M.Insel and Walton T .Roth 1988) Are fulfilled for one week with the parents support. As a quantitative study all data entry are elaborated in database. **Discussion.** Our study is tried to be realistic, honest and true. BMI itself seem to be lesser than the WHO standards, so we have no overweight and obesity. In Tirana, the correlation between them, mental health (>16 according to the scale) and time expenditure goes in right proportion, higher the PA (PA games Home Help, Stroll, Sp & GYM), higher Mental Health scale results we got. The same results seem to have also in other Cities. In five weeks adding three hours of PA per week (time expenditure) can not change BMI , but only Mental health was found to improve. **References** 1- James, W.P.T. 1995.A public health approach to the problem of obesity .International Journal of Obesity and Related Metabolic Disorders 19 (Suppl.3): S37-S43. 2 .Poul M.Insel and Walton T. Roth. 1998. Core Concepts in Health. Fifth Edition 3:50 -52. 3- WHO 1995. Physical status: the use and interpretation of anthropometry WHO Technical report Series # 854. WHO Geneva 4- Engeland A, Bjorge T, Sogaard AJ, and Tverdal A. Body mass index in adolescence in relation to total mortality: 32-year follow-up of 227.000 Norwegian boys and girls. Am J Epidemiology. 2003; 157:517-23.

## THE BODY COMPOSITION CHART ANALYSIS FOR ELLITE ATHLETES

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1. EULJI UNIVERSITY SCHOOL OF MEDICINE, 2. KOREA NATIONAL SPORT UNIVERSITY

**Introduction** The quantitative fat mass (FM), fat-free mass (FFM) and percent body fat (PBF) have been separately used for body composition status, although the optimal physical performance of athletes needs not only an amount of FM and PBF but also an amount of FFM (ADA et al., 2009). Profiles and changes of body composition for elite athletes have not been discussed. To show body components visually as a quantitative measure, a chart based on the fat-free mass index (FFMI, FFM/height square) and fat mass index (FMI; FM/height square) can be applied to investigate the nature of body composition changes with physical training and sport events (Hattori et al., 2004). Therefore, this study is aimed to address sport-specific profiles and change of athlete's body composition on a graphical chart called the FFMI-FMI chart. **Methods** A sample of 743 subjects (385 elite athletes, 358 control) aged 18 - 39 years was studied to determine body composition by DXA. Among the subjects, 27 soccer players participated in the 12-week intensive physical training and their body compositions were measured before and after the intervention for body composition changes. Among the body components, FFMI and FMI were put on an x- and y-axis in a body composition chart, where FMI, FFMI, PBF, and BMI (= FMI + FFMI) were visually analyzed together. Hotelling's T2 test, MANOVA and the overlap zone analysis were used for the exploratory and statistical analysis. **Results** There were significant differences between male athletes and male controls in FFM, FM, FFMI, FMI, and BMI ( $p < 0.001$ ) even though the body weights between the two groups were alike ( $p = 0.562$ ). All of the body components of Female athletes were different from them of

female controls ( $p = 0.001$ ). In the FFMI-FMI chart, body components were separately distributed by sport events and sex. The migration of body components from pre-training and post-training can be expressed distinguishing all body components including FFMI, FMI, BMI, and PBF vividly and quantitatively. Discussion The findings of this study show the distribution of FFM and FM are characteristically delineated on the FFMI-FMI chart, demonstrating clear exercise-induced body-component differences and changes. The FFMI-FMI chart can vividly evaluate the profiles and changes of body composition for elite athletes. References ADA, ACSM, et al. (2000). *Med Sci Sports Exerc*, 41(3), 709-31. Hattori K, Tahara Y, Koji K, Aoyagi K, Furusawa T. (1999). *Int J Obes*, 28(4), 520-4.

### THE DIFFERENCE OF VARIATION OF BODY COMPOSITION IN JAPANESE FEMALE UNIVERSITY STUDENTS.

YUMIGETA, R., TSUNODA, N., HORIKAWA, H.

SHOWA UNIVERSITY

**Introduction** In order to keep in good health, it is important for keeping health to recognize the change in the body composition. In recent years, bioelectrical impedance analysis method (BIA) has become available for determination of human body composition. However, it is not clear which part of the body's fat and muscle has change in term of body composition is not clear. The purpose of this study was to examine the difference of variation of body composition in Japanese female university students. **Methods** The participants were forty-five healthy female university students. Their mean (SD) values of age, height were 18.3(0.5) yrs, 159.4(6.1) cm respectively. Body weight(BW), percentage of body fat in whole body(FWB), left arm(FLA), right arm(FRA), left leg(FLL), right leg(FRL) and trunk(FTK) and muscle volume in whole body(MWB), left arm(MLA), right arm(MRA), left leg(MLL), right leg(MRL) and trunk(MTK) were measured by bioelectrical impedance analysis method(TANITA, Japan). Each item was measured in April and January. And also, each item was measured that subjects get up and after urination as soon as impossible. **Results** BW and FWB in January were significantly higher value than that of April. On the other hand, significantly difference was not observed between April and January in MWB. FLA, FRA and FTK in January were significantly increased than that of April. The volume of increase of fat in each part of body, FTK was showed the highest value, and the significant difference was observed between FTK and FLA. However, the difference was not significant between April and January in muscle volume of in each part of body. **Discussion** From these results, it was cleared that the increase of body fat caused the increase of body weight. It was considered that there were a part to which the body fat was like to be attached and a part not attached in human's body. And also, it was suggested that the part to which the body fat was likely to be attached most would be a trunk. Thus, we suggest that there is a possibility of accumulating the body fat in the order of the body trunk, the arm, and the foot. Reference Shimomura H, Andres R, Coon PJ(1989): Studies in the distribution of body fat II, longitudinal effects of change in weight, *Int J Obesity*, 13, 455-464.

15:00 - 16:00

## Poster presentations

### PP-PM52 Biochemistry 3

#### INFLUENCE OF COMFORTABLE SELF-PACED RUNNING AND IT'S EXERCISE INTENSITY ON THE STRESS BIOMARKER RESPONSE

KUDO, H., TAZAWA, T.

MEIJO UNIVERSITY

**Introduction** In recent years, the comfortable self-paced running is reported to be beneficial to the health maintenance (Mizuno et al., 2006). The salivary amylase has been known as one of the stress biomarker (Yamaguchi, 2007). Therefore, the purpose of this study was to elucidate the effect of comfortable self-paced running and it's exercise intensity on the salivary amylase. **Methods** This study comprised 33 healthy male volunteers, and the volunteers were classified into three groups (comfortable self-paced running group (CSPR group) of 11 people, comfortable self-paced running  $\pm 15\%$  of peakVO<sub>2</sub> load group ( $\pm 15\%$  group) of 11 people each). The volunteer of the three groups performed the treadmill run for 15 minutes at each loaded speed. The Rating of Perceived Exertion(RPE) and peakVO<sub>2</sub> were measured during exercise. In addition, the salivary amylase content was measured at time of pre-exercise, immediately after exercise, and 30 minutes after exercise. **Result** In both (CSPR and  $-15\%$ ) groups immediately after exercise, the salivary amylase content had not changed remarkably from pre-exercise value. However in  $+15\%$  group, the salivary amylase content increased by 34.18 KU/L. In addition, the meaningful correlation was accepted between RPE during exercise and value of fluctuation of the salivary amylase content immediately after exercise. **Discussion** These results suggests that the stress biomarker response such as salivary amylase content does not only depends on exercise intensity, but also RPE. References Mizuno T, Mizuno M. (2006). *Bulletin of Faculty of Education, Hokkaido University*, 99, 129-138. Yamaguchi M. (2007). *Folia Pharmacologica Japonica*, 129, 80-84. Kawashima S, Hagiwara K, Shimonagata S, Nomura J, Nozaki T. (2006). *Bulletin of Faculty of Education, Chiba University*, 54, 263-270.

#### ENDURANCE CYCLING EXERCISE INCREASES SERUM HEAT SHOCK PROTEIN 72 IN HUMANS

KAKIGI, R., NAITO, H., MURADE, S., YOSHIHARA, T., NAKAGATA, T., OZAKI, H., KATAMOTO, S.

JUNTENDO UNIVERSITY

**Introduction** Heat shock proteins (HSPs) play important physiological roles in various cells as a molecular chaperone. Some studies have shown that HSPs are released into the systemic circulation during exercise. Walsh et al. reported that extracellular HSP72 increases 30 and 60 min after treadmill running at 70% Vo<sub>2</sub>max. Suzuki et al. reported that plasma HSP72 concentration were elevated after Ironman triathlon race. However, the effect of endurance cycling exercise on extracellular heat shock protein 72 in human has not been established. **Purpose** To examine serum HSP72 after endurance cycling exercise in humans. **Methods** Recreationally male cyclists ( $n=25$ , age;  $42.7 \pm 11.7$  years, weight;  $65.2 \pm 7.1$  kg and Vo<sub>2</sub>peak;  $51.3 \pm 7.4$  ml·kg<sup>-1</sup>·min<sup>-1</sup>) volunteered and participated the endurance cycling race. Heart rate was recorded to estimate %Vo<sub>2</sub>peak during race. Before and immediately after race, blood sample were taken for determining blood lactate concentration and HSP72 concentration. HSP72 in serum were quantified by EIA methods. **Results** Mean exercise time was  $145 \pm 91$  min. In addition, estimated %Vo<sub>2</sub>peak during race was  $87.9 \pm 9.7\%$ . In addition, Serum HSP72 concentrations were signifi-

cantly increased after endurance cycling race (pre;  $0.52 \pm 0.47$  ng/ml, post;  $0.79 \pm 0.55$  ng/ml,  $p < 0.05$ ). Blood lactate concentrations were also significantly elevated after race. (pre;  $2.2 \pm 1.3$  mmol/l, post;  $4.6 \pm 2.4$  mmol/l,  $p < 0.05$ ). There was no relationship between serum HSP72 and blood lactate concentration, %Vo2max and exercise time. Discussion Previous studies showed that treadmill running and marathon increase extracellular HSP72 in humans. We also demonstrated that serum HSP72 was increased after endurance cycling exercise. Although cycling exercise is non-bearing weight and does not contain eccentric contractions, differences of exercise mode may not affect extracellular HSP72 during exercise. In addition, our data suggests that eHSP72 may constantly release into the systemic circulation during exercise, since eHSP72 concentrations were elevated after race regardless of exercise time. Conclusion Endurance cycling exercise increases serum HSP70 in humans.

#### **VISUALISATION OF GLUT4 LOCALISATION IN HUMAN SKELETAL MUSCLE WITH IMMUNOFLOUORESCENCE MICROSCOPY**

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**Introduction** Glucose transporter 4 (GLUT4) is an insulin and contraction responsive glucose transporter. Animal studies have shown that GLUT4 is primarily located in the membranes of intracellular vesicular organelles in the basal state. Upon stimulation these vesicular organelles translocate to and fuse with the sarcolemmal and transverse (T)-tubule cell surface membranes allowing glucose transport into skeletal muscle. We aimed to visualise the localisation of GLUT4 in human skeletal muscle in fasted conditions and to develop a method to quantify GLUT4 localisation, which could be used to investigate GLUT4 translocation in future studies. **Methods** A GLUT4 antibody was validated in experiments in GLUT4-GFP transfected L6 cells which showed strong colocalisation between GLUT4-GFP and GLUT4 antibody staining. GLUT4 localisation was subsequently investigated using immunofluorescence staining methods in skeletal muscle biopsies from 5 lean human males. T-tubules were stained using an antibody against the T-tubule-specific calcium channel DHPR, fibre type was determined using an antibody against myosin heavy chain type 1, and the cell basement membrane was stained with wheat germ agglutinin-350 or an antibody against collagen IV. Images were viewed using widefield immunofluorescence microscopy. **Results** GLUT4 staining in human skeletal muscle in basal conditions appears in type I and type II fibres as bright intracellular spots, which are particularly abundant in perinuclear and (sub)sarcolemmal regions. When fibres are oriented longitudinally a striated pattern of GLUT4 staining is observed, and co-staining with the T-tubule marker (DHPR) indicates association of GLUT4 with the T-tubule membranes. GLUT4 spot number and area in the immunofluorescence images obtained can be quantified in areas corresponding to sarcolemmal and cytosolic regions of the muscle fibre. T-tubule GLUT4 content can be measured as mean fluorescence intensity in the striations corresponding to the T-tubules. **Discussion** These results confirm previous rodent studies showing the subcellular localisation of GLUT4 in human skeletal muscle cells in basal conditions. The quantitation methods for immunofluorescence images introduced here will be used in future studies to investigate skeletal muscle GLUT4 translocation in response to feeding and exercise in insulin sensitive and insulin resistant humans.

#### **EFFECT OF ACUTE ECCENTRIC EXERCISE ON MUSCULAR MITOCHONDRIAL OXIDATIVE STRESS IN ELDERLY RATS**

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TOHO UNIVERSITY

**[Introduction]** Loss of skeletal muscle function with age caused by a reduction of muscle activity via disuse triggers increase of tissue oxidative stress. The mitochondrion is a major site for generating reactive oxygen species (ROS) that facilitates oxidative stress in tissue. It has been pointed out that ROS might be reduced by mitochondrial uncoupling protein 3 (UCP3). Aging decreases UCP3 protein content in muscle. But, it is not clear whether such UCP3 depression with aging induces an oxidative stress in elderly muscle. The aim of this study was to examine the effect of aging on muscular oxidative stress during acute exercise. **[Methods]** Male wistar rats (Young: 12wk, Elderly: 89wk) rats performed downhill running on a treadmill: Young (incline: -16 degree, 10m/min for 3hr); Elderly (incline: -7 degree, 8m/min for 1.5hr). Quadriceps muscles were removed 4 hours after exercise. Superoxide dismutase (SOD) and glutathione peroxidase (GPX) activities were determined. Protein content of uncoupling protein 3 (UCP3) and manganese superoxide dismutase (MnSOD) was also determined with western blotting. Nuclear and mitochondrial DNA was extracted and 8-hydroxy-2'-deoxyguanosine (8-OHdG) was determined in both nuclear and mitochondrial DNA as indices of oxidative stress. **[Results]** SOD activity tended to increase with age but was not affected by exercise. GPX activity was higher in Elderly than in Young and was reduced by the exercise in Young but not in Elderly. UCP3 protein content decreased with age and was reduced by the exercise in Elderly. MnSOD protein, located in mitochondria, greatly increased with age and was elevated with the exercise in Elderly. There was a positive correlation between UCP3 and MnSOD in Young ( $r = 0.87$ ). Oppositely, in Elderly there was a negative correlation between UCP3 and MnSOD ( $r = 0.80$ ). Content of 8-OHdG (DNA damage) was higher in Elderly than in Young in both nuclei and mitochondria. The exercise enhanced mitochondrial DNA damage in Young and Elderly. But there was no effect of exercise on nuclear DNA damage in either group. Mitochondrial DNA damage positively correlated with MnSOD ( $r = 0.75$ ) and negatively correlated with UCP3 ( $r = 0.77$ ) in Elderly, but no correlation was observed in Young. **[Discussion & Conclusion]** In this study, low intensity eccentric endurance exercise enhanced oxidative DNA damage in muscular mitochondria and induced expression of MnSOD in Elderly. UCP3 tended to decrease with age. This data indicates that lower levels of UCP3 might be related to increases in mitochondrial oxidative stress. This UCP3 reduction might lead to a differential contribution of MnSOD to mitochondrial DNA damage during exercise. This result suggests the importance of maintaining UCP3 content to reduce mitochondrial oxidative stress in aged muscle.

#### **HEART BIOCHEMICAL ASPECTS IN OBESE RATS SUBJECTED TO PHYSICAL DETRAINING**

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**INTRODUCTION** The practice of regular physical exercise is highly recommended for the treatment of heart disease, but little is known about the effect of detraining associated with a high fat diet on heart metabolism. **OBJECTIVE** The aim of this study was to analyze the effect of exercise training, of detraining and of the administration of a high fat diet (HFD) on body weight and levels of triglycerides (TG), total protein and DNA of the left ventricle of rats. **METHODOLOGY** Forty weanling rats (28 days) were fed up to 90 days of age with a commercial rat chow. From there, they were divided into four groups: control (C), sedentary rats fed semipurified AIN-93M diet (Reeves et al., 1996) from 90 to 160 days of age; High-Fat Diet (HFD) sedentary rats fed a semipurified diet containing 35% fat from 90 to 160 days of

age; Trained High-Fat Diet (THFD) rats exercised from 28 to 160 days of age, fed a diet containing 35% fat from 90 to 160 days; Detrained High-fat Diet (DHFD) rats exercised from 28 to 90 days, whose exercise training was suspended, fed a diet containing 35% fat from 90 to 160 days. The exercised groups were trained by swimming 80% of anaerobic threshold (AT), determined by the lactate minimum test performed every 25 days (Mello et al., 2010). RESULTS DHFD and HFD groups had higher body weight (g) (C:  $527.13 \pm 71.39$ ; HFD:  $575.81 \pm 68.57$ ; DHFD:  $575.78 \pm 62.25$ ; THFD:  $487.62 \pm 62$ , 1990) and heart TG concentrations (mg / g) (C:  $3.58 \pm 0.37$ , HFD:  $4.39 \pm 1.93$ ; DHFD:  $4.39 \pm 1.99$ ; THFD:  $3.46 \pm 9.92$ ) compared to C and THFD. No difference was found between the groups for: protein (mg/100 mg) (C:  $1.04 \pm 0.18$ , HFD:  $1.15 \pm 0.20$ ; DHFD:  $1.22 \pm 0.26$ ; THFD:  $1.09 \pm 0.31$ ), DNA (mg / g) (C:  $0.079 \pm 0.026$ ; HFS:  $0.078 \pm 0.013$ ; DHFD:  $0.078 \pm 0.019$ ; THFD:  $0.086 \pm 0.018$ ) and Protein / DNA ratio (C:  $14.37 \pm 4.76$ ; HFD:  $15.40 \pm 4.98$ ; DHFD:  $16.46 \pm 5.11$ ; THFD:  $12.98 \pm 3.64$  in the left ventricle. DISCUSSION AND CONCLUSION It was possible to induce obesity in adult rats by HFD without leading to heart hypertrophy and hyperplasia. Exercise training at 80% of LA reduced the weight gain induced by the high consumption of fat, as well as attenuated the accumulation of TG in the heart. REFERENCES REEVES et al. AIN-93 purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. J Nutr. v.123 p.1939-51, 1993. MELLO et al. Determination of anaerobic threshold in weanling rats by lactate minimum test.. In: 15th Annual Congress of the European College of Sport Science, 2010, Antalya. Book of Abstracts 15th Annual Congress of the European College of Sport Science, 2010. v. 15. p. 171-172.

### INFLUENCE OF EXERCISE ON PLASMA HOMOCYSTEINE LEVELS.

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INFLUENCE OF EXERCISE ON PLASMA HOMOCYSTEINE LEVELS. Maroto B, García-González C, Pedrero R, Benito PJ, Meléndez A, González-Gross M. ImFINE research group. Department of Health and Human Performance. Universidad Politécnica de Madrid (Spain). Introduction High levels of Homocysteine (Hcy) in plasma have been identified as a cardiovascular risk factor (Boushey, et al., 1995), relating hyperhomocysteinemia with cardiovascular diseases, venous thrombosis and disruption of the central nervous system and stroke, among others. In relation to physical exercise, the results are contradictory (Gelecek, et al., 2007). Some studies show a decrease in Hcy concentrations induced by exercise, others that physical exercise increases the levels of Hcy, or that there has been no effect. The aim of this research is to determine the influence of maximal intensity exercise of short duration and submaximal exercise of moderate intensity on plasma Hcy levels. Methods We studied 10 physically active male subjects (mean age:  $23.51 \pm 1.84$ ), who performed two treadmill tests: a maximal test with an average time of 14'14"; and a stable submaximal test of 40 minutes with an intensity of 65% of VO<sub>2</sub>max. Blood samples were taken immediately before and after each test. Concentrations of Hcy, Folate, and B12 were analysed. Physiological parameters were monitored during both tests, as heart rate and VO<sub>2</sub>max using a Polar S810 and a gas analyzer Jaeger Oxicon Pro, respectively. Results We found statistically significant increases ( $p < 0.05$ ) in plasma Hcy levels after the maximal test. After the submaximal test plasma Hcy levels were significantly higher ( $p < 0.001$ ) than before. Levels of Folate and B12 also significantly increased after both tests ( $p < 0.05$ ). A statistically significant inverse relationship ( $p < 0.05$ ) was found between Folate and tHcy levels. Discussion A comparison with other studies showed similar results in relation to the increase in Hcy during the submaximal exercise test. Those findings support our results. Furthermore, our findings related with Folate levels are similar with those found in other studies. Investigations also indicate that Hcy levels increase according to exercise intensity and duration, although there are no conclusive data (Gelecek, et al., 2007). Nevertheless, it can be said that both high intensity and moderate aerobic exercise are enough to increase plasma tHcy levels immediately after exercise in young, healthy and physically active men. Since the rise of these levels could be identified as a cardiovascular risk factor, its impact on health should be carefully studied. References Boushey, C. J., Beresford, S. A., Omenn, G. S., & Motulsky, A. G. (1995). A quantitative assessment of plasma homocysteine as a risk factor for cardiovascular disease. JAMA, 274, 1049-1057. Gelecek, N., Teoman, N., Ozdirenc, M., Pinar, L., Akan, P., Bediz, C., et al. (2007). Influences of acute and chronic aerobic exercise on the plasma homocysteine level. Ann Nutr Metab, 51(1), 53-58.

### CHANGE IN LACTATE ACCUMULATION AFTER ISOMETRIC EXERCISE TRAINING AND ITS RELATIONSHIP WITH REDUCED RESTING BLOOD PRESSURE

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Change in lactate accumulation after isometric exercise training and its relationship with reduced resting blood pressure Swaine, I. 1, Devereux, G.2, Wiles, J.1, Coleman, D.1. 1: CCCU (Canterbury, UK), 2: UAD (Dundee, UK) Introduction The purpose of this study was (a) to assess lactate accumulation during incremental isometric exercise (b) to quantify the shifts in this lactate accumulation after isometric training and (c) to relate the training-induced changes in lactate accumulation to the reductions in resting blood pressure. Methods 11 male subjects participated in a 4 week isometric training study using double-leg exercise. Before and after the training resting blood pressure was determined (SBP, DBP and MAP). A discontinuous incremental isometric exercise test was also performed, during which finger-prick blood sampling was used to determine blood lactate (La) at each intensity of exercise. From this, peak lactate was identified (L<sub>peak</sub>) and from the pre- and post- training exponential curves it was possible to quantify shifts at 2, 3 and 4mmol.L<sup>-1</sup> blood lactate. Results There were reduction in mean SBP, DBP and MAP of ( $-4.9 \pm 6.3$  mmHg,  $p = 0.01$ ;  $-2.6 \pm 2.3$ ,  $p = 0.001$ ; and  $-2.6 \pm 3.0$  mmHg,  $p = 0.01$  respectively) and a mean shift in the lactate curve, from  $135.60 \pm 25.27$  to  $155.22 \pm 33.55$  mV and from  $114.43 \pm 21.70$  to  $131.03 \pm 27.07$  mV for 4 and 3 mmol.L<sup>-1</sup> respectively. There was no relationship between shifts in lactate curves and reductions in resting blood pressure. However, training intensity, when expressed relative to lactate peak (%L<sub>peak</sub>), was strongly correlated with reduction in resting SBP ( $r = 0.78$ ;  $p < 0.01$ ) and MAP ( $r = 0.75$ ;  $p < 0.01$ ) in individuals. Discussion These findings using double-leg isometric exercise showed that (a) lactate accumulates in an exponential fashion during incremental isometric exercise (b) 4 weeks of training caused significant shifts in the lactate accumulation curves and (c) reductions in resting blood pressure are not related to changes in lactate metabolism but they are strongly related to training intensity, when it is expressed relative to pre-training peak lactate. This raises the possibility that lactate, or some metabolite associated with it, might provide the stimulus for the reductions in resting blood pressure observed after isometric training.



## THE IMPORTANCE OF THE DETECTION OF BOTH MACROSCOPIC AND MICROSCOPIC CHARACTERISTICS OF SPONTANEOUS PHYSICAL ACTIVITY IN POST-MENOPAUSE

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**Introduction** The analysis of spontaneous physical activity is important to characterise the lifestyle and to promote behavioural modifications. Usually, the attention of the analysis is focused on macroscopic characteristics of daily movement, such as total energy expenditure (DEE m/die), daily steps (STEPS m/die), mean daily intensity of physical activities (METs m/die), and both time (TPA m/die) and energy spent (PAEE m/die) on physical activities at moderate intensity. Therefore, literature indicates that it is also important the way through which, for example, TPA is totalized. The aim of our study was to investigate the importance of the detection of microscopic characteristics of daily movements, during spontaneous physical activity analysis, in post-menopause. **Methods** Sixty-two post-menopausal women ( $55.71 \pm 4.94$  yrs) were enrolled in the study. Body composition was assessed by electrical bioimpedance technique, while the SenseWear Pro3 Armband (Bodymedia, Pittsburg, PA) measured daily physical activities characteristics. The device gives information about mean daily values of DEE, STEPS, METs, TPA and PAEE. By our software we calculated the numbers of total daily bouts of moderate intensity physical activities, and the number of those lasting almost 3 (B3), 5 (B5) and 10 (B10) consecutive minutes. Blood was collected to measure plasma lipoproteins, insulin and glucose. A dietitian estimated dietary habits and calories intake. **Results** Pearson's correlations showed METs m/die and TPA m/die inversely correlated with body composition and plasma triglycerides, while their correlations with fasting glucose to insulin ratio (G/I) were direct. Partial correlation, performed controlling for METs m/die, TPA m/die and daily energy intake, showed BMI, WC, fat mass and visceral fat inversely correlated with both B10 and mean duration of each bout. On the contrary, they were found directly correlated with the number of those bouts of moderate intensity physical activities lasting minus than 3 minutes. Plasma HDL-cholesterol has been found positively correlated with B10; the same was for G/I. **Discussion** Together with macroscopic characteristics of spontaneous physical activity (i.e. METs m/die and TPA m/die), microscopic characteristics (i.e. B10) are important for body composition, insulin sensitivity and plasma HDL-cholesterol of post-menopausal women that are not under controlled diet and physical exercise program. The analysis of microscopic characteristics of daily movement should be always carried out in order to better understand the physiological and pathological conditions of the persons concerned, and the effectiveness of their spontaneous physical activity.

## Poster presentations

### PP-PM53 Sports Nutrition: Supplements 4

## INFLUENCE OF A VITAMIN SUPPLEMENTATION ON MAXIMAL MUSCULAR PERFORMANCE DURING A STRENGTH-TRAINING PROGRAM IN MASTER ATHLETES

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**INFLUENCE OF A VITAMIN SUPPLEMENTATION ON MAXIMAL MUSCULAR PERFORMANCE DURING A STRENGTH -TRAINING PROGRAM IN MASTER ATHLETES** Louis J1,2, Hausswirth C1, Bieuzen F1, Brisswalter J2 **Laboratory of human motricity, education and health, University of Nice-Sophia Antipolis, France** 2Research department, National institute of sport, expertise, and performance (INSEP), Paris, France **Introduction:** Intensive physical training may lead to severe damages in muscles fibers, inducing fatigue and bad recovery capacities (Barnett, 2006). Micronutritional supplementations are one of the most used strategies to enhance muscular recovery in young athletes (Gauché et al. 2007). However, very few information is available for master athletes for whom the age could accentuate the effect of exercise in damaging muscles (Close et al. 2005). Within this framework, the purpose of this study was to analyze the efficacy of a vitamin supplementation in enhancing maximal muscular performance in master athletes during a strength-training program. **Methods:** Twenty well-trained master athletes took part in a 3 weeks strength-training program and in a same time in a micronutritional supplementation program. At first, master athletes were assigned in a double-blind process to one of the two treatment groups: vitamin supplementation (Isoxan Force®, Vit group) or placebo supplementation (Pl group). Three times a week, subjects had to perform 10x10 bilateral knee extensions at 70% 1RM, separated by 3min rest, on a leg extension device (Technogym, Gambettola, Italy). Before and after the training period, blood markers of muscle damages (creatine kinase, CK, and tumor necrosis factor- $\alpha$ , Tnf- $\alpha$ ) were assessed. Before each training sessions knee extensors' maximal voluntary isometric strength was recorded (Biodex S3, Shirley, NY, USA). **Results:** After the training period, knee extensor's maximal voluntary strength significantly increased (+9,7% in Vit group versus +6,3% in Pl group) in both groups. However, this increase was more pronounced in Vit group than in Pl group and strength recovery between training sessions was improved. Moreover, significant differences in blood markers of muscle damages were found between groups at the end of the training program. CK concentration increased in Pl group (+58,5%) whereas it decreased in Vit (-34%), and Tnf- $\alpha$  concentration increased in Pl group (+87%), whereas it was only a trend in Vit group (+14,3%). **Conclusion:** In all subjects, strength production capacity has significantly increased after the 3 weeks of training. Moreover, the micronutritional supplement is associated with a lower muscle inflammation suggesting an improvement of the beneficial effect of strength training with vitamin and mineral supplementation. **References:** Barnett A. (2006) Sports Med, 36(9):781-96. Close GL, Kayani A, Vasilaki A, McArdle A. (2005) Sports Med, 35(5):413-27. Gauche E, Lepers R, Rabita G, Leveque JM, Bishop D, Brisswalter J, Hausswirth C. (2006) Med Sci Sports Exerc, 38(12):2110-7.

## LOWER-VOLUME EXERCISE TRAINING AND BRANCHED-CHAIN AMINO ACID INTAKE PREVENT MUSCLE DEGRADATION DURING IMMOBILIZATION

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**Lower-volume exercise training and branched-chain amino acid intake prevent muscle degradation during immobilization** Fujioka M1, Hamaoka T2, Osada T1, Murase N1, Kime R1, Kurosawa Y3, Ichimura S4, Homma T5, Ueda C6, Esaki K7, Ohmori F8, Yamaguchi K9, Katsumura T1 **1) Tokyo Medical University, 2) Ritsumeikan University, 3) University of Cincinnati, 4) Tokyo University of Science, 5) Japan Institute of Sports Sciences, 6) Meisei University, 7) Shiga University, 8) Kokugakuin University, 9) Yamanashi Gakuin Junior College** **Introduction** In our previous research, muscle functions declined without a decrease in muscle cross-sectional area after a 3-week forearm immobilization (3W-IMM) (Kitahara et al., 2003) and the low-volume endurance training twice weekly was effective in preventing IMM-

induced declines in muscle endurance (Homma et al., 2009). In a previous study, branched-chain amino acids (BCAA) supplementation has beneficial effects on decreasing exercise-induced muscle damage. The purpose of this study was to investigate the effect of a lower-volume training once weekly with BCAA intake on muscle functions and protein turnover during 3W-IMM. Methods Twelve healthy male subjects with the 3W-IMM were designated into BCAA (100mg/kg/day) or placebo daily-intake group in a double blind manner. Both groups performed strength (70% of maximum voluntary contraction: MVC, 10 repetitions) and endurance (30% MVC, 1 contraction every seconds until exhaustion) grip exercise training once weekly during the 3W-IMM period. Blood BCAAs and aromatic amino acids (tyrosine and phenylalanine) were evaluated before and 3 hours after the acute supplementation test both pre- and post-3W-IMM. Moreover, MVC, and forearm circumference were measured. Muscle endurance and oxidative capacity were evaluated using 31-phosphorus magnetic resonance spectroscopy and near-infrared continuous wave spectroscopy, respectively. Results MVC significantly decreased (-9.9% for BCAA group and -9.7% for placebo group) and muscle endurance and oxidative capacity did not change in both groups after 3W-IMM. Blood BCAAs were significantly elevated and aromatic amino acids, significantly lowered after acute supplementation test both pre- and post-3W-IMM in the BCAA group. Discussion BCAA intake during 3W-IMM did not show the functional and morphological effect on muscle, but it seems that the lower-volume training itself was effective on functional deterioration. It is reported that BCAA intake decreased the efflux of the aromatic amino acids from the leg, indicating a decreased net rate of protein degradation during exercise (MacLean et al., 1994). Therefore, it is suggested that acute BCAA intake may have prevented muscle degradation pre- as well as post-immobilization. References Kitahara et al. (2003). *Med Sci Sports Exerc*, 35, 1697-702. Homma et al. (2009). *Acta Physiol*, 197, 313-320. MacLean et al. (1994). *Am J Physiol*, 267, E1010-1022.

### LEUCINE-RICH DIET AND EXERCISE CHANGED GENE EXPRESSION OF MUSCLE GLYCOLITIC ENZYMES IN TUMOUR-BEARING RATS.

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UNICAMP

LEUCINE-RICH DIET AND EXERCISE CHANGED GENE EXPRESSION OF MUSCLE GLYCOLITIC ENZYMES IN TUMOUR-BEARING RATS. Salomão E.M., Toneto A.T., Silva G.O., Gomes-Marcondes M.C. Laboratory of Nutrition and Cancer, Department of Physiology and Biophysics, IB, UNICAMP, Campinas, SP, Brazil. Introduction Cancer-cachexia state promotes intense involuntary weight loss resulting mainly in muscle protein depletion due to increase in proteolysis and/or decreased protein synthesis. Leucine can be used as energy source by skeletal muscle or acts as a cell signaling. Physical exercise promotes an increased glucose uptake, reducing the glucose and insulin levels, which supplies less substrate to tumour cells (Inui, 1999). Methods We evaluate muscle glycolytic enzymes gene expression and muscle glucose and lactate receptors in rats submitted to aerobic exercise and leucine-rich diet and distributed into 8 groups: C-control rats; TC-trained, W- Walker 256 tumor-bearing; TW-trained tumor-bearing, L-rats fed leucine diet, TL-trained rats fed leucine diet; LW-tumor-bearing fed leucine diet; TLW-trained tumor-bearing fed leucine diet (Salomão et al., 2010). The results are expressed as optical density (arbitrary unit). Results The gene expression of glucose transporter Glut-4 in the gastrocnemius muscle reduced significantly only in tumour groups (W=44.0+11.0; TW=47.7+5.7) compared to leucine-rich diet groups (LW=76.0+20.1; TWL=62.2+11.2). Hexokinase phosphorylates the glucose uptake into glucose-6-phosphate and has its gene expression increased significantly in trained groups and in all tumour groups (TC=69.6+8.3; W=63.6+4.3; TW=51.3+19.7; LW=93.9+7.8), except in TWL(39.0+12.4) vs C(31.8+2.8) group. The pyruvate dehydrogenase converts pyruvate into acetyl-CoA, and this enzyme gene decreased in TWL(47.2+14.9) compared to TC(134.6+17.7) and L(140.7+0.9) and slightly increased in W(116.7+7.6) and LW(102.9+8.4). The conversion of L-lactate and NAD<sup>+</sup> to pyruvate and NADH in the final step of anaerobic glycolysis in the gastrocnemius muscle is catalyzed by lactate dehydrogenase, which gene expression increased in W(67.9+12.9) vs C(21.3+5.2) group. The MCT1 and 4 (monocarboxylate transporter) transport lactate in and out of muscle cells. The gene expression of MCT1, related oxidative muscle fibers, in the gastrocnemius muscle reduced significantly in tumour-trained group (TW=33.0+5.6; TWL=29.8+6.3) compared to W(67.2+4.3). Discussion Tumour growth produced deleterious effects in host leading to the cachectic state, since reduced the muscle glucose transporter diverting this substrate to neoplastic cell metabolism. Leucine supplementation combined with exercise benefited host tissues, as shown in metabolism of glucose by enzyme gene expression, improving host tissue in detriment of tumour growth. References Inui A. (1999) *Cancer Res* 59: 4493-450. Salomão EM, Toneto AT, Silva GO, Gomes-Marcondes MC. (2010) *Nutr Cancer*. Nov;62(8):1095-104.

### PHYSICAL EXERCISE AND LEUCINE-RICH DIET IMPROVES THE GLUCOSE METABOLISM IN TUMOR-BEARING RATS.

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UNICAMP

PHYSICAL EXERCISE AND LEUCINE-RICH DIET IMPROVES THE GLUCOSE METABOLISM IN TUMOR-BEARING RATS. Salomão E.M., Toneto A.T., Silva G.O., Gomes-Marcondes M.C.C. Nutrition and Cancer, Department of Physiology and Biophysics, IB, UNICAMP, Campinas, SP, Brazil. Introduction Cancer patients often have hypoglycaemia associated to reduced host-tissue glucose metabolism. However, the anaerobic glycolysis that occurs in neoplastic cells, due to high glucose oxidation, leads to energy waste and catabolism of store depots from host, converting lactate, alanine and glycerol into glucose, by Cori cycle, increasing energy deficit in cachectic state. Methods We analyzed serum and gastrocnemius muscle in Wistar rats submitted to aerobic exercise and leucine-rich diet and distributed into 8 groups: C-control rats; TC-trained, W- Walker tumor-bearing; TW-trained tumor-bearing, L-rats fed leucine diet, TL-trained rats fed leucine diet; LW-tumor-bearing fed leucine diet; TLW-trained tumor-bearing fed leucine diet. Results The serum glucose content reduced in tumor-bearing groups (W=102.2+15.3mg/dL, LW=90.9+17.3, TWL=97.7+21.6) when compared to control groups (C=133.0+6.8; TC=181.3+13.7; L=151.6+17.8; TL=156.1+16.8). Despite having cancer, the TW(128.6+20.8) had similar glycaemia as the control group. Insulin levels decreased in all tumor-bearing groups (W=60.29+2.9pg/mL; TW=46.90+3.8; LW=42.50+7.0 TWL=55.48+6.3) compared to control (C=147.6+48.6; TC=173.8+43.6; L=126.7+61.6; TL=54.53+7.3) and serum glucagon levels increased in tumor groups (W=7.3+3.6pg/mL; TW=10.5+5.7; LW=6.0+1.1; WL=6.5+2.5; control groups: C=0.8+0.2; TC=0.8+0.2; L=0.6+0.2; TL=0.8+0.2); although, this increase was lower in LW and TLW groups. Muscle cell glycogen content reduced in tumor-bearing group (W=1.3+0.1 arbitrary unit from histological analyses, LW=1.8+0.3) when compared to other groups (C=2.8+0.1; TC=3.1+0.4; TW=3.1+0.1; L=6.3+0.3; TL=7.1+0.4; TWL=2.8+0.6). Discussion We observed decrease in serum glucose in tumor-bearing groups, justifying the high glucose utilization preferentially by neoplastic cells. In experimental animals, hypoglycaemia is common since glucose is the main energy substrate used by tumor growth (Tisdale, 1997). Several studies with experimental tumors have shown a decreased insulin secretion in response of tumor effects, providing glucose supply to cancer cells, as well as increasing peripheral resistance to insulin (El Razi et al., 1996). The hormonal changes due to tumor growth showed a compensatory balance between anabolic and catabolic hormones, since the glycaemia and muscle glycogen in TW and TLW was maintained under normal values, despite being leucine-rich diet treated. The exercise diverted the

substrate from tumor cells toward to skeletal muscle, decreasing the neoplastic energy supply in order to prevent muscle energy storage. References Tistale JM. (1997) Nutrition 13: 1-7, 1997. El Razi Neto S, Zorn TM, Curi R, Carpinelli A.R. (1996) Am. J Physiol. 271: 804-809.

### **EFFECT OF SUPPLEMENTATION OF CRUDE MAGNOLIA AND ENDURANCE TRAINING ON LIVER IL-6, TAC AND GLYCOGEN CONCENTRATIONS IN MALE RATS.**

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**Introduction:** Study on Effect of supplementation of crude magnolia and endurance training on liver IL-6, TAC and glycogen concentrations in male rats. **Methods:** Twenty one adult Wistar male rats (6–8 weeks old, 142.19±12.733 g) were used for this study. Animals were divided into three groups including: control (placebo), experimental-1(placebo+training) and experimental-2 (magnolia+training). Training group was given exercise for 6 weeks (at 25 m/min, 0% grade, for 60 min/day, 5 days/week). Rats were sacrificed 72 h after the last session of exercise and 4 h fasting. **Results:** IL-6 concentrations was significantly increased in experimental-1 group and decreased in experimental-2 group when compared with control group that this decrease not significant. Liver TAC and glycogen concentrations were significantly increased in experimental-2 group and decreased in experimental-1 group when compared with control group that also this decrease not significant. **Discussion:** findings of Present study indicated that supplementation of crude magnolia and endurance training can play protective role against oxidative and inflammatory agents by increase of liver TAC and glycogen stores. **Keywords:** IL-6, TAC, Glycogen, extraction of magnolia, Endurance training **References** 1. Chiu JH, Wang JC, Lui WY, Wu CW, Hong CY. Effect of magnolol on in vitro mitochondrial lipid peroxidation and isolated cold-preserved warm-reperfused rat livers. J Surg Res. 1999; 82:11-6. 2. Lo YC, Teng CM, Chen CF, Chen CC, Hong CY. Magnolol and honokiol isolated from Magnolia officinalis protect rat heart mitochondria against lipid peroxidation. Biochem.Pharmacol. 1994; 47:549-53. 3. Chen SC, Chang YL, Wang DL, Cheng JJ. Herbal remedy magnolol suppresses IL-6-induced STAT3 activation and gene expression in endothelial cells. Br J Pharmacol. 2006; 148:226–32. 4. Lee J, Jung E, Park J, Jung K, Lee S, Hong S, Park et al. Anti-inflammatory effects of magnolol and honokiol are mediated through inhibition of the downstream pathway of MEKK-1 in NF-kB activation signaling. Planta Med. 2005; 71:338–43. 5. Sohn EJ, Kim CS, Kim YS, Jung DH, Jang DS, Lee YM, Kim JS. Effects of magnolol (5,5'-diallyl-2,2'-dihydroxybiphenyl) on diabetic nephropathy in type 2 diabetic Goto-Kakizaki rats. Life Sciences. 2007; 80:468–75.

### **EFFECT OF 8-WEEKS OF EICOSAPENTAENOIC AND DOCOSAHEXAENOIC ACID SUPPLEMENTATION ON IMPROVEMENT OF EXERCISE ECONOMY DURING AEROBIC EXERCISE**

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**Introduction** Based on the effects of omega-3 fatty acid such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) on reduction of blood viscosity, it could improve aerobic performance by increasing oxygen supply to tissue (Woodcock et al., 1985). However, the effects of ingestion of omega-3 fatty acid on oxygen uptake (VO<sub>2</sub>) during exercise has not yet confirmed (Brilla et al., 1990; Raastad et al., 1997). Therefore, the purpose of this study is to investigate the effects of continuous supplementation of EPA and DHA on energy supply during aerobic exercise. **Methods** Twenty healthy physically active college male were divided into two groups (n=10 in each group, Active and Placebo groups). Before 8-weeks of ingestion of either EPA/DHA capsules containing 3.6 g/day of fish oil (Active group; ACT) or capsules containing 3.6 g/day of medium-chain triglyceride (Placebo group; PLA), they measured maximal oxygen uptake (VO<sub>2</sub>max) and relationship between blood lactate concentration (BLA) and submaximal exercise intensity using cycle ergometer. They also measured oxygen uptake during submaximal exercise (two sessions of 30-min exercise at intensity levels equivalent to 2 mM and 3 mM of BLA based on the relationship). After 8-weeks ingestion, they measured again VO<sub>2</sub>max and submaximal VO<sub>2</sub> at two sessions of 30-min same absolute intensity levels. Before and after 8-weeks ingestion, blood samples were used for the determination of EPA, DHA and hematocrit. **Results** After 8-weeks ingestion, EPA (148%, p<0.001) and DHA (13%, p<0.001) in the red blood cell membrane of ACT was significantly increased compared to pre-ingestion, but these of PLA did not change. In ACT, the negative linear correlation (r=0.750, p<0.05) was detected between the differences of EPA in RBC versus whole VO<sub>2</sub> during submaximal exercise between before and after 8-weeks ingestion. **Discussion** These results suggest that increased EPA in RBC after 8-weeks ingestion could influence the energy supply during steady state submaximal exercise and induce improved exercise economy. The major factor seems to be a more efficient oxygen supply to exercise muscle due to reduced blood viscosity. The influence of DHA on VO<sub>2</sub> was not detected in this study. Therefore, EPA is the important determinant of exercise economy during steady state submaximal exercise. **References** Woodcock BE., Smith E., Lambert WH. et al. (1984). Br Med J, 288, 592-4. Brilla LR., Landerholm TE. (1990). J Sports Med Phys Fitness, 30, 173-9. Raastad T., Hostmark AT., Stromme SB. (1997). Scand J Med Sci Sports, 7, 25-31

### **SUPPLEMENTATION WITH VITAMIN C ATTENUATES OVERLOAD-INDUCED SKELETAL MUSCLE HYPERTROPHY**

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**Introduction** Physical exercise generally provides beneficial effects on human health. On the other hand, it generates reactive oxygen species (ROS) in skeletal muscle and other organs, which gives rise to undesirable reactions with biological substances, i.e., DNA oxidation, fat peroxidation and protein carbonyl. Although supplementation with antioxidants is recommended for individuals regularly performing exercise, it has recently been shown that ROS acts not only as a harmful substance but also as an important signal mediator. In fact, antioxidants supplementation has been shown to attenuate endurance training-induced muscle adaptation and gene expression (Gomez-Cabrera et al., 2008; Ristow et al., 2009). However, it remains unclear whether antioxidants such as vitamin C attenuate the hypertrophic response of skeletal muscle to overload. Thus we investigated the effect of vitamin C supplementation on overload-induced skeletal muscle hypertrophy in the rat. **Methods** Male Wistar rats were randomly assigned into 3 groups: sham operated (SHA group; n = 8), placebo (PLA group; n = 8) and vitamin C (VC group; n = 9). For PLA and VC groups, surgical removal of the gastrocnemius and soleus muscles was performed on the right hindlimb with sham surgery on the contralateral limb, inducing chronic overload on the plantaris muscle for 14 days. SHA group was subjected to sham surgery for both hindlimbs. VC group was orally administered with a large amount of vitamin C (500 mg/kg) once a day for 14 days. **Results** There was no significant difference in body weight between PLA and VC groups. In PLA and VC groups, the plantaris muscle of overloaded limb showed a significant increase (P < 0.05) in wet weight when

compared with those in SHA group. However, the increase in muscle wet weight in VC group was significantly smaller ( $P < 0.05$ ) than that in PLA group. Discussion The results indicated that supplementation of vitamin C attenuated overload-induced skeletal muscle hypertrophy. Since vitamin C is a non-specific antioxidant, we believe that this result is due mainly to suppression of ROS generation. Although the mechanisms underlying vitamin C-mediated attenuation of skeletal muscle hypertrophy remain unclear, ROS would play an important role in overload-induced skeletal muscle hypertrophy. References Gomez-Cabrera MC, Domenech E, Romagnoli M, Arduini A, Borrás C, Pallardo FV, Sastre S, Viña J. (2008). American Journal of Clinical Nutrition, 87(1), 142-149. Ristow M Zarse K, Oberbach A, Klötting N, Birringer M, Kiehntopf M, Stumvoll M, Kahn CR, Blüher M. (2009). Proceedings of the National Academy of Sciences of the United States of America, 106(21), 8665-8670.

### THE EFFECT OF A VITAMIN C+E SUPPLEMENT AND A COMBINED OMEGA-3 AND PROTEIN SUPPLEMENT ON RECOVERY FROM A BOUT OF RESISTANCE EXERCISE

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The effect of a vitamin C+E supplement and a combined omega-3 and protein supplement on recovery from a bout of resistance exercise Hamarstrand, H.1, Paulsen, G.1, Raastad, T.1 1: NSSS (Oslo, Norway) The generation of free radicals (RONS) in the working muscles during resistance exercise seems to be important for cell signalling and the concomitant increase in rate of protein synthesis. Consequently, intake of high dosages of antioxidants may inhibit muscle growth by reducing the oxidative stress during exercise. On the other hand, increased intake of antioxidants may reduce some of the negative stress on muscle structures and thereby increase the rate of recovery. In this study we aim to investigate some of the acute effects of vitamin C and E on recovery from a bout of resistance exercise. Eleven subjects (8 men and 3 women;  $27 \pm 7$  years) were recruited from an ongoing 12 week strength training intervention with vitamin C and E, combined omega-3 and protein (Smartfish® recovery drink) or placebo supplementation (more subjects are currently being enrolled). The subjects performed a maximal voluntary isometric contraction (MVIC, knee-extension) before (-15min) and after (10 min and 24 h) a bout of 4x10RM of leg press and knee-extension (1 min between sets). 500 mg vitamin C and 117.5 mg vitamin E, Smartfish® (7 g of protein) or placebo supplements were taken 3 h before exercise and again half way into the exercise bout. Biopsies were collected before exercise and 80 and 130 min after exercise. Protein measurements of p70, RPS6 and eEF2 phosphorylation are currently being conducted. MVIC was decreased by  $24 \pm 9\%$  in the vitamin C+E group 10 min after exercise and recovered to  $11 \pm 2\%$  below baseline 24 h after exercise. For the Smartfish group the decreases were:  $23 \pm 11\%$  and  $2 \pm 8\%$ , and for the placebo group:  $15 \pm 8\%$  and  $4 \pm 5\%$ , 10 min and 24 h after exercise, respectively. The preliminary data indicate that recovery after a bout of resistance exercise is somewhat slower in subjects receiving vitamin C and E, compared to the combined omega-3 and protein supplement and placebo. The addition of more subjects in these analysis and the ongoing measurements of the phosphorylation of kinases related to protein synthesis might explain the apparent differences in recovery of muscle function between groups.

### VITAMIN C AND E SUPPLEMENTATION DOES NOT INHIBIT IMPROVEMENTS IN CARDIOPULMONARY FITNESS INDUCED BY ENDURANCE TRAINING

PAULSEN, G., HANSEN, J., SVEEN, O., RØNNESTAD, B.R., SKAUG, A., HALLÉN, J., RAASTAD, T.

NORWEGIAN SCHOOL OF SPORT SCIENCE

Vitamin C and E supplementation does not inhibit improvements in cardiopulmonary fitness induced by endurance training Paulsen, G.1, Hansen, J.2, Sveen, O.3, Rønnestad, B. R.2, Skaug, A.3, Hallén, J.1, Raastad, T.1 1: NSSS (Oslo, Norway), 2: LUC (Lillehammer, Norway), 3: ØUC (Halden, Norway) Vitamin C and E supplementation has recently been found to inhibit adaptations to endurance training in some studies (Gomez-Cabrera et al., 2008; Ristow et al., 2009), but not in others (Yfanti et al., 2010). We aimed to test the hypothesis that high dosages of exogenous antioxidants eliminate some of the oxidative stress necessary to initiate adaptation processes after endurance exercise training. Twenty-three, young, endurance trained subjects (10 females and 13 males;  $23 \pm 4$  years,  $VO_{2max} = 52 \pm 9$  ml/(kgxmin)) were randomized to receive vitamin C and E (1000 mg + 235 mg pr. day;  $n=12$ ) or placebo supplementation ( $n=11$ ) in a double-blinded fashion. All subjects followed the same training program for 11 weeks with 3-4 sessions per week. The exercise consisted of 30 and 60 minutes continuous running sessions at 80-90% and 70-85% of HRmax, respectively, as well as sessions with 4 and 6 minutes intervals (x4-6) at  $>90$  of HRmax.  $VO_{2max}$  was measured and the beep-test was conducted before and after the 11 weeks of training. Biopsies from m. vastus lateralis were collected before and after the training period.  $VO_{2max}$  increased by  $5.1 \pm 3.9\%$  in the C+E vitamin group and  $5.5 \pm 4.1\%$  in the placebo group ( $p < 0.001$ ). The performance in the beep-test was improved by  $9.2 \pm 10.4\%$  and  $11.6 \pm 15.3\%$  in the C+E vitamin group and the placebo group, respectively ( $p < 0.05$ ). No group differences were found in these parameters. We are currently analyzing the biopsies for changes in endogenous antioxidant systems and markers for mitochondrial biogenesis, as well as capillarization. A mixed running endurance training program increased cardiopulmonary fitness in already trained individuals, and there were no detectable effect of vitamin C and E supplementation. Thus, intake of large dosages of vitamin C and E seem not to hamper increases in  $VO_{2max}$  or the beep-test. Potential effects in the exercised muscles are under examination. References: Gomez-Cabrera MC, Domenech E, Romagnoli M, Arduini A, Borrás C, Pallardo FV, Sastre J, & Vina J (2008). Am J Clin Nutr 87, 142-149. Ristow M, Zarse K, Oberbach A, Klötting N, Birringer M, Kiehntopf M, Stumvoll M, Kahn CR, & Blüher M (2009). Proc Natl Acad Sci U S A 106, 8665-8670. Yfanti C, Akerstrom T, Nielsen S, Nielsen AR, Mounier R, Mortensen OH, Lykkesfeldt J, Rose AJ, Fischer CP, & Pedersen BK (2010). Med Sci Sports Exerc 42, 1388-1395.

### PHYSICAL ACTIVITY, BODY COMPOSITION AND ENERGY CONSUMPTION IN UNIVERSITY STUDENTS

ARABACI, R., ERDEN, S., KORKMAZ, N.H., CANKAYA, C., KORKMAZ, F., YILDIZ, H.

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Introduction Today, in many countries around the world dramatic increase obesity, bone disorders, cardiovascular (CVD) and some cancer diseases. Physical activity and dietary intake have preventive role on these diseases. Therefore, the aim of this study was to determine ambulatory activity, body composition and energy consumption in university students and investigate relationship between these components. Methods A total of 914 Turkish university female ( $n=441$ , age  $21.1 \pm 1.6$  years) and male students ( $n=473$ , age  $22 \pm 1.9$  years) participated in present study. Pedometer determined number of daily step method used to assessment physical activity of subjects. One week number of daily steps was measured by YAMAX PW 610 pedometer. Body composition was analyzed by Bio-electrical Impedance method (Tanita BC-418MA). The subjects recorded a weekly food intake. Mean energy consumption was determined by nutrition and diet

computer program (BEBIS 6). Results Mean  $\pm$  SS of daily step number, BMI, energy intake, BMR, percentage body fat, fat mass, free fat mass and total body water in female and male students were  $7981 \pm 3048$  steps $\cdot$ day $^{-1}$  and  $8509 \pm 3139$  steps $\cdot$ day $^{-1}$  ( $p > 0.05$ ),  $20.6 \pm 2.9$  kg $\cdot$ m $^{-2}$  and  $22.7 \pm 2.6$  kg $\cdot$ m $^{-2}$  ( $p > 0.05$ ),  $1548 \pm 661$  kcal $\cdot$ day $^{-1}$  and  $1559 \pm 715$  kcal $\cdot$ day $^{-1}$  ( $p > 0.05$ ),  $1445 \pm 317$  kcal $\cdot$ day $^{-1}$  and  $1859 \pm 328$  kcal $\cdot$ day $^{-1}$  ( $p < 0.05$ ),  $19.2 \pm 6.6$  % and  $10.5 \pm 5.7$  %,  $11.4 \pm 5.1$  kg and  $7.7 \pm 4.9$  kg ( $p < 0.05$ ),  $46.8 \pm 6.6$  kg and  $63.2 \pm 7.1$  kg ( $p < 0.05$ ),  $34.4 \pm 5.3$  kg and  $46.1 \pm 6.3$  kg ( $p < 0.05$ ), respectively. Daily step number was not significantly correlated with BMI, fat % and energy consumption ( $r = .080$ ,  $r = -.072$ ,  $r = .024$ , respectively,  $p > 0.01$ ). Daily step number was inversely correlated with right leg and left leg fat percentage ( $r = -.110$  and  $r = -.104$ , respectively,  $p < 0.05$ ). Discussion From 1960s in Japan achieving 10000 steps $\cdot$ day $^{-1}$  gaining popularity with the media and practice. Tudor Locke and Bassett classify 'somewhat active' healthy adults that pedometer-determined ambulatory activity 7500-9999 steps $\cdot$ day $^{-1}$ . According this classify subjects of present study were somewhat active. Information about associations between daily step number and body composition variables is more limited. In some studies was stressed that daily step number was inversely correlated with body composition parameters such BMI and body fat percentage. In present study daily step number was not significantly correlated with BMI and body fat percentage, however there was inversely significant correlation between daily step number and leg (both) fat percentage. In female subjects energy intake and BMR was similar, but in male subjects BMR was high than energy intake. As a result, we say that both female and male university students should increase physical activity and male university student intake more energy. References 1. Arabacı R. (2010). Journal of Medical Sciences, 30 (3), 985-994. 2. Tudor-Locke C and Bassett DR. (2004). Sports Medicine, 34 (1), 1-8. 3. Gilson N, McKenna J, Cooke C and Brown W. (2007). Preventive Medicine, 44(2), 167-169.

## MARGINAL VITAMIN D INTAKE IN ELITE ATHLETES

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Introduction Diet intake in athletes must ensure optimal health and athletic performance. Protein (P), carbohydrate (CH) and energy intake have been related to physical performance. Moreover, vitamin D intake may influence athletic performance, and it has been associated with bone and muscle health. In recent years, the number of diseases associated with vitamin D deficiency has been growing (Holick, 2007). The aim of this work was to analyze diet composition and describe vitamin D and calcium intake in elite athletes competing in three different events: fast events (FE), middle distance (MD) and long distance (LD) runners. Methods Participants were 81 Spanish elite athletes (45 females, 36 males; 22 FE, 30 MD, 29 LD). Group characteristics were similar for age ( $23.8 \pm 4.9$ ) and height ( $1.73 \pm 0.09$ ), but weight ( $70.0 \pm 13.1$ ;  $60.4 \pm 8.3$ ;  $57.8 \pm 6.3$ ) and BMI were higher ( $p \leq 0.01$ ) in FE athletes. Diet composition was estimated by a retrospective method over a 3-day period and compared to Dietary Reference Intake (FNB, 2006). Additionally, during the same period the participants completed a 24h activity questionnaire to determine different training patterns in each group. Results Energy intake ( $2672 \pm 640$  Kcal/day) was similar in all groups, however we found differences ( $p \leq 0.01$ ) in energy intake related to body weight (Kcal/Kg) in FE ( $39 \pm 9$ ) compared to LD ( $47 \pm 11$ ). Energy distribution was similar by groups (%P =  $17 \pm 3$ ; %CH =  $49 \pm 7$ ; and %lipid =  $34 \pm 6$ ). P ( $1.6 \pm 0.4$ ;  $1.8 \pm 0.3$ ;  $2.0 \pm 0.4$ ) and CH ( $4.4 \pm 1.4$ ;  $5.1 \pm 1.4$ ;  $5.7 \pm 1.3$ ) relative to weight (g/Kg) were significantly lower ( $p \leq 0.01$ ) in FE vs. LD. Additionally, FE group fibre intake ( $24.1 \pm 7.9$ ) was lower than LD ( $36.2 \pm 18.8$ ;  $p \leq 0.05$ ) and MD ( $31.2 \pm 18.5$ ). Marginal intake for vitamin D was found in more than half of the athletes: 59% of FE, 63% of MD and 55% of LD. Moreover calcium intake was also suboptimal and affected 50% of FE, 40% of MD and 31% of LD. Discussion/Conclusion We found low CH intake in all groups. However, P intake was adequate in MD and in LD, but FE athletes achieved only the minimum recommendation level for power training. Athletes competing in FE and MD had a higher incidence of low vitamin D and Ca intake than those competing in LD. LD athletes usually train more often outdoors, while MD and FE groups spend more training time indoors, so the latter groups may be at greater risk for vitamin D deficiency. In order to ensure bone health and athletic performance, vitamin D status must be monitored throughout the year in order to ensure bone health and athletic performance in athletes with different training patterns. Food and Nutrition Board (2006). National Academies Press, Washington (DC). Holick MF (2007). N. Engl. J. Med. 357: 266-81.

## Poster presentations

### PP-PM54 Physiology: Signalling and Gene Testing

## HIGH-INTENSITY INTERMITTENT SWIMMING TRAINING REDUCED IN DMH-INDUCED ABERRANT CRUPT FOCI IN RAT COLON

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Introduction: The incidence of colon cancer is increasing at a faster rate than that of rectal cancer in recent years in advanced countries. Epidemiological evidence has suggested that physical activity has a protective effect on colon cancer incidence (1, 2). Some animal studies found that both voluntary and treadmill running training reduced tumor incidence after the administration of 1,2-dimethylhydrazine (DMH) or azoxymethane (3). Low-intensity running training inhibits the initiation of aberrant crypt foci (ACF) in rat colon induced by DMH (4). However, the effect of high-intensity exercise or training is unknown. Therefore, we examined the effects of high-intensity intermittent swimming training on the number of DMH-induced ACF, because previous studies suggested that physical training of this type has a protective effect on colon tumor incidence in rats. Methods: Four-week-old F344 rats ( $n = 16$ ) were randomly assigned to training (8 rats) and control (8 rats) groups. After a week, all rats were given DMH (20 mg/kg-1 body weight) once a week for 2 wk. High-intensity intermittent swimming training was started at age 7 wk (repeated a 20-sec swimming bout 12 times while bearing weight equivalent to 16%). After 4 wk of training, the rats were sacrificed and the colon was removed, opened, and counted for ACF with 0.2% methylene blue staining. Results: High-intensity intermittent swimming training resulted in lower body weight (Control:  $263.75 \pm 15.02$  g, Swimming:  $246.50 \pm 10.62$  g) ( $p < 0.05$ ) and perirenal adipose tissue weight (Control:  $1.84 \pm 1.10$  mg/g-1 body weight, Swimming:  $1.23 \pm 0.65$  mg/g-1 body weight). The numbers of ACF were significantly lower in the swimming training group ( $122.4 \pm 47.4$ ) than in the control group ( $47.4 \pm 21.6$ ) ( $p < 0.05$ ). Conclusion: Our result suggests that high-intensity intermittent swimming training inhibits DMH-induced initiation of colon ACF development. However, our experimental study has not been conducted to elucidate the mechanisms of exercise-related effects on colon cancer. In future, the clinical implications and pathophysiological mechanisms of these findings warrant further investigation. References: 1) Wolin, KY., Colditz. (2011). GA, Br J Cancer. 1-4. 2) Wolin, KY., Tuchman H. (2011). Recent Results Cancer Res. 186:73-100. 3) Reddy, BS., Lowenfels, A. (1988). Cancer Res. 48:7079-7081. 4) Fuku, N., Tabata, I. (2007). Med. Sci. Sports Exerc., Vol. 39, No. 1, pp. 70-74.

**PLASMA ADENOSINE TRIPHOSPHATE IS A TRIGGER OF HEAT SHOCK PROTEIN 72 RELEASE AFTER EXERCISE.**

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**Introduction** Extracellularly localized and surface-bound Heat Shock Protein (eHsp) plays a major role in the activation of the immune system and may also be of importance for the immune response to exercise. Recently, the endolysosome pathway has been proposed for secretion of Hsp72 with a regulatory role for extracellular adenosine triphosphate (ATP). We tested the hypothesis that extracellular ATP mediates the increase in plasma Hsp72 during and after exercise. **Methods** All subjects cycled for 60 min at 70% VO<sub>2</sub> max (mean±SE: 157.4±6.9 W) in warm conditions and performed 7 sets of 10 eccentric actions with a set interval of 60 sec. Blood samples were obtained immediately after the exercise (post) and at 10, 30, and 60 min after exercise. **Results** Compared with the levels of Hsp72 and ATP in plasma after bicycle exercise, those after eccentric exercise did not change. A significant group x time interaction was not observed for Hsp72 or ATP in plasma. A significant correlation was found between Hsp72 and ATP in plasma ( $r=0.79$ ,  $P<0.05$ ), but not between Hsp72 and norepinephrine ( $r=0.64$ ,  $P=0.09$ ) after bicycle exercise. We used stepwise multiple-regression analysis to determine independent predictors of exercise-induced elevation of eHsp72. Candidate predictor variables for the stepwise multiple-regression analysis were time (Pre, Post, Post10, Post30, Post60), exercise type (aerobic, eccentric), ATP, cathepsin D, norepinephrine, epinephrine, glucose, and FFA. In the regression model for Hsp72 in plasma, increased ATP and glucose were the strongest predictors of increased Hsp72 (ATP:  $R^2=0.213$ ,  $B=0.473$ ,  $P=0.000$ ; ATP and glucose:  $R^2=0.263$ ,  $B=0.534$ ,  $P=0.000$ ). **Discussion** The present study demonstrated that circulating levels of ATP are associated with plasma levels of Hsp72. It has been proposed that lysosome exocytosis is a possible mechanism of Hsp release from cells; a schematic model involves the activity of ABC-family transmembrane transporters and the participation of purinergic receptors. Extracellular ATP binding causes the opening of purinergic receptor channels, and the entry of Hsp72 into the secretory compartment of lysosomes through ABC-family transporters. The lysosomes are then transported to the cell surface. Subsequent fusion of Hsp72 containing lysosomes with the cell surface results in release of Hsp72. We postulated that circulating levels of ATP stimulated during exercise lead to lysosome exocytosis with the release of Hsp72. In the present study, the plasma levels of ATP were associated with the elevation of eHsp72 after bicycle exercise, which, at least in part, supports our hypothesis on the mechanism of Hsp release—that circulating ATP is a necessary factor to induce secretion of Hsp72 during aerobic exercise.

**OREXIN-A REGULATES THE AMPK ACTIVITY IN VARIOUS TISSUES**

MOLNÁR, A.H.1,2, KIS, G.K.2, RÁKOSI, K.3, SCERIF, M.4, LÁSZLÓ, F.A.2, LÁSZLÓ, F.1,2, KORBONITS, M.4

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**Introduction** The hypothalamic hormone orexin-A (OXA) increases food and water intake, regulates the sleep-wake cycle, muscle tone and energy balance (Heinonen et al., 2008; Mileykovskiy et al., 2002). AMP-activated protein kinase (AMPK) is an important metabolic regulator with direct hypothalamic orexigenic and diverse peripheral effects including fat tissue and muscle (Kola et al., 2006). We aimed to study the influence of OXA on the activity of AMPK in the hypothalamus, subcutaneous and visceral adipose tissues, and skeletal muscle. **Methods** Thirty minutes after intraperitoneal (i.p.) or intracerebroventricular (i.c.v.) administration of OXA to male Wistar rats, tissues were rapidly dissected and protein extracts were immunoprecipitated and the AMPK activity was determined by an in vitro kinase assay. **Results** AMPK activity significantly increased in the hypothalamus after i.c.v. OXA administration [ $172\pm15.8$  pmol ATP/min/mg protein (control, mean±SEM),  $236\pm11.5$  (OXA)  $P=0.0022$ ,  $n=6-8$ ]. The AMPK activity decreased in white adipose tissues after i.p. OXA administration [subcutaneous fat:  $52\pm14.3$  (control),  $14\pm2.9$  (OXA),  $P=0.0121$ ; visceral fat:  $76\pm6.8$  (control),  $41\pm6.3$  (OXA),  $P=0.0173$ ]. In the skeletal muscle neither types of OXA administration had effect on AMPK activity. **Conclusion** Central administration of OXA increases appetite by the elevation of the AMPK activity in the hypothalamus. Peripheral administration of OXA reduces the AMPK activity in both subcutaneous and visceral white adipose tissues, which could lead to increased fat stores. **References** Heinonen MV, Purhonen AK, Mäkelä KA, Herzig KH. (2008) *Acta Physiol (Oxf)*. 192(4):471-485. Kola B, Boscaro M, Rutter GA, Grossman AB, Korbonits M. (2006) *Trends Endocrinol Metab*. 17(5):205-215. Mileykovskiy BY, Kiyashchenko LI, Siegel JM. (2002) *J Neurophysiol*. 87(5):2480-2489. **Acknowledgements** A.H.M. was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences. This project was sponsored by the Hungarian Government and EC (SROP-4.2.2-08/1-2008-0006 and SROP-4.2.1./B-09-1/KNOV-210-0005) research grants.

**EXPRESSION OF SIGNALING PROTEIN MOLECULES DURING RECOVERY AFTER ENDURANCE EXERCISE IN RATS**

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**Introduction** Skeletal muscle is a plastic tissue with the ability to respond to a variety of external stimuli, such as exercise. Muscle contractile activity associated with physical exercise stimulates multiple signaling pathways and induces transient changes in gene transcription. The present study was to investigate protein synthesis immediately after exercise and during recovery after endurance exercise in rats, using an endurance exercise protocol consisting of one session separated by 6h recovery (VO<sub>2</sub>max 75-80% treadmill exercise). **Methods** The samples were obtained before, immediately after, 30 min, 1h, 2h, 3h and 6h after exercise for the determination of mammalian target of rapamycin (mTOR), p70S6 kinase (p70S6k) and eukaryotic initiation factor (eIF) 4E-binding protein (4E-BP1) phosphorylation. **Results** Endurance exercise generated a significant increase in mTOR phosphorylation immediately after exercise occurred and maintained to 6h recovery (~90%,  $p=.024$ ). In addition, 4EBP1 phosphorylation was significantly increased at the immediately after exercise and decreased in an hour recovery. However, 4EBP1 was resumed to increase for 2-3 hours during recovery (~48%,  $p=.05$ ). Phosphorylation of p70S6K during recovery was continuously elevated above rest level and reached to peak at 6h recovery (303%,  $p=.001$ ). **Discussion** The present study demonstrates that endurance exercise increases mTOR signaling activity and protein synthesis in rodent skeletal muscle, and one session of high intensity endurance exercise activates rather p70S6k in muscle via an MAPK - independent pathway as reported in the previous studies. **References** Bodine SC, Stitt TN, Gonzalez M, Kline WO, Stover GL, Bauerlein R, Zlotchenko E, Scrimgeour A, Lawrence JC, Glass DJ, Yancopoulos GD (2001) Akt/mTOR pathway is a crucial regulator of skeletal muscle hypertrophy and can prevent muscle atrophy in vivo. *Nat Cell Biol* 3: 1014-1049 Coffey VG, Reeder DW, Lancaster GI, Yeo WK, Febbraio MA, Yaspelkis BB 3rd, Hawley JA (2007) Effect of high-frequency resistance exercise on adaptive responses in skeletal muscle. *Med Sci Sports Exerc* 39:2135-2144 Mascher H, Andersson H, Nilsson PA, Ekblom B, and Blomstrand E (2007) Changes in signalling pathways regulating protein synthesis in human muscle in the recovery period after endurance exercise. *Acta Physiol* 191:67-75

**NF- $\kappa$ B SIGNALING RESPONSE TO ACUTE ENDURANCE EXERCISE OF SKELETAL MUSCLE IN AGED RATS**

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**Introduction** Nuclear factor kappa B (NF- $\kappa$ B) is a important transcription factor of skeletal muscle atrophy. Several studies have been explored the possible pathways which may be modulated with exercise and age. The purpose of this study was to examine the effect of one single bout of endurance exercise on nuclear factor kappa B (NF- $\kappa$ B) activation and MuRF1 expression in old rat. **Methods** 32 rats were used and divided into two groups by age; 20 weeks (n=16), 72 weeks (n=16). Each experimental group was further divided into two subgroups; Before exercise (n=8) and after exercise (n=8). All animals in exercise groups performed one bout of 3 hr swimming exercise (30min x 6 bouts). **Results** Following the one single bout of endurance exercise, the protein level of NF- $\kappa$ B (p65) subunit was increased in both old and young group (p< .05). The protein level of NF- $\kappa$ B (p65) was higher in old than young group before exercise (p< .05). However, the expression of MuRF1 was increased in only old group after exercise (p< .05), whereas phospho-IkBa was unchanged (p> .05). **Discussion** Accordingly, these results represent the possibility of increasing the expression of nuclear factor kappa B (NF- $\kappa$ B) inducing muscle atrophy during endurance exercise by age. **References** Ji LL, Gomez-Cabrera MC, Steinhafel N, Vina J (2004) Acute exercise activates nuclear factor (NF)- $\kappa$ B signaling pathway in rat skeletal muscle. *FASEB J* 18:1499-1506 Cai D, Frantz JD, Tawa NE, Jr, et al. (2004) IKKbeta/NF-kappaB activation causes severe muscle wasting in mice. *Cell*. 119:285-298 Buford TW, Cooke MB, Manini TM, Leeuwenburgh C, Willoughby DS (2010) Effects of age and sedentary lifestyle on skeletal muscle NF-kappaB signaling in men. *J Gerontol A Biol Sci Med Sci*. 65(5) :532-7

**EFFECT OF ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE ON MGF AND MTOR GENE EXPRESSION**

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**EFFECT OF ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE ON MGF AND mTOR GENE EXPRESSION** Tricoli, V.1, Blazeovich, A.2, Ugrinowitsch, C. 1, Aoki, M.S.3, Nosaka, K.2 1: EEEF-USP (São Paulo-Brazil), 2: ECU (Joondalup-Australia), 3: EACH-USP (São Paulo-Brazil) **Introduction** It has been shown that exercise-induced damage is associated with the release of growth factors (i.e. MGF) by the skeletal muscle (Morgan & Partridge 2003). These growth factors may modulate signaling events in Akt/mTOR hypertrophy pathway which has been attributed as one of the key regulators of cell growth (Nader et al. 2005). It is well known that the magnitude of eccentric exercise-induced muscle damage is attenuated in the successive bouts of exercise (Nosaka et al. 2001). Thus, it is plausible to assume that a repeated bout of eccentric exercise will cause less muscle damage, thereby inducing a smaller MGF release and consequently smaller Akt/mTOR pathway activation. Thus, the aim of this study was to investigate the effect of two eccentric exercise bouts on muscle damage indirect markers and the MGF and mTOR gene expression. **Methods** Eight male subjects (33.9 yrs) participated in the study. They were submitted to two bouts of eccentric exercise (10 x 10 maximum reps, knee extension at 60deg/sec) 15 days apart. Muscle samples were obtained from the vastus lateralis before, 15 min and 2h after each bout. Indirect markers of exercise-induced muscle damage (maximum voluntary isometric contraction [MVIC], muscle soreness, serum creatine kinase [CK] activity) were assessed before, 2, 24, 48 and 72 h after each exercise bout. In addition, changes in MGF and mTOR gene expression were measured before, 15 min and 2h after each bout. **Results** Total work performed and changes in MVIC, muscle soreness and CK activity were not significantly different between bouts (p>0.05). Changes in mTOR gene expression were similar between bouts 1 and 2. On the other hand, after the second bout, MGF gene expression showed an early increase at 15 min (~2.4-fold induction, p<0.05), reaching the highest value 2h after exercise (~3.8-fold induction, different from bout 1, p<0.05). **Discussion** Despite similar alterations in muscle damage indirect markers after the two exercise bouts, we found a greater change in MGF gene expression 2h after the second exercise bout. However, it should be mentioned that there was non-significant trend toward smaller changes in MVIC and muscle soreness after the second bout. Interestingly, there was no difference in mTOR gene expression between bouts. Therefore, we concluded that the magnitude of exercise-induced muscle damage seems to have no effect on MGF release and Akt/mTOR pathway activation. **References** Morgan JE, Partridge TA (2003) *Int J Bioch Cell Biol*, 8, 1151-6. Nader GA et al. (2005) *Am J Physiol Cell Physiol* 6, C1457-65. Nosaka K et al. (2001) *Med Sci Sports Exerc* 33, 1490-1495.

**HEAT SHOCK PROTEIN RESPONSE TO TRAINING IN VASTUS LATERALIS MUSCLE OF YOUNG AND ELDERLY SUBJECTS**

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**Introduction** Ageing is associated with a progressive decrease in muscle mass, strength and regeneration capacity. Although the underlying mechanisms have not been comprehensively elucidated, the loss of an adequate stress response has been suggested to play an important role in the development of age-related muscular dysfunctions. Hitherto the exercise-induced heat shock protein (Hsp) response in ageing muscle is fairly uncharacterized. Consequently, the aims of the present study were to determine the effect of different training modalities on the Hsp response in elderly subjects and to identify whether the Hsp responses differ between elderly and young subjects. **Methods** 37 elderly subjects (> 70 years) performed traditional strength training (STG), functional strength training (FTG) or endurance training (ETG) 3 days/week for 13 weeks. A control group continued their daily activities (CON), whereas the 13 young subjects (YOUNG, 20-40 years) performed traditional strength training 3 days/week for 11 weeks. Biopsies were collected from the m. vastus lateralis before and after the training period.  $\alpha$ B-crystallin and Hsp70 levels were quantified by western blot, whereas Hsp27 levels were measured by ELISA. **Results** Elderly subjects displayed significantly higher baseline levels of Hsp27. After the training period, the Hsp27 and  $\alpha$ B-crystallin expression levels were not altered in any of the elderly groups in the cytosolic or membrane fraction. In contrast, in the YOUNG, Hsp27 and  $\alpha$ B-crystallin expression significantly increased after training in both the cytosolic and membrane fractions. Moreover, the Hsp70 expression in response to training was not changed in the YOUNG, the elderly ETG or CON, whereas it was significantly decreased in the cytosolic fractions of STG and FTG. **Discussion** Neither long-term strength training nor endurance training changed the expression of sHsps (Hsp27 and  $\alpha$ B-crystallin) in human ageing skeletal muscle. Furthermore, long-term strength training caused a downregulation of Hsp70 in elderly individuals, which inversely correlated with age. Taken together, the Hsp response in ageing muscle is severely impaired and this lack of adaptation might be contributing to the development of age-related muscular dysfunctions.

**EFFECT OF EXERCISE ON FIBROBLAST GROWTH FACTOR 21 OF MUSCLE IN MICE.**

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**INTRODUCTION:** Fibroblast growth factor 21 (FGF21) is a novel metabolic regulator and improve glucose and lipid metabolism. FGF21 is produced and secreted by liver, adipose, and skeletal muscle. Recently, it was shown that FGF21 secreted from skeletal muscle is elevated upon activation of the PI3k/Akt signaling pathway in mice. Akt is activated by insulin and cellular stress (i.e. muscle contraction). Therefore, we hypothesize serum FGF21 is increased through elevation of the expression of muscle in response to acute exercise. We reported serum FGF21 increase after exercise in human (ECSS 2010 in Antalya). This time, we examined whatever FGF21 of muscle increase after exercise. **METHODS:** ICR mice (8 weeks old) were divided into two groups: sedentary (SED), running exercise (EX). EX group performed treadmill running (30m/min, 60min), then taking blood and gastrocnemius was rapidly removed and analysed for FGF21 mRNA, and blood. The expression of FGF21, and glucose in mice was assessed by real-time polymerase chain reaction, ELISA and enzyme assay. The alteration of FGF21 expression was compared with SED. **RESULTS:** The level of serum FGF21 in EX significantly increased compared with the level in SED ( $P < 0.05$ ). mFGF21 of muscle in EX tended to increase compared with SED ( $P = 0.1$ , effect size  $d = 0.7$ ). Blood glucose in EX tended to decrease compared with SED ( $P = 0.05$ , Effect size  $d = 0.99$ ). **DISCUSSION:** Serum FGF21 of EX in this study was significantly increased compared with SED as well as our previous study. FGF21 mRNA was elevated in EX in comparison to SED mice. Thereby, serum FGF21 may be secreted through the elevation of the expression of FGF21 in muscle in response to muscle contraction. These result may be suggest exercise including muscle contraction induced FGF21. Further study needs to examine the improvement of lipid by exercised-induced FGF21. **CONCLUSION:** FGF21-derived muscled may be increase after exercise.

**COMPLEX DNA TEST METHOD WITH A DNA CHIP AMONG HUNGARIAN ATHLETES**

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**Introduction** We have been studying the genetic background of sport and exercise physiology on several genes and their polymorphisms. We wanted to broaden the number of measured genes and examine not only the specific sport genes but the area of sudden cardiac death (SCD) and metabolic syndrome (MetS) as well. SCD can strike both professional and amateur, young and old. When it happens to an athlete it makes us re-evaluate exercising for health. The reason of SCD in athletes is mostly unclear, therefore it is essential to understand the genetic background. The MetS is a cluster of risk factors including central obesity, hypertension, hyperglycaemia and dyslipidaemia. There is evidence already of a complex interplay between genetic determinants and environmental factors. These factors are lesser-known, therefore it can be informative to study athlete population, who live a healthy lifestyle (nutrition, exercise, non-smoking) to associate the genetic variants with measurable phenotypes (blood pressure, lipid levels etc.) **Method** DNA is extracted from blood samples using a DNA isolating kit. 64 genes are studied from each DNA sample. DNA detection is done with a DNA chip at Avidin Ltd. TaqMan OpenArray plate is divided into 48 subarrays; each subarray consists of 64 through-holes, which means that 3072 nanocapillary quick reaction time (QRT) PCR can be run at one time. To measure the polymorphisms fluorescently signaled Taqman probes are used. The isolated DNA (150ng) is mixed with OpenArray MasterMix and loaded into the nanocapillary reaction chamber. The OpenArray plates are put into Perkin Elmer 1000 Plate PCR device for 50 cycles and afterwards are put into the BioTrove OpenArray™ NT Cycler where 3 plates can be analyzed at the same time which means that more than 9000 individual reactions can be run. The intensity of fluorescence is detected automatically in every point and can be analyzed afterwards. **Results, Targeted genes** The system has been validated with previously genotyped DNA samples. From the studied 64 genes the first part is in connection with physical performance. They are put together based on international studies. I emphasise the ADRB2 ARG16Gly SNP, which is associated with elite endurance performance and SCD and other genes (ACTN3, Myostatin etc.) The second group of genes includes genes in connection with SCD, Heart Failure and Cardiovascular Disease. (AMPD1, NOS1 AP, AMPD-1 etc.). The third group contains genes in connection with MetS. For example the LIPG gene which is associated with interindividual variability in HDL-C and its subfractions and their response to exercise training, and many others (ADIPOQ, FABP2, Ghrelin). **Discussion** The results of the study could be used as a tool to filter out individuals who have risk factors.

**ANALYSIS OF 'HEALTH' GENE POLYMORPHISMS IN ELITE PROFESSIONAL ICE-HOCKEY PLAYERS**

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**Introduction** Association of genes polymorphisms with physical performance is well-known. The most valuable association was shown for ACE, ACNT3, AMPD gene polymorphisms (Myerson et al., 1999; Papadimitriou et al., 2007; Rubio et al., 2005). Our aim was to study as sport skills are caused by different genetic factors involved in the regulation of many metabolic processes with physical performance in professional ice-hockey players. **Methods** The polymorphisms of NOS3 (5/4), AGT (Met235Thr), ACE (I/D), AGTR1 (1166A>C), AGTR2 (3123C>A), BDKRB2 (-58T>C), REN (-83G>A), F5 (1691G>A), PAI1(5G>4G), ITGB3 (1565 T>C), F2 (20210G>A), F1 (455G>A), MTHFR (677C>T), ADRB2 (48A>G, 81C>G), PPARA (2528G>C), PPARG (294T>C), PPARG (Pro12Ala), UCP2 (Ala55Val), UCP3 (-55C>T), PPP3R1 (51/5D), AR (ICAGIn), DRD2 (A1/A2), HTR2A (SR) (102 T>C), PPARGC1A (Gly482Ser) were studied in high ice-hockey professional (N=20, men, several world cup champions) and population controls (N=196, men without sport success). DNA was extracted from the blood cells. Then the polymorphisms of 28 genes were determined by PCR-RFLP and PCR-biochip methods. **Results** Only distribution of genotypes frequencies of five genes were different in both groups ( $p < 0.036$ ). Four from these genes are regulators of arterial pressure. Genotypes A/A of AGTR1, C/C of AGTR2, A/G of ADRB2, 5/5 of NOS3 were prevalence in ice-hockey men compared to controls (A/A - 100%, C/C - 80%, A/G - 75%, 5/5 - 90% for athletes and 61%, 55%, 53%, 37% for controls respectively;  $p < 0.01$ ). Also we have determined prevalence of C/C genotypes of ACNT3 in controls compared to athletes (49% and 20%, respectively;  $p < 0.02$ ). **Discussion** Important to note that differences were determined for genotypes which associated with «normal» arterial pressure that is not consistent with the hypothesis about prevalence of the «genotype of hypertension» in athletes involved in short and intense physical training (Ying et al., 2010). But it might be speculated that determined genotypes of those genes has provided some inherited advantages for physical performance in ice-hockey sportsmen. **References** Myerson S, Hemingway H, Budget R, Martin J, Humphries S, Montgomery H. J (1999). Appl Physiol. Oct;87(4):1313-6. Papadimitriou I.D., Papadopoulos C., Kouvatzi A., Triantaphyllidis C. (2007). Int J Sports Med. 2008 Apr;29(4):352-5. Epub 2007 Sep 18. Rubio J.C., Martin M.A., Rabadan M., Gomez-Gallego F., San Juan A.F., Alonso J.M., Chicharro J.L., Perez M., Arenas J., Lucia A. (2005). J Appl



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### MARKERS OF INSULIN RESISTANCE ARE ASSOCIATED WITH OBJECTIVELY ASSESSED PHYSICAL ACTIVITY IN EUROPEAN ADOLESCENTS. THE HELENA STUDY.

JIMÉNEZ-PAVÓN, D., ORTEGA, F.B., MARTÍNEZ-GÓMEZ, D., MORENO, S., URZANQUI, A., GOTTRAND, F., MOLNÁR, D., CASTILLO, M.J., SJÖSTRÖM, M., MORENO, L.A., RUIZ, J.R.

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Institutions: 1GENUD (Growth, Exercise, Nutrition and Development) Research Group, E.U. Ciencias de la Salud, Universidad de Zaragoza, Spain. 2Department of Medical Physiology, School of Medicine, University of Granada, Spain. 3Unit for preventive nutrition, Department of Biosciences and Nutrition, Karolinska Institutet, Sweden. 4Immunonutrition Research Group, Department of Metabolism and Nutrition, Instituto del Frío, Institute of Food Science, Technology and Nutrition (ICTAN), Spanish National Research Council (CSIC), Madrid, Spain. 5Department of Health and Human Performance, Faculty of Physical Activity and Sport Sciences-INEF, Universidad Politécnica de Madrid, Spain. 6Faculté de Médecine, Université de Lille2, France. 7Department of Paediatrics, University of Pécs, Hungary. 8Department of Physical Education and Sport, School of Physical Activity and Sport Sciences, University of Granada, Spain Objective: To examine the association of insulin resistance markers with objectively assessed physical activity after controlling for total and central body fat in European adolescents. Material and Methods: We conducted a cross sectional study (the HELENA-CSS) which comprised 1053 (499 males; 12.5-17.5 years) adolescents from ten European cities. Weight, height, waist circumference and skinfold thickness were measured, and body mass index (BMI) was calculated. Markers of insulin resistance included fasting insulin glucose and homeostasis model assessment (HOMA). Physical activity (PA) was assessed by accelerometry and the follow intensities were calculated; inactive, low PA, moderate PA, vigorous PA, moderate to vigorous physical activity (MVPA) and average physical PA. Results: In females, MVPA and average physical activity were negatively associated (all  $P < 0.05$ ) with insulin resistance after controlling for pubertal status, center and markers of body fat (BMI, skinfold thickness and waist circumference). In males, vigorous physical activity was negatively associated (all  $P < 0.05$ ) with insulin resistance after controlling for pubertal status, center and BMI or waist circumference, but not when using skinfold thickness. Conclusions: Our results suggest that PA, especially those with high intensities, could positively influence markers of insulin resistance after controlling for several confounders including total and central body fat. Preventive strategies should not only focus on increasing PA, but also to increase the intensity of PA.

## Poster presentations

### PP-PM55 Rehabilitation 2

#### DEVELOPMENT OF SIMPLE LEG/TRUNK TRAINING METHODS SAFELY ACHIEVABLE EVEN BY THE FRAIL ELDERLY

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**PURPOSE** This study evaluated the effects of leg training to improve the load-bearing capacity, easily practicable using a commercially available resistance-training machine, on physical functions of the frail elderly. **SUBJECTS** The subjects were 60 elderly persons, 30 men and 30 women, who were either frail or certified as in need of low levels of care with an average age of 78.4 (SD=4.1) years. **METHODS** Twenty-nine elderly people who successfully continued 15-minute daily training three times weekly for 12 weeks (intervention group) were compared regarding their physical functions (lower limb loading force, grip strength, walking speed, muscular strength of the quadriceps femoris, Timed up & go test(TUG), and the frequency of standing up) with 28 who did not practice any specific exercise (control group). **RESULTS** The results showed no significant differences between the groups in grip strength, TUG, and the frequency of standing up. However, in the elderly in the intervention group, the lower limb loading force ( $p < 0.01$ ), muscular strength of the quadriceps femoris ( $p < 0.01$ ), and walking speed ( $p < 0.01$ ) significantly increased after the training, with the former two significantly higher than those in the control group. The elderly in the control group, on the other hand, showed no significant changes in any items measured before and after the training. **CONCLUSION** These findings suggest that leg training to improve the load-bearing capacity effectively promotes the muscle strength as well as ambulatory ability of the frail elderly.

#### PREVALENCE OF THE FRAILTY SYNDROME IN THE ACTIVE AND SEDENTARY ELDERLY

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**Introduction** In recent years, geriatricians and gerontologists have used the term frailty syndrome to characterize elderly more vulnerable and weak, although there is still no agreement about the definition of frailty syndrome. Today, there are about 14 million elderly in Brazil, with over 75 years age and susceptible to frailty. This study aimed to determine the prevalence of frailty syndrome in active and sedentary elderly in the community. **Methods** This is a transversal (cohort) study, not controlled, in order to compare the prevalence of frailty syndrome in elderly. The sample, included 38 elderly, was divided into Group I (sedentary,  $n = 19$ ) and Group II (active,  $n = 19$ ), members of the continuing education program, 'UNIPAM-Senior'. The Mini-Mental, used as a cognitive screening was applied to the participants as an exclusion criterion. The modified evaluation protocol prepared by Fiber Network was used to assess the phenotype of frailty, and checked the five criteria proposed by the study of Fried (2004): 1- unintentional weight loss; 2- fatigue index; 3- test of grip strength; 4- caloric expenditure; 5- walk test. The independence test chi-square was used to verify the equivalence using SPSS version 15.0. **Results** There was a positive association ( $P = 0.05$ ) between groups I and II and the categories of frailty. In group I, 15.8% were classified as fragile, 73.7% pre-frail and 10.5% not-fragile. In group II none was classified as fragile, 63.2% were classified in stage pre-frail and 36.8% non-fragile. Positive correlations were also found in the occurrence of falls ( $P < 0.05$ ) and the presence of disease ( $P > 0.05$ ) with the classification of frailty. Still, among those who have suffered falls, 75% were pre-frail, and had two or more diseases. No significance was found between the presence of depression and the phenotype of frailty. **Discussion** For Petersen et al (2005), the association between regular physical activity and reduction of some inflammatory markers and reducing the sarcopenia in elderly are the most important

factors. The diversity of criteria for defining the frail elderly, hinders consensus on the necessary interventions. Sarcopenia is identified as the most important cause of frailty. Regular physical exercise can reduce the incidence of the frailty syndrome probably by a diminution of inflammatory markers, and a consequent reduction in sarcopenia. Physiotherapy has an important role in prevention and intervention in patients with the syndrome. References FRIED L. P. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. *Journal of Gerontology: Med Sci*, 2004; 59(3): 255-263 PETERSEN A. M. W., et al. The anti-inflammatory effect of exercise. *J Appl Physiol*, 2005; 98: 1154-62

### COMPARISON BETWEEN TOWEL-GATHERING EXERCISE AND TOE-PAD FOR THE ANKLE SPRAIN

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【Introduction】 This study examines physiotherapy for the ankle sprain from clinical data. Towel-gathering exercise (scrunching a towel lying on the floor with the toes) is commonly chosen in the treatment of ankle sprain in Japan. However, the towel-gathering exercise is unclear which toe exercises. Hence, author developed Toe-Pads (Size of each pad is 10×10mm, thickness is 2mm) which pasted on each toe. Therefore, we compared the pain-release effect of the towel-gathering with these Toe-Pads we developed. We welcomed 17 subjects (males 12, females 5) suffering from ankle sprain as subjects. The mean age was 21.7±12.2 years old. The subjects were chosen only cases to complain for pain when a therapist did supination. All subjects were given enough explanations about this experiment and obtained its consent. 【Methods】 Toe-Pads we developed have three conditions, which were pasted under First-toe, 2nd-to-5th and 3rd-to-5th. All subjects performed the towel-gathering exercise (about 3min), and were pasted each Toe-Pad condition randomly. Before and after each condition we assessed the pain scale by provocative tests such as stepping, hopping, running and others with Visual Analog Scale (VAS). We compared each condition to before, which each experiment condition was analyzed by statistics (Wilcoxon, Friedman test).

【Results】 The towel gathering and first Toe-Pad ( $p_T=0.001$ ,  $p_F=0.001$ ,  $N=17$ ) and were showed significant difference. On the other hand, both the 2nd-to-5th and 3rd-to-5th Toe-Pad were not shown significant difference ( $p_{2-5}=0.736$ ,  $p_{3-5}=0.234$ ,  $N=17$ ). 【Discussion】 As for the treatment and the prevention of the ankle sprain report, there are the exercise of the peroneal muscle (Monaghan, K. et al 2006), the balance exercise (Mohammadi, F. M. 2007) and mobilization or taping. In this study, it was aimed to consider an ankle sprain to be from the viewpoint that was slightly different from these, which it's a toe function. The towel gathering and First Toe-Pad were showed overtly significant the pain-release effect, which more than 70% of subject showed. However, the 2nd-to-5th and 3rd-to-5th Toe Pads were not showed overtly significant the pain-release effect. A result of the towel gathering was similar to first Toe-Pad greatly. Therefore, the towel gathering might be an exercise of the hallux mainly. Additionally, the result of this study seemed to present that this disease was bought by a dysfunction of the hallux. In our opinion, if a clinician chooses Toe-Pads as an assessment in clinical setting, it might be one of effective assessment for this disease. However, several attentions were necessary that all Toe-Pads didn't have pain releasing. For example, the towel gathering exercise might not be effective when First Toe-Pad didn't show pain releasing. References Monaghan, K. et al, *A. Clin. Biomech* 21, 168-174 (2006) Mohammadi, F. M., *s, Am J Sports Med*, 35(6): 922-926 (2007)

### SPINAL SHAPE AND LOW BACK PAIN – NON-INVASIVE MEASUREMENTS AND MULTIVARIATE ANALYSES FOR FEMALE LOW BACK PAIN PATIENTS

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Introduction In manipulative therapy concepts, spinal shape is well known to be associated with functional disorders of the locomotor system (4). But x-ray based diagnostic procedures are not suitable for screening surveys, and there is still a lack of evidence in the management of exercise programs based on spine shape findings. Subjects 129 female patients with chronic LBP (age: 50.5±14.2 y; body mass index: 24.2±1.6 kg/m<sup>2</sup>) and 79 pain free female volunteers with no back pain history (age: 24.5±4.7 y; body mass index: 22.8±1.4 kg/m<sup>2</sup>) participated in this controlled cross-sectional study. Spinal shape was measured by means of Formetric®-System, an optical high resolution (10 pts/cm<sup>2</sup>, 0.2-0.5 mm reconstruction error) device for three-dimensional back surface reconstruction (3). Statistics: Multivariate discriminant analyses were calculated to reveal predictive spine shape variables to identify low back pain patients. Univariate tests for mean differences followed multivariate findings (Student's t-test). Results Discriminant analyses lead to moderate estimation models (canonical correlation: 0.448; Wilks' Lambda: 0.799;  $p<0.000$ ) and pointed out the role of trunk imbalance (tr-imb), trunk inclination (tr-inc), and pelvis torsion (p-tors) to discriminate LBP patients from pain free controls: tr-imb ( $t=-3.993$ ;  $p<0.000$ ), tr-inc ( $t=-4.959$   $p<0.000$ ), p-tors ( $t=-3.811$ ;  $p<0.000$ ). Discussion and conclusions Using a non-invasive back surface reconstruction system, our results confirmed x-ray findings, where frontal plane spinal asymmetries and pelvis position parameters were associated with low back pain and judged to be risk factors for its development (1, 2, 4). Differences in the trunk inclination should be considered to be due to the higher age of LBP patients (5). The findings provide applications for screening surveys in junior elite sports or medical school examinations. References: 1. Adams, M.A., Mannon, A.F. & Dolan, P. (1999). Personal risk factors for first time low back pain. *Spine*, 24 (23), 2497-2505. 2. Balagué, F., Troussier, B. & Salminen, J.J. (1999). Non-specific low back pain in children and adolescents: risk factors. *European Spine Journal*, 8, 429-438. 3. Drerup, B. & Hierholzer, E. (1994). Back shape measurement using video rasterstereography and three-dimensional reconstruction of spinal shape. *Clinical Biomechanics*, 9, 28-36. 4. Lewit, K. (1991). *Manipulative therapy in rehabilitation of the locomotor system*. 2nd edition. Oxford: Butterworth (pp 60-62). 5. Takeda, N., Kobayashi, T., Atsuta, Y., Matsuno, T., Shirado, O. & Minami, A. (2009). Changes in the sagittal spinal alignment of the elderly without vertebral fractures: a minimum 10-year longitudinal study. *Journal of Orthopaedic Science*, 14 (6), 748-753.

### POSTURAL STABILITY IN WOMEN WITH JOINT HYPERMOBILITY SYNDROME

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POSTURAL STABILITY IN WOMEN WITH JOINT HYPERMOBILITY SYNDROME Iatridou, K.1, Mandalidis, D.2, Chronopoulos E.1, Vagenas, G.1, Athanasopoulos, S.1 1: NKUA (Athens, Greece) 2: PhD, PT (Athens, Greece) Introduction Joint hypermobility syndrome (JHS) is a heritable disorder of the connective tissue and especially of type I collagen (Grahame, 2003). Type I collagen is proposed to be a key structural component of load-bearing tissues such as tendons, ligaments and fascia. These tissues contribute to joint stabilization via passive and active mechanisms. Active joint stabilization is mainly based on proprioceptive input from ligaments, joint capsule, tendons and muscles. The combination of proprioceptive, visual, and vestibular sensory information is utilized by the central nervous system for conscious

appreciation of the position and movement of the body and limbs. Although, deficiencies in proprioceptive sense have been described in subjects with JHS, there is a limited amount of literature studied the role of proprioception deficits in postural control. The aim of the present study was to assess static balance in female persons diagnosed with JHS. Methods Static balance was assessed in 21 women with JHS and in 20 age matched women without JHS. For the assessment, it was recorded the distribution of foot pressure (CoP) during a 20-second single-leg stand on a platform under three different conditions; opened eyes, closed eyes, opened eyes with head extension. Results Non parametric statistical analysis showed that during the single-leg stand with opened eyes the JHS group demonstrated significantly greater sway path length ( $p=0.009$ ), mediolateral sway ( $p=0.003$ ) and ellipse area of CoP ( $p=0.003$ ) than that of controls. During single leg stance with opened eyes and head extension all the indices that characterize the sway path were significantly greater for the JHS group ( $p<0.05$ ). In the condition of closed eyes the group with JHS demonstrated significantly greater values for sway path length ( $p=0.05$ ). Discussion Physically active hypermobile women without acute symptoms demonstrated impaired postural control based on the distribution of CoP during single-leg stance. A possible explanation of the results could be that the proprioceptive deficit that has been detected in hypermobile subjects may have affected the feedback and feedforward mechanisms (Ferrell et al., 2007; Gatev et al., 1998). The interaction of these mechanisms is responsible for the modulation of spine and lower limbs muscle activity in order to maintain balance during stance. Further study of these mechanisms could lead to a design of rehabilitation protocols specific to the impairment, for the improvement of static balance in females with JHS. References Ferrell W, Tennant N, Baxendale R, Kusel M, and Sturrock R.(2007). *Arthritis Rheum*, 57, 1329-1333. Gatev P, Thomas S, Kepple T, and Hallet M.(1999). *J Physiol*, 514, 915-928. Grahame R.(2003) *Hypermobility and hypermobility syndrome*, 1-14 Butterworth Heinmann, London.

## EVALUATION OF FUNCTIONAL CAPACITY IN MYOTONIC DYSTROPHY TYPE 1 PATIENTS

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Introduction Myotonic dystrophy type 1 (DM1) is one of the most frequent neuromuscular disorder in adults. Although this disease affects primarily muscle function, DM1 causes multisystemic impairments. Thus, DM1 is often presented as an accelerated aging model. In clinical setting, most of the physical evaluations are based on subjective factors, which can cause a lack of precision in the rehabilitation strategy. Recently, a new functional test battery (UQAM-YMCA) has been developed for elder persons. The nature of this test battery seems to be an interesting tool to help clinicians to improve their assessment of the physical limitation in DM1 patients. Thus, the aim of this research is to assess the validity and reliability of the UQAM-YMCA functional test battery with DM1 patients. Methods A total of 28 participants (14 men, 14 women, mean age  $45.8 \pm 11.7$  years old), fifteen diagnosed with DM1 stage 3 to 4 according to the Muscular Impairment Rating Scale (MIRS) and a control group composed of 13 healthy individuals, were assessed with the UQAM-YMCA functional test battery. The test battery allows measuring 17 variables regrouping in 6 main factors: reaction time, balance, and flexibility, speed of limbs, muscular strength and walking capacity. Results The test-retest procedure (t-test paired sample) showed a high reliability with correlation coefficients greater than 0.80 for most of the tests. Comparison of the groups by an independent sample t-test procedure (DM1 vs Healthy) showed significant differences ( $p \leq 0.05$ ) for all the tests but one (shoulder flexion). Discriminant analysis showed that the model predicts correctly more than 92% of the participants in the right group. Finally, when the DM1 group was compared with Canadian normative data for aging population, the average test results indicated that DM1 patients have a functional capacity similar to women aged 72 years old. Discussion The UQAM-YMCA test battery showed excellent test-retest reliability with DM1 patients, which is an important step to determine the usefulness of this test battery for this population. When compared with healthy participants (age and gender match), DM1 patients in this study showed impairments in all of the 6 factors assessed. In fact, even if the mean age of the DM1 group was approximately 46 years old, their functional capacity was comparable to women over 70 years old. DM1 phenotype was extremely distinctive as showed by the stepwise discriminant analysis. Hand grip and balance eyes opened contribute the most to classify correctly 92.9% of the participants in the right group. Conclusion The UQAM-YMCA test battery appears to be an excellent tool to determine, globally or specifically, the degree of impairment for DM1 patients.

## THERMOGRAPHIC PROFILE FOR THE REHABILITATION OF THE TOTAL OF ACL RUPTURE

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Introduction Infrared thermography is a noninvasive technique that allows, quickly, and without any contact, display and record temperatures of different areas of the body by a Infrared sensor (Ring & Ammer, 2000). When the muscles or joints of a body area are overloaded or injured there is an acute increase in temperature (Santilli, 1981). On the other hand, the rupture of anterior cruciate ligament (ACL) is an injury very common in the field of sport (Codesido, 2009). The time needed from the operation to a total recovery is about 2 months (Paus, 1999). Methods The study was carried out for six months. Patients of ACL injuries ( $N = 30$ ) were followed throughout their stay in a room specially prepared for them with the same hospital rehabilitation protocol. Data was taken once a week: Anterior and posterior thermogramme of the lower extremities, leg, thigh and knee (above the patella) anthropometric measurements, BORG subjective pain scale CR10 (Borg, 1998) and manual goniometer to measure degrees of flexion and extension. The thermograms from our FLIR T335 were analyzed establishing areas in each leg, obtaining averages and maximum points temperature. The results were analyzed with SPSS v.15.0. Results The thermograms shows an increase in temperature of the inner zone of the affected knee in the anterior view ( $1.4^\circ \text{C}$ ) and an acute increase in temperature throughout the posterior view of the uninjured leg ( $0.92^\circ \text{C}$ ). Both leg and thigh circumferences decreased in the injured leg ( $\bar{x} = 0.83 \text{ cm}$ ,  $\bar{x} = 1.42 \text{ cm}$ , respectively). Otherwise, the measures taken in the upper perimeter of the affected knee patella is significantly higher ( $\bar{x} = 2.3 \text{ cm}$ ) than the healthy knee. Discussion We can describe a thermographic profile of ACL rupture and its evolution during rehabilitation: In the beginning we found big temperature descompensation between knees in the anterior view, being much higher in the injured one. In contrast, in the posterior view the temperature rise up in the area of the hamstring of the uninjured leg, possibly due to result of overload of lameness. As rehabilitation progresses, the thermal values of both legs should match. The greatest differences in the areas are found in the leg and patella measurements. At the start of the treatment, the perimeter of the injured leg has lower muscle mass due to non-exercise. Referring to the patella we see a significant perimeter increase, in this case, because of inflammation. References Borg, G. (1998). Borg's perceived exertion and pain scales. Stockholm: Human Kinetics. Paus, V. (1999). El entrenamiento de la fuerza en la rehabilitación del Ligamento Cruzado Anterior. The strength training in the anterior cruciate ligament rehabilitation., 4(14). Ring, E., & Ammer, K. (2000). The Technique of Infra red Imaging in Medicine. *Thermology International*, 10(1), 7-14. Santilli, G. (1981). Teletermografia in traumatologia dello sport. *Telethermography in sports traumatology*, 3(3), 225-232.

### PHYSICAL PERFORMANCE OF SUBJECTS WITH OR WITHOUT OSTEOARTHRITIS. A LONGITUDINAL STUDY WITH A 10-YEAR FOLLOW-UP

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Physical performance of subjects with or without osteoarthritis. A longitudinal study with a 10-year follow-up D.M. van Leeuwen 1,2, C.J. de Ruiter 1, D.J.H. Deeg 3, G.M.E.E. Peeters 4, J.W.R. Twisk 3, P. Lips 1,3, A. de Haan 1,2 1 Research Institute MOVE, VU University Amsterdam, The Netherlands 2 Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University, Manchester, UK 3 EMGO+ Institute, VU University medical center, Amsterdam, The Netherlands 4 The University of Queensland, School of Human Movement Studies, Brisbane, Australia Osteoarthritis (OA) is a joint disease which is characterized by pain, loss of strength and problems with activities of daily life, especially when the hip or knee joint is affected. Longitudinal studies can bring insight in the change of function over time to distinguish between loss of function due to OA and aging. There are indications that detrimental effects of OA on physical performance occur on the long term, but there is a lack of studies with long follow up periods. In addition there are very few longitudinal studies with physical performance as the primary outcome measure (as opposed to self-report). The present study aimed to compare physical performance between older people with and without knee or hip OA during a follow-up period of 10 years. Subjects from the Longitudinal Aging Study Amsterdam (LASA) with OA (N=158) and without OA (N=822), age between 58 and 90, were followed-up during 10 years on 4 occasions. OA was assessed by self report. Physical performance was defined by the sum of the scores (0-4) of a chair stand, walking, and balance test (range 0-12). Generalized estimating equations were used on a model with physical performance as the primary outcome variable, time as categorical variable, OA and the interaction between OA and time as independent variables. A significant interaction was found for gender, and therefore, analyses were performed separately for men and women. For men with OA, performance was significantly lower ( $p < 0.05$ ) on all 4 occasions. Performance was 1.0 point lower on the first occasion, and this deficit increased to 3.3 points on the fourth occasion after 10 years. For women with OA, only the performance on the third (-1.0) and fourth occasion (-1.8) was significantly lower. Adjustment for confounders (BMI, age, physical activity and number of chronic diseases) marginally influenced the results for men, but only the performance after 10 years was lower for women with OA. Additional analyses of the individual performance tests showed that balance was impaired in both men and women with OA on occasions 3 and 4. Chair rise and walking ability were already impaired in men with OA from the first occasion on, and from occasion 3 (chair) and 4 (walk) for women with OA. The results suggest that physical performance is affected in older people with OA. The difference in performance between OA and non OA is greater in men than in women.

### ELECTRICAL STIMULATION IN PATIENTS WITH A PERONEAL NERVE LESION: ANALYSIS OF STIMULATION PARAMETERS

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[1] Institute of Sport Science [2] Department of Orthopaedics, Biomechanics and Implant Technology Research Laboratory [3] Institute for Diagnostic and Interventional Radiology [4] Department Aging Science and Humanities Introduction Functional electrical stimulation is a treatment for both training in healthy subjects and therapy of disease. Even in patients with lesion of the peroneal nerve it is used to improve strength and function of foot raising muscles during walking. The purpose of the present study is to determine the effect of different stimulation parameters on strength of dorsal extensor muscles and sensation of pain. Methods Nine patients aged 34-77 ( $58.2 \pm 13.7$  years) with a drop foot resulting from an incomplete lesion of the peroneal nerve participated in the study. An electrical stimulator (DKI, Dresden and MTR, Berlin) generated nine different programs with variations in envelope (rectangle, triangle, trapezium) and single pulses (short: 0.25 ms, medium: 7.5 ms, long: 15 ms). All currents were bipolar with same frequencies. Patients were placed with the leg in horizontal position and the foot in neutral zero position. Contraction strength of dorsal extensors was recorded by a piezoelectric force sensor (Kistler, Winterthur) and interpreted in relation to the maximal voluntary contraction (MVC) forces. Stimulation intensities were chosen by the patients and differed between subjects related to their experience of pain. Results High muscle forces were noticed in programs with rectangular envelopes (up to 26 % of MVC). Triangular and trapezoid envelopes produced lower values (up to 17 % of MVC and up to 22 % of MVC). Long and medium single pulses induced similar forces between 14 and 26 % of MVC whereas short single pulses reached 8 to 19 % of MVC. Intensities of current remained small in programs with long and medium single pulses (15-21 mA). Discussion The results suggest that rectangular envelopes with long or medium single pulses offer the best variety for producing strength of the dorsal extensors with electrical stimulation. Low current intensities in such programs indicate small pain tolerance. Both contraction strength of dorsal extensors and current intensities have an influence on the effectiveness and tolerance of functional electrical stimulation as a therapy for patients with lesion of the peroneal nerve.

### INJURY RATE AND RISK FACTORS IN YOUNG AND ADULT FEMALE NATIONAL BASKETBALL TEAM ATHLETES: A TWO-YEAR FOLLOW-UP STUDY

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Introduction Many studies have investigated injury risk factors at lower level of competition levels (Arendt & Dick 1995, Messina et al., 1999, McKay et al., 2001, Anderson et al., 2003, Agel et al., 2007). In contrast, a few studies have focused in women basketball players competing at professional level (Deitch et al., 2006, Junge et al., 2006, Kofotolis & Kellis 2007), but it is clear that more longitudinal studies at elite level athletes are necessary. The purpose of this study was to determine injury rate and risk in female national basketball Greek athletes. Methods Eighty-two female athletes (Senior n=14, U20 n=23, U18 n= 22, U16 n=23) were followed during a two-year period. Injury data were retrospectively reviewed for two-year period. The frequency of all injuries and the rate of game and practice related injuries were calculated. Results Among 82 players, there were 61 injuries ( $S=27.8\%$ ,  $U20=24.6\%$ ,  $U18=24.6\%$ ,  $U16=23\%$ ) with an injury rate of 4.24 per 1000 hours of exposure ( $S=3.72/1000$ ,  $U20=4.1/1000$ ,  $U18=4.4/1000$ ,  $U16=5.5/1000$ )  $p=0.024$ . Ankle and knee sprains represented the most commonly injured region (36.2%) while a considerable number of participants (29.5%) displayed low back pain. Game injury rates were significantly higher compared with those occurring in practice ( $p=0.030$ ). Most injuries were contact injuries with another player  $p<0.001$ , occurring inside the key area of the basketball court  $p<0.001$ . Discussion The results of this study showed that young basketball players display a high injury rate, at all participation levels. It was also very interesting that almost 1/3 of the sample had severe incidents of back pain which prevented them from participation. Given the young age of these players, the provision of safety guidelines regarding prevention of trunk and ankle injuries is absolutely necessary. References Arendt E, Dick R. Am J Sports Med.

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## Poster presentations

### PP-PM56 Soccer 4

#### UNDERSTANDING AND QUANTIFYING THE CORNER KICK IN FOOTBALL

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**INTRODUCTION** In the FIFA World Cup 2010 there was an average of 28.28 shots per game (14.14 per team), but only 10.67 shots on goal (5.34 per team). There was an average of 9.80 corner kicks per game (4.9 per team). The corner kick is a very important opportunity to score. However, knowledge of the corner kick is essentially empirical and there is not enough data to try to understand how we can improve practice and how to take decisions in competitions. **METHODS** Starting from the model of football corners (Almada et al., 2010) we've defined limits for  $t$  (being  $t$  - the time the ball takes to reach the goal area) and the intermediate times in that we can decompose this  $t$  and what actions can be made in those times by the attacking team. We compared all these times with the times that concomitantly were used by the defending team,  $t'$ , and the parcel times that compose this  $t'$ . We've compared the reached conclusions with what we have analyzed in all the 14 corner kicks from the FIFA World Cup 2010 Final (Netherlands-6 vs. Spain-8), trying to see if our definitions where coherent. To do it, we've calculate the time the ball can take to reach the goal area utilizing the ballistic trajectory formula. Simultaneously, we've defined the different conditions that were possible in acceptable limits. We've measured the time the ball took until being touched by any player. The time the attacking team took to prepare their action and their consequences was also taken into account, as well as the time the defending team had to intercept the ball and what the player could do/did. **RESULTS** The ball took a minimum of 960 up to a maximum of 1720 milliseconds to reach the goal or being touched/shot by a player. The attacking players always started their movement before the defending players and 280 milliseconds before the ball being kicked from the corner. No goal was scored from this situation. **DISCUSSION** The definition of possible strategies for the attacking team with the knowledge of the limits of the variables and the limits of their values is feasible and could improve the performance even for a top level team. However, the attacking team could be in advantage if they prepare the right strategy. We can conclude that there are limits that can be reached and are useful, but depending on the objectives aimed there are others that are neither reachable nor useful. Their definitions are interesting to define practice and improving player's performances. **REFERENCES** 1. Almada, F., Fernando, C., Lopes, H. & Vicente, A. (2010). V.M.L., 1

#### DETECTION OF COUNTER-ATTACK INTERACTION PATTERNS IN FOOTBALL

SARMENTO, H.1,2,4, MARTINS, N.1,2, MARTINS, J.3, MARQUES, A.3, BARBOSA, A.1,2, ANGUERA, T.2,3, CAMPANIÇO, J.1,2, LEITÃO, J.1,2

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**Introduction** The purpose of this study was to observe and to characterize the tactical performance in the counter-attack (CA) of three football teams (F.C. Internazionale Milano (IM), FC Barcelona (FCB) and Manchester United (MU)) with different philosophies of the game in the 2009/2010 sporting season. **Methods** Thirty-six games (12 per team) were encoded by using the observational instrument developed by Sarmento et al. (2010). The study of the data reliability was calculated by the intra-observer agreement, and values above 0.95 for all criteria were achieved. For the detection of temporal patterns, we used the software THÈME 5.0, and the following criteria were used: the minimum number of events was set at 3 and the level of significance was set at 0.005. **Results and discussion** We detected 788 T-patterns in the CA developed by the FCB team. One of those is a complete t-pattern, and represents an offensive sequence that occurs three times in different situations and ends in a goal. The CA starts by an interception of the ball in the defensive midfield (lateral right corridor) in a context of relative superiority (i.e., the observed team has one or two more players in the center of the game). The development of the CA was done in a context of numeric equality and the ball moves, by conduction, from the central to the left corridor. The CA ends with a goal, resulting by a shot in the offensive third (central corridor), in a context of relative inferiority (the observed team has one or two players less in the center of the game). The analysis of the CA actions of MU team showed 87 t-patterns (3 completed t-patterns). In relation to the team of the IM, we found only 3 incomplete t-patterns. The analysis of the detected incomplete patterns provided important information about how the teams start, develop and end the CA. The more significant T-patterns will be later explained in a detailed way. **Conclusion** The results show a high variability of environmental situations that are expected at this competitive level. The study of the incomplete patterns made it possible, in a phased way, to characterize the observed offensive actions, and we consider that it is relevant for the understanding of the game. The difference in the number of t-patterns detected in the different teams can explain different philosophies of the game, and suggest that the CA of FCB team has more consistency in their temporal structure than those of other teams. The preliminary data highlights the potential for t-pattern analysis to make a significant contribution to sport performance analysis. Sarmento, H., Anguera, T., Campaniço, J. & Leitão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. Medicina (Kaunas), 46(6), 401-407.

#### OFFSIDE DECISION MAKING SKILLS OF ASSISTANT REFEREES IN FOOTBALL IMPROVE AFTER 12-WEEK TRAINING USING VIDEO FEEDBACK

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**Introduction** An ability to make accurate offside decisions is highly required for assistant referees in football. Helsen et al. (2006) revealed the accuracy of offside decision during 2002 FIFA World-Cup, and reported that the error rate was 26.2%. There have been several attempts to reduce the error rate in offside decisions such as "on-the-field offside test" that evaluates the current decision skills (Gillis et al., 2009). The training effect of the field offside test (offside decision making training, ODMT) is however yet to be investigated. This study therefore aimed to investigate whether 12-wk training using ODMT would improve the offside decision making skills of assistant referees.

**Methods** Eight male assistant referees ( $21 \pm 1$  y-o) having a beginner class licence accredited by Japan Football Association participated in this study. The ODMT was designed based on Helsen et al. (2006) to improve referees' decision makings in a situation difficult to judge offside or inside. Subjects were assigned five complicated situations (varying positions of the ball and players) randomly, with each situation repeated for three times (15 trials, one session/week for 12-wk). All trials were recorded by a video camera. A correct or incorrect decision was respectively assigned 1 or 0 point, determined by the video film. The correctness of the decision and the recorded scene were fed back to the subjects prior to the commencement of next session. The assigned scores in the 1st week were compared to those after 12th week to evaluate the training effect. **Results** The decision score significantly increased from  $9.0 \pm 2.6$  to  $13.0 \pm 1.5$  following the 12-wk training ( $p = 0.0078$ ). **Discussion** To our knowledge, this is the first to have demonstrated the effect of offside decision making training for assistant referees using video feedback. For assistant referees, it is important not only to keep up with the offside line but to keep the most appropriate visual field (Gilis et al., 2006). Catteeuw et al. (2010) suggested that the ideal positions of assistant referees from the field players could be determined by using video feedback. In this study, the subjects indeed received feedback before commencing each training session using the video scene on both the correctness of offside decision and the actual positioning from the field players of the previous session, allowing them to adjust their moves for a better visual field in the subsequent test. The present finding suggests that decision making training can be recommended to improve overall performance of assistant referees. **References** Catteeuw P, Gilis B, et al. (2010) *J Sports Sci*, 28(5):471-81. Gilis B, Hersen W, et al. (2009) *J Sports Sci*, 27(6):551-63. Helsen W, Gilis B, et al. (2006) *J Sports Sci*, 24(5):521-28.

## THE INFLUENCE OF DELIBERATE PRACTICE ON THE OFFENSIVE PERFORMANCE IN YOUTH SOCCER

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**Introduction** The influence of deliberate practice on skill acquisition in sports remains an actual and debatable issue among researchers and coaches (Ericsson, 2006; Williams & Ford, 2008). The autonomous playing experiences seem to influence skill acquisition in different way, when compared with the activities specifically designed to improve performance. The present study aimed to analyze the influence of deliberate practice on the offensive sequences performed by different experienced level groups of young soccer players. **Methods** Thirty under-15 males were distributed per two groups according to their deliberate practice experience in soccer game: the Non-Experienced group (N-Exp) and the Experienced (Exp) group ( $3.87 \pm 0.99$  years of experience). The experimental protocol consisted of three independent sessions separated by one week intervals. In each session both groups participated in two small-sided games (Gk+3v3+Gk and Gk+6v6+Gk) during 10 minutes interspersed with 5 minutes of passive recovery. Two types of performance indicators were used to characterize the observed Offensive Sequences (OS): the simple parameters (SP) and the composite parameters (CP). The SP were simple counts of the game performance: Duration of Ball Possession, Number of Players Involved, Ball Touches, Number of Passes, Number of Shots. The CP were defined as "ratios" obtained by dividing two SP: Number of Players/Duration of Ball Possession, Ball Touches/Duration of Ball Possession, Number of Passes/Duration of Ball Possession, Ball Touches/Number of Players, Number of Passes/Number of Players, Number of Passes/Ball Touches and Goal/Shots. A non-parametric MANOVA was used to analyze the effect of "experience level" on the OS characteristics. **Results** The factor 'experience level' revealed a significant effect on SP and CP that characterize the OS in four-a-side ( $\chi^2(5) = 20.604$ ;  $p = 0.001$  and  $\chi^2(6) = 24.072$ ;  $p = 0.001$ , respectively) and seven-a-side games ( $\chi^2(5) = 14.592$ ;  $p = 0.012$  and  $\chi^2(6) = 14.592$ ;  $p = 0.024$ , respectively). **Discussion** Results demonstrate that deliberate practice experience can be a relevant factor for improving sport-specific game skills of young soccer players. While the Exp group adopted a more positional style of play, with a larger ball circulation between players, the N-Exp group performed faster OS where the individual actions were predominant. **References** Ericsson KA (2006). The influence of experience and deliberate practice on the development of superior expert performance, 685-706. Cambridge University Press, New York. Williams AM, Ford PR (2008). *Int Rev of Sport Exe Psychol*, 1, 4-18.

## SEASONAL BIRTH EFFECT AND HEIGHT, WEIGHT AND GIRTHS MEASURES OF YOUNG SOCCER PLAYERS

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**Introduction** The morphologic characteristics of athletes can determine in several ways the success they will achieve in a few particular sports (Matkovic et al., 2003). So, the purpose of this study was to show how the seasonal birth influences the anthropometric variables and the performance level of elite young soccer players, disregarding the effect of bone age. **Methods** A total of 133 under-15 young soccer players were studied. Each participant was measured in some anthropometric variables, namely height, weight and calf, thigh and upper arm girth (see Marfell-Jones et al., 2006). The athletes were divided in four trimesters: first trimester with a  $n=60$  (45.1%); second trimester with a  $n=43$  (32.3%), third trimester with a  $n=22$  (16.6%) and; fourth trimester with a  $n=8$  (6.0%). Soccer-specific performance was obtained according to the success level achieved by each soccer player: Level 1, representing those who were dismissed from the club (27.8%); Level 2, player that stayed on the club but was never called to a youth selection (28.6%); Level 3, player that is called to the district selection (23.3%) and; Level 4, player of youth international level (20.3%). Maturity (bone age) was evaluated through Tanner-Whitehouse III Method (TW III). The 4 groups were compared with ANCOVA using the SPSS for windows (v.18.0). Permissions from parents and from the boys (self assent) were obtained before data collection. **Results** The athletes that achieve a higher degree of success in this sport were the ones that obtained better scores in the physical anthropometric's tests, and it should also be noted that most of them were born during the first semester of the year (77.4%). However the results showed that in general the studied groups were very similar in what respect anthropometric variables. The only exceptions were height (1-3;  $p=.034$ ) and arm girth (2-3;  $p=.043$ ) when comparing the four trimesters and arm girth (2-3;  $p=.044$  and 3-4;  $p=.022$ ) when comparing the four performance levels. **Discussion** Although the present results enable the conclusion that the young soccer players born in the first two trimesters (77.4%) of the year are, in general, taller, heavier and have larger calf, thigh and upper arm girth, only the height and arm girth presented significant differences. Besides that, the four groups of performance had very similar anthropometric results, which mean that after removing the bone age effect they seem to show a very identical robustness. **References** Marfell-Jones M, Olds T, Stewart A, Carter JEL (2006). *International Standards for Anthropometric Assessment* (revised 2006). Underdale, S.A.: ISAK. Matkovic BR, Durakovic MM, Matkovic B (2003). Morphological differences of elite Croatian soccer players according to the team position. *Coll. Antropol.*, 27(1), 167-74.

## THE TIME-COURSE OF CHANGES IN SKILL PERFORMANCE OF ELITE FOOTBALL PLAYERS FOLLOWING RESISTANCE EXERCISE IS INTENSITY-DEPENDENT

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**Introduction** Resistance exercise-induced muscle damage is associated with an acute-phase inflammatory response characterized by phagocyte infiltration into muscle, free radical production, and performance deterioration (Margonis et al., 2007). Resistance training is essential for the physical preparation of elite football players. However, little is known regarding the effects of resistance training on skill performance of football players. Therefore, the present investigation aimed to determine whether the time-course of changes in skill performance of elite football players following resistance training is intensity-dependent. **Methods** Following familiarization, 16 elite football players (20.1±0.7 yrs) participated in three different trials in a counterbalanced fashion: a) controlled trial (C, subjects participated only in the measurement procedures but they abstained from exercise), b) low-intensity resistance exercise protocol (LIR, 4 sets of 8-10 reps/set at 65% 1RM), and c) high-intensity resistance exercise protocol (HIR, 4 sets of ≤ 6 reps/set at 85-90% 1RM). Squat, side lunges with a barbell, leg curls, leg extension, calf raises were the exercises used in HIR and LIR. In each exercise trial, blood sampling and measurement of muscle damage markers (delayed onset of muscle soreness-DOMS, knee joint range of motion-KJRM, thigh girths) and football performance (short passing, dribbling, long passing, shooting, heading) were measured before exercise, 12 hours post-exercise as well as daily for six consecutive days. Blood samples were analyzed for creatine kinase activity (CK), white blood cell count (WBC), and CRP concentration. **Results** The control trial demonstrated no changes in all dependent variables measured. Both HIR and LIR induced a moderate DOMS and inflammatory response that peaked 24h post-exercise and subsided thereafter. Short passing was improved 48h following exercise in both groups. Furthermore, dribbling, heading, and long passing remained unaffected throughout recovery in both groups. However, shooting deteriorated for 12h post-exercise and recovered thereafter. **Discussion** In agreement with previous reports (Jamurtas et al., 2000), the results of the present study indicate that resistance training elicits only a moderate muscle damage response for as long as 24h. Besides shooting, football skill performance appears to remain unaffected by resistance training. These results suggest that resistance exercise is not a critical factor for skill performance within a training microcycle. **References** Jamurtas AZ, Fatouros IG, Buckenmeyer PJ, Kokkinidis E, Taxildaris K, Kambas A, Kyriazis G. (2000). J Strength Cond Res, 14(1), 68-74. Margonis K, et al. (2007). Free Radic Biol Med, 43, 901-910.

## REPORTING THE DEVELOPMENT OF A TACTICAL ASSESSMENT SYSTEM IN SOCCER

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**Introduction** Assessment tools commonly used in the analysis of tactical behaviour have often been criticized because of their limitations in evaluating specific game characteristics, as well as there being little connection with the different structure and elements developed in training sessions. Accordingly, several researchers have recommended the development of tactical assessment tools should take into account specific aspects of the game as well as its training settings. The purpose of this study is to report the development and preliminary validation of a tactical assessment system in Soccer (FUT-SAT). **Methods** The system was designed to assess player's tactical actions (with and without the ball) according to ten core tactical game principles. Furthermore the evaluation took into account the location of the action and its outcome. The field test was designed in a space of 36 meters long by 27 meters wide and required the player to perform during four minutes (3 vs. 3 with goalkeepers). The validation process followed the main suggestions of Cronbach (1988): i) the players accept the fairness and accuracy of the test; ii) the analysis is carried out by a panel of experts; iii) the ability of the panel to assess the quality of the player's performance; iv) observer reliability. **Results** The players who carried out the field test agreed with its fairness and accuracy. It was found values higher than 0.63 for correlations between coaches' assessments and the system, showing the potential of FUT-SAT to distinguish the performances of players on the basis of the coaches' evaluations. All experts endorsed the categories and variables of this system. Reliability estimates were higher than 0.79 for intra and inter-observers. **Discussion** This system presents some improvement in the evaluation of players' behaviour related to the objective measures of players' movements on the field. This critical point has been mentioned by the literature as being a necessity in the construction of reliable assessment tools in match and training contexts (Olsen & Larsen, 1997). Additionally, the evaluation of the tactical actions performed by the players (with and without the ball), according to ten core tactical principles of the Soccer also provide advantages in evaluations carried out throughout the training process (Gréhaigne & Godbout, 1998). Therefore, it is possible to conclude that the system is valid and reliable for the assessment of the tactical behavior of soccer players. **References** Cronbach, L. J. (1988). Five Perspectives on Validity Argument. In H. Wainer & H. I. Braun (Eds.), Test Validity (pp. 3-17). New Jersey: Lawrence Erlbaum Associates, Inc. Gréhaigne, J. F., & Godbout, P. (1998). Formative Assessment in Team Sports in a Tactical Approach Context. JOPERD, 69(1), 46-51. Olsen, E., & Larsen, O. (1997). Use of match analysis by coaches. In T. Reilly, J. Bangsbo & M. Hughes (Eds.), Science and Football III (pp. 209-220). London: E & FN Spon.

## COMPARISON OF SPECIAL EXERCISE AND SOCCER ORIENTED EXERCISE IN AMATEURS SOCCER PLAYERS

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Sprint and vertical jumping abilities are usually improved by jumping exercises [2], and can be classified in general, special and specific. The general exercises are divided into analytical and global, the special in general and oriented, and the specific in pure and analytical [1]. The aim of this work is to evaluate the vertical jumping ability related to special-general exercises and special-soccer oriented exercises. **METHODS** 46 amateur soccer players (19.1±4.8 yr; height 176.8±5.8; weight 69.6±7.8) were tested with the Optojump (Microgate, Bolzano, Italy) [3], measuring the vertical jump height in two different jumping exercises. Every jumping session was made up of 3 trials, and the average jump height value has been computed for every one. Special-general exercises squat jumps (SJ) and counter movement jumps (CMJ), both with arms swing, have been performed. In the SJ the subjects started to jump from a standard position (sitting on a bench top 50 cm). The special-oriented exercises have been performed in the same way but with one variation: the ball has been launched by the coach from a distance of about 3 m, giving a task to hit the ball as high as possible (SJball - CMJball). Every trial has been executed after a rest of 30 seconds, while the recovery period between every session was one minute. The data were analyzed using paired T-test using SPSS software v. 17 (SPSS Inc, Chicago, IL). The significant level was set up to p<.05. **RESULTS** The mean value of

SJ, SJball, CMJ and CMJball, were respectively,  $40.9 \pm 5.7$ ,  $36.9 \pm 6.2$ ,  $41.9 \pm 5.9$  and  $37.5 \pm 6.6$  cm. There is a significant difference between SJ and SJball ( $p < .001$ ) and between CMJ and CMJball ( $p < .001$ ). **DISCUSSION** The mean jump height reached without ball during a SJ is significantly higher compared with the mean jump height reached when the ball is launched by the coach (SJball). The mean jump height reached without ball during a CMJ is significantly higher compared with the mean jump height reached when the ball is launched by the coach (CMJball). This data suggest that, during special-soccer oriented exercises, the expression of lower limb muscular strength is less than during special-general exercises. A player must be trained to perform a specific task in order to be able to execute the specific-exercise expressing his maximum potential. **REFERENCES** [1]Cometti G. (2005) In La Préparation En Football. [2]Chelly MS, Ghenem MA, Abid K, Hermassi S, Tabka Z, Shephard RJ. (2010) J Strength Cond Res. 24:2670-6. [3]Glatthorn JF, Gouge S, Nussbaumer S, Stauffacher S, Impellizzeri FM, Maffiuletti NA. (2010) doi: 10.1519/JSC.0b013e3181ccb18d Jul 17.

## HEAT STRESS AND DECISION MAKING IN ELITE SOCCER REFEREES

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**HEAT STRESS AND DECISION MAKING IN ELITE SOCCER REFEREES** Clarke, N.D.1, Gregson, W.2, Drust, B.2, Reilly, T. 2, Helsen, W.3 and Weston, M.4 1: London Metropolitan University (UK), 2: Liverpool John Moores University (UK), 3: K.U.Leuven (Belgium) 4: Teesside University (UK) Introduction Soccer refereeing represents a significant physical and mental challenge (Castagna et al., 2007). Heat stress and dehydration have been shown to decrease performance of cognitive abilities such as decisional and perceptual tasks (Hancock, 1986). However, no previous study has determined the effect of heat stress on elite referees' ability to make match-specific decisions. The aim of this study was to examine the effect of heat stress on the physiological and cognitive responses of elite soccer referees during an exercise protocol simulating the demands of match-play. Methods Eight professional male soccer referees (age:  $37 \pm 5$  years) performed a 90-min referee-specific intermittent exercise protocol under laboratory ambient temperatures of  $33^\circ\text{C}$  (HEAT) and  $12^\circ\text{C}$  (COOL) (RH 70%). Rectal and skin temperatures and heart rate (HR) were recorded continuously. The accuracy and speed of the referees' decision making was assessed via digital video clips of match incidents every 3 min, on which the referees had to award the appropriate sanction. The appropriate sanction for each clip was previously determined by an independent panel of FIFA referees. Non-specific simple (SRT) and choice reaction times (CRT) were also recorded on 30 and 12 occasions, respectively. Results Rectal temperature was similar during HEAT compared with COOL after 45-min (HEAT:  $38.6 \pm 0.2^\circ\text{C}$ , COOL:  $38.4 \pm 0.4^\circ\text{C}$ ;  $P=0.08$ ) and was greater at exercise cessation (HEAT:  $39.6 \pm 0.3^\circ\text{C}$ , COOL:  $38.4 \pm 0.4^\circ\text{C}$ ;  $P<0.001$ ). Mean skin temperature and HR were also higher throughout HEAT ( $P<0.001$ ). There were no between-trial differences in the referees' accuracy (HEAT:  $62 \pm 15\%$  COOL:  $52 \pm 8\%$ ;  $P=0.07$ ) or speed (HEAT:  $757 \pm 455$  ms COOL:  $752 \pm 243$  ms;  $P=0.69$ ) of decision making during the match-specific incidents or SRT (HEAT:  $445 \pm 77$  ms COOL:  $412 \pm 72$  ms;  $P=0.73$ ). However, CRT was slower in the HEAT trial (HEAT:  $685 \pm 70$  ms COOL:  $661 \pm 63$  ms;  $P=0.03$ ). Discussion Performing a referee-specific exercise protocol in the heat does not impair the speed or accuracy of making match-specific decisions in elite soccer referees. In contrast, non-specific tasks may be impaired in the heat. These observations may reflect the use of elite referees in the current study. Expert performers are better able to cope with changing conditions such as physiological stress (McMorris & Graydon, 1996), possibly due to developing automatic processes in task performance. Consequently, in highly learned tasks, stress does not have the opportunity to disrupt the link between stimulus and response (Hancock, 1986). References Castagna et al. (2007). Sports Med, 37, 625-646. Hancock (1986). Psychol Bull, 99, 263-281. McMorris & Graydon (1996). J Hum Movement Stud, 30, 177-193.

## IMPROVEMENTS IN FUNCTIONAL MOVEMENT SCREEN SCORES ACROSS 6 MONTHS OF IN-SEASON STRENGTH AND CONDITIONING TRAINING IN ELITE ACADEMY FOOTBALL PLAYERS

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**Introduction** In elite academy football injuries occur at a rate of 37.2 and 4.1 per 1000 game/training hours respectively (Hawkins and Fuller, 1999). Players are injured on average 0.4 times per season with each injury prohibiting normal activity for an average of 21.9 days, equating to the player missing about 6% of the season and consequently a large portion of his development (Price et al., 2004). Epidemiological data indicate the most prominent risk factor associated with injury is previous injury and thus it is prudent to use methods of movement screening to predict functional specific weaknesses, with a view to intervening and reducing injury incidence (Kiesel et al. 2009). One method easily administered is the functional movement screen (FMS) that manipulates extremes of mobility and stability to uncover limitations and asymmetries in movement (Cook et al. 2006). This particular screening tool indicates that players scoring lower than 14 within the FMS are more likely to be injured (Kiesel et al. 2009). **Aim** To evaluate changes in FMS scores within elite academy players through a 6 month in-season strength and conditioning programme. **Methods** 6 elite football academy players ( $17.4 \pm 0.1$  yrs;  $1.75 \pm 6.6$  m;  $66.2 \pm 5$  kg) undertook a 6 month (once or twice a week in season) strength and conditioning programme consisting of developing technique (1st month) followed by a periodised programme consisting of strength and power phases. This programme incorporated the following exercises, snatch, clean and jerk, squat, overhead squat, deadlift, prone row, bench press, stiff leg deadlift and nordic hamstring curl. FMS was assessed pre and post. Data were analysed using Wilcoxon Signed Ranks Test. **Results** Mean total scores increased from pre ( $13.8 \pm 1.2$ ) to post ( $17.5 \pm 0.9$ ,  $P=0.03$ ). Significant differences pre and post were observed in overhead squat, in-line lunge and trunk stability ( $P=0.03$ ). In season there were 2 incidences of non-contact lower limb injury resulting in 3 lost training days. **Discussion** Positive changes were apparent in FMS scores over the 6 month intervention. Players improved in two of the three tests relating to the lower body function (overhead squat, in-line lunge), where the majority of football injuries occur (Hawkins and Fuller, 1999). Furthermore players maintained scores in the active straight leg raise demonstrating that hamstring length was maintained throughout the competitive season through use of eccentric hamstring exercises. This is despite football training and match play reducing hamstring range of motion, reducing function score and increasing lower limb injury risk (Engebretsen et al. 2010). **References** Cook G, et al. (2006). North Am J Sports Phys Ther, 1, 62-72. Engebretsen A, et al. (2010). Am J Sports Med, 38, 1147-1154. Hawkins R, Fuller, C. (1999). Br J Sports Med, 33, 196-203. Kiesel K, et al. (2009). Scand J Med Sci Sports, 1038. Price R, et al. (2004). Br J Sports Med, 38, 466-471.



## MONITORING OF BODY LOADING FOR RUGBY PLAYERS DURING TRAINING SESSION BASED ON "SMALL SIDED GAMES" METHOD.

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**INTRODUCTION** The purpose of this study is to investigate the relation between the external and internal body load on rugby players, in order to verify the efficacy of control method to be used in action on field. In team sports, as rugby game, it is very complex to obtain reliable measurements because there are a lot of factors impacting the performance. Moreover it has to be pointed out that the instruments in use are often poor, the high costs and the reduced ecological validity where these experiences are carried out in laboratory (Bakatash). **METHODS** The research has been carried out on 24 subjects, divided in 4 player groups having a different qualification: (G1) six elite junior players; (G2) six senior amateur players; (G3) six senior professional players; (G4) six non-professional women players. In order to investigate on this relation, 8 different "small sided games" (SSG) have been identified, which are often used in high level rugby training, and then three have been chosen randomly and proposed to the four different player groups, in one only training session. In the body load evaluation it has been decided to use the Heart Rate (HR) survey, by calculating the % of highest HR of such player during the whole training session including three exercises, and then to proceed to the calculation for the SSG individuals, by using 6 "Polar team system®". In order to evaluate the individual perceived exertion after each SSG and after the training session, the players have been submitted to the RPE-Borg (CR10) test, according the following timing conditions: within 2' at the end of SSG, within 10' at the end of training session. The internal body load has been determined according the procedure proposed by Coutts and Impellizzeri (2003). **RESULTS** In order to verify the correlation between the HR and the obtained score in RPE, the Pearson test has been used. The following significant correlations have been found: (G1)  $r=0.66$ ; (G2)  $r=0.53$ ; (G3)  $r=0.85$ ; (G4)  $r=0.57$ . **DISCUSSION** At the end of this research we can state that the higher qualification level of players corresponds to the higher correlation between RPE/HR session. There are no difference among the different training typologies, that is to say an high match action "in the defence" or fixing training "in front of the defence" and so we can say that the use of RPE-Session through the "training body load" calculation as perception of body load in rugby activity, is a reliable, simple and inexpensive methodology. **REFERENCES** G.Borg (1998). Borg's Perceived Exertion and pain scales Human Kinetics A.Coutts PhD; F.M.Impellizzeri; "The monitoring of training of team sports with particular reference to football" in Teknosport n.29, September-October 2003. S.Bakatash, A.Hy, S.Muir, T.Walton, Y.Zhang, The Effects of Different Instep Foot Positions on Ball Velocity in Palce Kicking, Int.Journal of Sports Science and Engineering 03(2010)085-092.

## TIME-MOTION ANALYSIS IN RUGBY SEVENS

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**Introduction** The purpose of this study was to perform a Time Motion Analysis in "Rugby Seven", in high level players, involved in a real competitive event under the kinematics and dynamics points of view. "Rugby Seven", that will be an Olympic Sport in 2016, is still poorly investigated, particularly regarding to the performance model. **Methods** Three Italian elite players men (age  $26.6 \pm 4.5$  yrs; body mass  $80 \pm 4.3$  kg; height  $175.3 \pm 1.5$  cm; years of experience  $15 \pm 4.5$  yrs) were monitored during four matches at the "Rome Seven's" international tournament through the SPI ELITE GPSport Systems®, 3 cardio-frequency meters Polar team system® and the software GPSport Team AMS v1.2.1.0. These parameters were analyzed: the Total Distance Covered (TDC; m); the Distances covered in each different speed zones (DSZ; m); the percentage of the Distance Covered (DCSZ%) and the Time Spent (TSSZ%) in the different speed zones, the amount of repeated Sprints (S), the amount and the intensity of Impacts (nl; gl) and the Heart Rates (HR). **Results** (TDC) of  $1260.5 \pm 196.1$  m, (match time 14'). On the first half was  $629.35 \pm 52.4$  m while on the second half a mean value of  $630.9 \pm 149.87$  m. (DCSZ%): (0-6 km/h):  $41.3 \pm 0.24\%$ ; (6-12 km/h):  $25.8 \pm 1.76\%$ ; (12-14 km/h):  $9.7 \pm 2.68\%$ ; (14-18 km/h):  $12.7 \pm 3.57\%$ ; (18-20 km/h):  $2.9 \pm 0.40\%$ ; (20 km/h-Upper):  $7.8 \pm 3.83\%$ . (S) : [1.50-1.99 m/s-s]:  $n=12.5 \pm 3.42$ ; TD =  $15 \pm 10.12$  m; mean acceleration (Ma)  $1.7 \pm 0.14$  m/s-s. [2.00-2.49 m/s-s]:  $n=12 \pm 1.49$ ; TD =  $22.4 \pm 17.50$  m; (Ma)  $2.2 \pm 0.12$  m/s-s. [2.50-2.74 m/s-s]:  $n=20 \pm 3.47$ ; TD =  $17.9 \pm 10.83$  m; (Ma)  $2.6 \pm 0.06$  m/s-s. [ $a > 2.50$  m/s-s]:  $n=1.3 \pm 1.80$ ; TD =  $21.1 \pm 9.66$  m; (Ma)  $3.2 \pm 0.57$  m/s-s. (nl; gl): Zone (Z) 1 (5-6 gl):  $37.9 \pm 9.8\%$ ; (Z) 2 (6-6.65 gl):  $34.6 \pm 16.8\%$ ; (Z) 3 (6.5-7 gl):  $12.3 \pm 4.9\%$ ; (Z) 4 (7-8 gl):  $9.2 \pm 4.6\%$ ; (Z) 5 (8-10 gl):  $5.3 \pm 1.1\%$ ; (Z) 6 (10-12 gl):  $0.8 \pm 0.3\%$ . Heart Rates were recorded throughout all the matches and expressed as Percentages of the maximal theoretical Heart Rate (HR), computed according to Tanaka's equation (Tanaka, 2001). We observed a mean HRmax% of  $93.13 \pm 3.25\%$ . **Discussion** There are no significant differences between the total distance covered in each half of the match, maybe due to the reduced game time. We found worth mentioning the amount of the recorded sprints at high acceleration rate [2.50-2.74 m/s-s:  $n=20 \pm 3.47$ ; TD =  $17.9 \pm 10.83$ m; mean acceleration  $2.6 \pm 0.06$  m/s-s] whereas in Rugby Union only 10 sprints of this class were found over 83' of game (Cunniffe, 2009). The observed mean HRmax% throughout all the matches witnessed the high physical demands imposed by this sport discipline. **Reference** Cunniffe B, Proctor W, Baker JS, Davies B.(2009). An evaluation of the physiological demands of elite rugby union using global positioning system tracking software. J Strength Cond Res 23, (4),1195-1203 Tanaka H, Monahan KD, Seals DR.(2001). Age-predicted maximal heart rate revisited. J Am Coll Cardiol 37,(1),153-156.

## Poster presentations

### PP-PM57 Training and Testing: Maximal Exercise 2

## RELATIONSHIP BETWEEN HAEMOGLOBIN MASS, BLOOD VOLUME, VO2MAX AND PEAK CARDIAC OUTPUT IN ROWERS

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**Introduction** VO2max is a strong predictor of rowing performance [1]. It has been shown that rowers possess a high VO2max, which is correlated to total haemoglobin mass (tHb) and blood volume (BV) [2]. Since rowers work at high intensities with large muscle groups, O2-delivery is likely to limit VO2max in this group of athletes. O2-delivery is determined by O2-transport capacity - explaining the importance of tHb - and by cardiac output (Q). Up to now, there are no data that describe the relationship between tHb, VO2max and especially BV and Qpeak in rowers. Therefore, this was the focus of our study. **Material and Methods** 9 trained rowers (age =  $21 \pm 3$  y (19 - 37); height =  $187 \pm 17$  cm (177 - 193); body mass =  $84 \pm 10$  kg (72 - 107); VO2max =  $53 \pm 10$  ml/kg/min (47 - 66)) performed a VO2max-test on a rowing

ergometer (Concept 2, Morrisville, USA). tHb was measured and BV was calculated according to [3]. Q was measured on a cycle-ergometer with an inert-gas rebreathing technique (Innocor, Innovision, Odense, DK). For attaining near maximal conditions, Qpeak was measured at a work load equal or higher than 90 % of VO2max, which was determined in a preceding test. All data are Median (Min - Max). Correlations were calculated by Spearman's coefficient (rSP). Results The inert gas rebreathing maneuver for determination of Qpeak was performed at 93 % (90 - 100) of VO2max. Qpeak amounted to 23.6 l/min (18.8 - 30.7). tHb was 1039 g (930 - 1358), BV was 7390 ml (6679 - 9096). Analysis of correlation revealed rSP(VO2max:tHb) = .69; rSP(VO2max:BV) = .67; rSP(Qpeak:tHb) = .78, rSP(Qpeak:BV) = .80, rSP(Qpeak:VO2max) = .83. The ratio Qpeak:BV in the whole group was 3/min. Discussion We measured Q in rowers in near maximal or maximal work conditions. The strong correlation of BV:Qpeak explains the correlation of BV and VO2max in rowers, that has been shown in previous studies [2]. A large BV increases cardiovascular preload and consequently enhances stroke volume (and Q) via the Frank-Starling-mechanism in a compliant heart. Q is a key variable of the Fick principle and therefore strongly correlated to VO2max. The relationship between tHb and VO2max is obvious, since tHb determines O2-transport capacity and consequently affects avDO2. Finally, the ratio of Q:BV indicates, that the blood passes the cardio-respiratory system 3 times per minute at high intensive rowing. Conclusion The study illustrates the relationship between BV and Qpeak and underlines the importance of blood volume and oxygen delivery for VO2max in rowers. References [1] Wolf W, Roth W (1987). *Med Sport (Berl)* 6:162-66. [2] Treff G et al. (2008). *Med Sci Sports Exerc*, 40(5):S397. [3] Schmidt W, Prommer N (2005). *Eur J Appl Physiol*, 95:486-95.

## UP-HILL TREADMILL TESTING PREDICTS CROSS-COUNTRY RUNNING PERFORMANCE IN YOUNG ELITE ORIENTEERS

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**Introduction** Cross-country running performance in elite orienteers has most often been evaluated through level treadmill testing. More recently, Zürcher et al., 2005, evaluated Swiss elite orienteers' ability to perform extreme uphill treadmill running at 22% inclination (INC) in preparation for the WOC in Japan, but the relationship to field performance was not investigated. The aim of the present study is to test the hypothesis that uphill treadmill testing may be a better test indicator for cross country running performance compared to level testing. **Methods** Thirteen young Danish elite orienteers (7 women, 6 men) participated in the project (Age: 18.7±2.3 years), including several medal winners at the JWOC 2010 and EOC 2010. Level, 0% INC, as well as up-hill submaximal treadmill runs (15% INC) were performed at succeeding days in the lab. Maximal oxygen uptake (VO2max) was measured during semi-level (2-8% INC) and uphill conditions (15% INC). Within 3 weeks of lab testing, a 4.5 km cross country course was raced individually by the participants (short dist. orienteering course previously raced by the participants). Finishing time served as indicator for cross-country field performance. Results Men performed faster than women in the field performance test (25:32 min vs. 31:46 min, p < 0.001). During uphill running, the velocity triggering 4 mmol lactate conc. in the blood showed higher correlation values with cross-country performance compared to the equivalent level velocity in both men and women (Men: r = -0.88, p < 0.05 vs. r = -0.53, ns; Women: r = -0.85, p < 0.05 vs. r = -0.71, ns). Overall comparison: r = -0.95, p < 0.0001 vs. r = -0.88, p < 0.0001 for uphill and level respectively. VO2max was higher during up-hill treadmill testing compared to semi-level testing (P < 0.05). **Discussion** In competitive orienteers tested at level conditions (0-2% INC.), it has been shown that VO2max and running velocity at the onset of blood lactate accumulation are predictors of cross-country running performance (Jensen et al., 1994, 1999; Moser et al., 1997). Here we show that uphill testing leads to higher VO2max in some, but not in all orienteers, and that uphill testing further contributes to prediction of cross country field performance with strong correlation within gender groups. We suggest to use uphill testing for prediction of cross-country running performance in elite orienteers. References Jensen K, Franch J, Kärkainen O-P, Madsen K. (1994). *Scand. J. Med. Sci. Sports*. 4, 234-238. Jensen K, Johansen L, Kärkainen O-P. (1999). *J. Sports Sci.* 17, 945-950. Moser T, Gjerset A, Johansen E, Vader L. (1997). *Sci. J. Orienteering*. 13, 4-25. Zürcher S., Clemen G, Marti B. (2005). *Sci. J. Orienteering*. 16, 4-11.

## DIFFERENT TREADMILL-PROTOCOLS TO ASSESS VO2MAX IN WELL-TRAINED RUNNERS

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**INTRODUCTION:** Several different test protocols exist to estimate VO2max on the treadmill. They usually differ in speed, treadmill gradient and the increments of both as well as the duration per step. Some ramp test protocols are not challenging enough for trained athletes to reach exhaustion within target time of 8 to 12 min. Therefore we chose four demanding ramp test-designs and one incremental step test as control protocol to measure VO2max in trained athletes. We hypothesized that above mentioned differences effect the maximal oxygen consumption. **METHODS:** 14 male well-trained athletes (26.1 ± 4.2 yrs; 184.0 ± 6.2 cm; 78.0 ± 6.2 kg) participated in the study. They performed five different treadmill protocols in randomized order: 1. Incremental step test (ST) (2.8 m/s; increase 0.4 m/s every 5 min). 2. Velocity-dependent ramp test (VR) (12 km/h; increase 0.5 km/h every 30 sec.). 3. Ramp test designed by Costill/Fox (Kang et al. 2001) (CF) (4.0 m/s constant speed; increase 2% in treadmill gradient every 2 min). 4. Velocity and gradient- dependent ramp test (VGR) (2.4 m/s for 2 min; increase 0.2 m/s every 30 sec. till 4 m/s; then 0.5% in treadmill gradient every 30 sec.). 5. Individual Protocol (IP) (increases in velocity and treadmill gradient at will). Oxygen uptake was measured with a portable Spirometry-system (Metamax 3b, Cortex, Germany). ACSM-criteria for exertion were met in all tests. **RESULTS:** Time to exhaustion (test duration until subjects voluntary stopped the protocol due to individual exertion) for each test protocol was: ST 25.5 ± 3.0; VGR 10.9 ± 1.5; IP 9.8 ± 0.9; CF 7.5 ± 1.2; VR 7.3 ± 1.1 min. Despite CF vs. VR (p=0.58) other differences are significant (VGR vs. IP p<0.03, all other combinations p<0.01). The highest oxygen uptakes measured during the five tests were: CF 63.1 ± 3.2; VGR 62.6 ± 5.0; VR 61.8 ± 4.1; IP 61.5 ± 4.3; ST 59.5 ± 4.1 ml/min/kg. These differences were only significant between ST and all ramp test protocols (ST vs. VR/CF/VGR: p<0.01; ST vs. IP: p<0.02). Between the ramp test protocols there were no statistical differences in VO2max, RQ, max. heart rate and blood lactate concentration. **DISCUSSION:** Although the test durations were significantly different in most protocols no significant differences in VO2max, RQ, max. blood lactate or max. heart rate could be measured. Thus, in contrast to our hypothesis, the exercise protocol (variations in velocity and treadmill gradient) of a ramp test seems to have no effect on VO2max, as long as cardio-respiratory exhaustion is reached within target time, that might be even shorter than 8 - 12 minutes. Therefore all ramp test protocols used in this study can be recommended for well-trained athletes.

**REPRODUCIBILITY OF TREADMILL TESTS TO EXHAUSTION IN RATS: IS THERE A SLOPE EFFECT?**

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**Introduction** Accurate exercise tests with animal models are of paramount importance in the evaluation of exercise capacity and aerobic function (Booth et al, 2010). Previous studies have shown a good reproducibility (CV typically ~5%) of maximal oxygen uptake measurement (Wisloff et al, 2001; Copp et al, 2009). However, the reproducibility of peak treadmill velocity (Vpeak), time to exhaustion at Vpeak (Tlim@Vpeak) and the effect of incline treadmill on these parameters are not known. The aim of this study was to determine the reproducibility of Vpeak and Tlim@Vpeak in level vs. 25° grade treadmill running in rats. **Methods** Twelve young male Wistar rats (317±3g) performed a total of 8 treadmill tests to exhaustion separated by 48h rest: 2 level incremental tests, 2 incremental tests with 25° grade, 2 level constant- and 2 constant-speed tests with 25° grade. The incremental tests to determine Vpeak involved 2min stages with 8 or 5 cm/s speed increments at 0° or 25° grade respectively. The constant-speed tests were performed at Vpeak to determine Tlim@Vpeak. Blood samples were obtained at the tip of the tail during each test after 3min of recovery for maximal blood lactate determination. Results Vpeak during level treadmill running was 73±2 cm/s and decreased to 45±2 cm/s with 25° grade with similar CV (22±3 and 20±4% respectively). Tlim@Vpeak during level running was 446±95s and remained unchanged at 451±85s with 25° grade with equivalent CV (30±9 and 44±11% respectively). CVs were significantly higher for Tlim@Vpeak than for Vpeak (P<0.05). Maximal blood lactate was 8.4±0.7 and 8.6±0.9 mmol/L after level vs. 25° grade incremental tests and was not different after Tlim@Vpeak (7.0±0.6 vs. 7.7±0.9mmol/L at level or 25° grade respectively). CVs for maximal blood lactate were similar whatever the type of test or the slope of the treadmill (ranging from 19 to 26%). **Discussion** These data demonstrate that duplicate Vpeak and Tlim@Vpeak tests give similar group mean results with intra-rats CV being unaffected by the treadmill slope. However, intra-rat CVs for Tlim@Vpeak are greater than for Vpeak. Both Vpeak and Tlim@Vpeak tests lead to similar maximal blood lactate with equivalent CVs with no effect of the treadmill slope. It is concluded that 25° grade vs. level treadmill running does not allow for a better reproducibility of usual exercise performance parameters in rats. **Bibliography** Booth FW, Laye MJ, Spangenberg EE (2010) J Appl Physiol, 108, 219–221 Wisloff U, Helgerud J, Kemi OJ, Ellingsen Ø (2001) Am J Physiol Heart Circ Physiol, 280, H1301–H1310 Copp SW, Davis RT, Poole DC, Musch TI (2009) J Appl Physiol, 106, 1072–1078

**DETERMINING EXERCISE INTENSITY AT MAXIMAL OXYGEN UPTAKE: METHODOLOGICAL ISSUES AND REPEATABILITY**

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**DETERMINING EXERCISE INTENSITY AT MAXIMAL OXYGEN UPTAKE: METHODOLOGICAL ISSUES AND REPEATABILITY** **Introduction** The minimum exercise intensity that elicits 2max (2max) is one of the most pertinent factors associated with endurance exercise performance (Jones and Doust, 2000; Berthon and Fellmann, 2002). A direct method of determining 2max from a single incremental test utilising 1 minute stages is favoured in research (Billat et al., 1996); however, this approach is limited by the size and duration of the increments used. The aims of this study were to address those limitations to develop a method that more accurately determines minimum 2max from a single trial and then assess the repeatability of the modified method (MM). A secondary aim was to compare the 2max value produced by a single trial of MM with a refined 2max value (RV) derived from repeated trials of MM. **Methods** Seventeen male cyclists (age 33.9 ± 7.7 years, body mass 80.9 ± 10.2 kg, height 1.82 ± 0.05 m; 2max 4.27 ± 0.62 litres.min<sup>-1</sup>) performed 4 separate incremental cycle ergometer tests (3 min stages; 20 W increments). Trials 1 and 2 were identical and used for assessing the repeatability of MM using an intraclass correlation coefficient (ICC) and coefficient of variation (CV). Trials 3 and 4 had different starting intensities in comparison to trials 1 and 2 and were used for determination of RV. MM and RV were then compared using a paired samples t-test. Results MM showed good test-retest repeatability for 2max (CV = 4.1%; ICC = 0.93), 2max (CV% = 6.3; ICC = 0.90), and test duration (CV% = 6.7; ICC = 0.89). 2max values for MM (309 ± 44 W) were significantly greater than those for RV (301 ± 42 W) (P < 0.05). 2max values were 52.6 ± 9.1 and 52.7 ± 8.6 ml.kg<sup>-1</sup>.min<sup>-1</sup> for MM and RV respectively and were not significantly different (P > 0.05). Test duration was not significantly different between MM (20.9 ± 2.9 min) and RV (20.4 ± 2.9 min) (P > 0.05). **Discussion** The present results suggest that MM is a repeatable method of single trial 2max determination. However, identification of the minimal 2max during a single incremental test appears to be dependent upon the starting intensity of the test. Therefore, determination of the minimal 2max may not be a realistic criterion to assign to single trial approaches to determining 2max. **References** Berthon P, Fellmann N. (2002). J Sports Med Phys Fit, 42, 257-266 Billat VL, Hill DW, Pintoneau J, Petit B, Koralsztein JP. (1996). Arch Physiol Biochem, 104, 313-321 Jones AM, Carter H. (2000). Sports Med, 29(6), 373-386

**VENTILATORY EQUIVALENT RATIO FOR VCO2-VO2 DIFFERENCE LINKED TO THE MAXIMAL BLOOD LACTATE LEVELS**

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**Introduction** Exercise represents one of the greatest stresses that an organism can encounter. There are many variables that influence endurance performance. VO2max is thought to be the best indicator of aerobic capacity and also is a relatively good predictor of endurance performance. Carbon dioxide is a by-product of cellular metabolic processes. VCO2 can be used as an indicator of the metabolic changes during incremental exercise. In our investigation we measured elite hungarian canoeists' performance. We used the ventilatory equivalent ratio for VCO2-VO2 difference (VCO2-VO2/VE) to analyze the important changes during an incremental test such as the anaerobic threshold (AT). **Methods** Elite men kayakers and canoeists participated in this study (n=48, 31 kayakers, 17 canoeist). Age: 23.3±5.1 years; height: 184±0.1 cm; weight: 85±8.3 kg; BMI: 25.2±1.7. The examination consisted of a vita maxima test. The athletes completed the test to exhaustion on treadmill with a constant velocity (10 km/h) and starting from a 1,5 % gradient, which ascended with 1,5 % every other minute. During the examination we registered heart rate (HR), maximal oxygen uptake (VO2max), ventilation (VE), respiration quotient (RQ), lactate concentration in rest (Lar), at peak of maximal load (Lamax), and 5 minutes after the maximal load (Lar5). Basic statistics and for comparison of the measured data linear correlation was used (significance level: p<0.05). Results After the vita maxima test the following peak values of the maximal respiratory parameters were registered: VO2max: 4722±522 (ml/min); VCO2max: 6034±668 (ml/min); VEmax: 163±16.3 (l/min); (VCO2-VO2)/VE: 8.1±1.9; HRmax: 188±10; watt:427±36; Lamax 12.7±2.8 mmol/l; Lar5:13.8±3.3 mmol/l. We have found a significant correlation (p<0.05) between the (VCO2-VO2)/VE to the maximal lactate values (Lamax) with a higher coefficient correlation (r=0.72). We have not found any correlations between the (VCO2-VO2)/VE to the Lar5. **Discussion** These not usual calculated indexes can be more informative for the athletes and can help to determine important changes during physical exercise.

## TEST-RETEST REPEATABILITY OF DIFFERENT MODELS TO ASSESS HR RECOVERY AFTER SUBMAXIMAL EXERCISE AT THE BICYCLE ERGOMETER

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**Introduction.** Measurement of HR recovery after exercise is used in healthcare and sport settings to assess adaptation to training, and it has also been proposed as independent predictor of all-cause mortality. Different models to assess HR recovery have been developed but knowledge of their reliability is poor at different submaximal exercise intensities and recovery durations. Submaximal exercise is more reproducible than maximal one and allows a better standardization of the test(1). **Objective.** Our aim was to determine the reliability of 11 indices of HR recovery after a test on a cycle ergometer, at two intensities of submaximal exercise (65% and 80% HRmax). **Results.** We found that: 1) assessment of HR recovery after 80% HRmax exercise leads to more reliable values than after 65% HRmax exercise (mean ICC: 0.827 vs. 0.747); 2) a longer recovery time increases the absolute consistency of the measurement (%SEM: 26.7 at 60 s, 19.5 at 120 s and 16.3 at 180 s, irrespective of model or exercise intensity); 3) T30min is more reliable than T30 (ICC: 0.691 vs. 0.528; %SEM: 28.5 vs. 70.8) for the calculation of the fast component of HR recovery (HR kinetics calculated over  $\leq 60$  s) after exercise. **Conclusion.** A good sensitivity of measurement - large ICC and small SEM - is obtained for analysis of HR recovery after submaximal exercises on the cycle ergometer, especially for internal workloads of 80% HRmax. At this workload, consistency of results increases for recoveries of longer duration. **References** 1.Cole CR, Foody JM, Blackstone EH et al. Heart rate recovery after submaximal exercise testing as a predictor of mortality in a cardiovascularly healthy cohort. *Ann Intern Med.* 2000; 132:552-555

## DOUBLE BOUT NON-EXHAUSTIVE TETHERED SWIM TO EVALUATE THE AEROBIC CAPACITY IN SPEED SWIMMERS

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**Introduction** The gold standard test to aerobic capacity evaluation in crawl swimming is the maximal lactate steady state (MLSS) but it requires direction changes at each pool turn, adding at this moment an underwater dolphin kick, altering the style. Besides of this, the MLSS test can promote exhaustion and athlete injury depending of training phase. However, a method used to training is the tethered swim (TS), which shows an advantage on prescription training by continuous swimming style. So, the aim of study was propose a non-exhaustive method to determine the aerobic capacity in a TS test applied to male swimmers. **Methods** Twelve subjects ( $23 \pm 1$ yr) were submitted to 2 TS tests: TS double bouts and TS-MLSS. The double bouts test consisted of four loads at different intensities (68, 70, 72 and 74N) accomplished at random with almost 24-h pause among them. The athletes swam twice for 3-min each time, at same intensity, with a 1.5-min rest between the efforts. Heart rate (HR) and blood lactate concentration (BL) were determined after the first and second bout exercise. These swimming intensities were got from a load cell coupled by the pool and integrated to the data acquisition system with signs collection at 1000Hz (Papoti et al., 2007). The non-exhaustive aerobic parameter was determined by two linear regressions of deltas (HR and BL) of the four loads, considering the y-intercept as critical force (CF - null delta HR and BL)(Chassain, 1986). So, two CFs were determined from HR and BL parameters. These tests were retested to verify the reproducibility and reliability. To validate this non-exhaustive tethered method, TS-MLSS was accomplished using five 30-min constant loads varying of 50 to 90N. The TS-MLSS was considered the load in which the increase of BL between 10 and 30-min was not superior to 1mM (Beneke, 2003). **Results** The CF test-retest from HR parameter was  $69.3 \pm 1.9$  and  $68.9 \pm 1.9$ N, respectively. To BL, the CF was  $69.0 \pm 1.8$ N (test) and  $69.1 \pm 1.9$ N (retest). The TS-MLSS load was obtained at  $70.8 \pm 1.9$ N. ANOVA two-way did not reveal differences among CF results (HR and BL, test and retest) and the Pearson's coefficients showed high significant correlations among parameters (mean  $r$  0.89, mean  $P$  0.001). Bland-Altman test verified reliability among CF (HR and BL) and MLSS. **Discussion** The non-exhaustive method to determine the aerobic capacity parameter (CF), using HR or BL is valid, reproducible and reliable in speed swimmers evaluated by double bouts tethered method. Supported by FAPESP, CAPES, CNPq. **References** Beneke R. (2003). *Eur J Appl Physiol*, 89, 95-99. Chassain A. (1986). *Sci Sports*, 1, 41-48. Papoti M, Martins LEB, Cunha SA, Zagatto AM, Gobatto CA.(2007). *J Strength Cond Res*, 21, 538-542.

## EFFECT OF TRAINING FREQUENCY ON ABDOMINAL MUSCLE ENDURANCE

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**Introduction** The frequency of training sessions is one of the factors that determine the effectiveness of a training program (Kraemer and Ratamess, 2004). However, we have only found two studies examining the influence of this variable on the results of abdominal exercise programs (DeMichelle et al., 1997; Vera-García, 2003). The aim of this study was to evaluate the effects of different training frequencies on the abdominal muscle endurance. **Methods** One hundred and eighteen high school students (59 men and 59 women; mean age: 17.0 years) without experience in trunk exercise programs, volunteered to take part in this study. The participants were randomly divided into four groups: G1 ( $n = 21$ ), which trained 1 d/w; G2 ( $n = 27$ ), which trained 2 d/w; G3 ( $n = 23$ ), which trained 3 d/w; and Control Group (CG;  $n = 47$ ), which did not train. The abdominal training program lasted 8 weeks. In each session, 2 sets of each of the following trunk flexion exercises were executed: crunches (or curl-ups) and cross-crunches (or cross-curl-ups). Before and after training the participants performed the bench trunk-curl test (Knudson and Johnston, 1995) to assess the dynamic abdominal endurance. During the first two weeks of training the number of repetitions for each set was 30% of the maximum number of repetitions reached at the first assessment, increasing 5% every two weeks. **Results** Statistical analysis of covariance revealed that exercise training significantly improved the abdominal endurance for G1, G2 and G3 ( $p < 0.001$ ). There were no significant gender differences for these improvements. In addition, results from inter-group comparisons showed no significant differences in abdominal endurance after training, either between G1, G2 and G3, or between GC and G1. However, the differences were significant between G2 and GC ( $p = 0.023$ ) and between G3 and GC ( $p = 0.006$ ). **Discussion** Although there is no optimal training frequency for all people and programs, training frequencies of 2-3 d/w appear to be appropriate for most of the abdominal endurance programs (DeMichelle et al., 1997; Vera-García, 2003). However, based on our results, a frequency of 1 d/w may be sufficient to produce improvements in non previously trained people, which may promote adherence to abdominal training programs. **References** DeMichele PL, Pollock ML, Graves JE, Foster DN, Carpenter D, Garzarella L, Brechue W, Fulton M. (1997). *Arch Phys Med Rehabil*, 78, 64-69. Knudson D, Johnston D. (1995). *J Strength Cond Res*, 9(3), 165-69. Kraemer WJ, Ratamess NA. (2004). *Med Sci Sports Exerc*, 36, 674-88. Vera-García FJ. (2003). Adaptaciones neuromusculares tras un programa de entrenamiento abdominal dinámico y otro estático. Valencia, Spain: Servei de Publicacions de la Universitat de València.

**EFFECT OF SPECIFIC RESISTANCE TRAINING ON READINESS TO CHANGE AND SELF-RATED HEALTH IN THE WORKING LIFE**

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**Introduction** The objective of this study was to investigate the effect of 20 weeks of strengths training on readiness to change and self-rated health, amongst laboratory technicians with industrial repetitive work. **Methods** A cluster randomised controlled trial was performed with an intervention group (IG)(n=282) and a control group (CG)(n=255). The IG performed five specific strengthening exercises for the neck-shoulder region, three times a week for approximately 20 minutes, during working hours. Participants replied to a questionnaire at baseline and follow-up. The main objectives were changes in readiness to change, self-rated health, strengths and fitness. **Results** The IG had a statistically significant higher readiness to change after 20 weeks of training compared to baseline, whereas no statistical significance was found for the CG, with mean values of intervention ( $3.72 \pm 1.53$  vs.  $3.89 \pm 1.44$ ) and control ( $3.79 \pm 1.42$  vs.  $3.82 \pm 1.48$ ). However, the increase in readiness to change in the IG was not statistically significant compared to the CG ( $p=0.238$ ), with delta values of ( $0.17 \pm 1.16$  vs.  $0.03 \pm 1.20$ ). The IG had a statistically significant increase in self-rated health after 20 weeks of training compared to baseline, while no increase was found for the CG, with mean values of ( $3.63 \pm 0.72$  vs.  $3.79 \pm 0.75$ ) and ( $3.65 \pm 0.82$  vs.  $3.65 \pm 0.85$ ). Increase in self-rated health in the IG was statistically significant higher compared to the CG, with delta values of ( $0.16 \pm 0.69$  vs.  $0.01 \pm 0.63$ ,  $p=0.019$ ). The IG had a statistically significant increase in self-rated strength after 20 weeks of training compared to baseline, while no statistically significant increase could be found in the CG, with mean values of ( $5.82 \pm 1.80$  vs.  $6.25 \pm 1.81$ ) and ( $5.75 \pm 2.12$  vs.  $5.84 \pm 2.01$ ). The increase in the IG was statistically significant compared to the CG with delta values ( $0.42 \pm 1.33$  vs.  $0.09 \pm 1.41$ ,  $p=0.013$ ). Both the intervention and the CG had a statistically significant increase in self-rated fitness after 20 weeks of training compared to baseline, with mean values of ( $5.72 \pm 2.05$  vs.  $6.02 \pm 2.06$ ) and ( $5.59 \pm 2.31$  vs.  $5.76 \pm 2.29$ ). The increase in self-rated fitness was not statistically significantly larger in the IG compared to the CG ( $0.29 \pm 1.41$  vs.  $0.18 \pm 1.26$ ,  $p=0.364$ ). **Discussion** The study has shown that specific resistance training has a positive effect on self-rated health, self-rated strength and self-rated fitness. However, the study did not show any significant effect of specific resistance training on readiness to change, perhaps because the participants entering the study were already selected on a high preference for exercising.

**Poster presentations****PP-PM58 Training and Testing: Sports Performance 2****A STUDY ON SPATIAL DISTANCE IN BUDO**

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**Introduction** In confronting opponents one-on-one in Budo, 'Ma'ai' is the spatial distance from your opponent. It is imperative that you keep Ma'ai advantageous to you and disadvantageous to your opponent. For this, you must set Ma'ai by not only taking into account your skills and tactics, predicting necessary skills and tactics to respond to your opponent's moves, but also by surveying your surroundings. Ma'ai is not constant; it varies according to the conditions at the time, and the techniques to be used vary in limitless ways accordingly. In this study, we conducted experiments to determine what Ma'ai actually means in Budo and the types of Ma'ai that invites the use of certain techniques, 'Waza'. **Study Method** For the experiments, a total of seven male black-belt Shorinji Kempo practitioners engaged in one-minute matches under three different rules respectively; one using assault arts only, another using grappling arts only, and the other for using both arts in combination. The confrontations were recorded using digital video cameras and the corresponding images were transferred to a personal computer. A three-dimensional DLT(Direct Linear Transformation) method was then used to plot three-dimensional position coordinates and thus determine Ma'ai, namely, the distance between the opponents. And, to study Ma'ai that provides chances opportune for initiating attacks on the opponent, the subjects were surveyed before the matches for subjective Ma'ai at which they would be tempted to make an attack on the opponent. **Results and Discussion** The average Ma'ai during the one minute matches in this study was  $1.63 \pm 0.09$ m for G ('hard' techniques, used to fell an opponent at a distance with a strike),  $1.05 \pm 0.32$ m for J ('soft' techniques, used to control and fell an opponent at close range while in constant contact), and  $1.58 \pm 0.11$ m for G+J. In G+J, the G Ma'ai was used as the standard, with the J Ma'ai being adopted in response to the opponent's moves, and the nature of the attack. The rate of attacks at subjective Ma'ai during the matches was 14.7% for G, 5.3% for J, and 11.9% for G+J, suggesting that the subjective Ma'ai is merely one factor affecting attack chances. It is possible that factors like gaps in opponent's stance, breaks in posture, physical attributes, and circumstances such as rules of the match might weigh on Ma'ai. We intend to further our study on these aspects in the future.

**MEASURING KAYAK PADDLE PERFORMANCE WITH WIRELESS STRAIN SENSORS ON THE SHAFT – A VALIDATION STUDY**

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**Introduction** In flatwater kayaking the boat is propelled by a combination of forces, which the athlete exerts on the seat, the foot stretcher and the paddle - to be more specific: on the paddle shaft. Due to this force the paddle shaft bends, because the immersed blade causes a friction in the water. We have designed a mobile, wireless force measurement and feedback system for measuring the two most prominent forces on-water: the paddle and for the foot stretcher force (Sturm et al., 2010). The aim of this study was to validate the paddle force data of this system against a laboratory system consisting of commercial force sensors. **Methods** A Labview programme (Labview 2010; National Instruments, USA) and data acquisition system (NI 9205, NI 9237; National Instruments, USA) was used to record data from the customised force transducers (Segeström et al.) on the ergometer (Dansprint, Denmark) and from the wireless system (Sturm et al., 2010) under evaluation. An experienced adult kayak athlete performed three sets of exercises at four work levels. After collection the data from the PC and the mobile phone was aggregated and analysed with Matlab (Matlab R2010a; Mathworks, USA). **Results** Force recordings during three trials each at the exercise levels of 80W/60s/72 strokes per minute (spm), 160W/60s/88spm, 240W/60s/100spm and 300W/30s/116spm revealed a mean absolute difference of 5.4N (12.7N), 12.4N (23.2N), 15.7N (29.0N) and 8.6N (20.6N) respectively with average force peaks at 110.0N, 162.8N, 205.3N and 174.2N. **Discussion** Although the two paddle transducers were calibrated simul-

taneously with the force sensors on the ergometer there is a slight difference in the recorded force value between the systems, which grows with an increase of applied force. Discrepancy between the force measured in the ergometer ropes and that of the paddle transducers is likely due to a varying angle between the rope and the paddle. In water – the design scenario for the paddle system, the wing paddle blade requires a specified orientation (Kendal et al., 1992); an ergometer's pole is a circular rod unaffected by rotation. Further differing characteristics between ergometer and on-water paddling have been discussed (Begon et al., 2007) and may have played a role. Our next investigations will look further into the agreement of both methods and are aiming at deeper insights into the biomechanical scenario. References Begon, M., Colloud, F. (2007). Proc ISBC 2007, 439 Kendal, S.J., Sanders, R.H. (1992). Int J Sports Med, 8, 233-50. Segerström, Å.B., Håkansson, P., Elgh, T., Eklund, Å., Svensson, I., Wollmer P. (Submitted for publication) J Sports Biomech Sturm, D., Yousaf, K., Eriksson, M. (2010). Proc BSN 2010, 159–163

### MULTIVARIATE RELATIONSHIP BETWEEN MORPHOLOGY, FUNCTIONAL CAPACITIES AND SPORT-SPECIFIC SKILLS IN ADOLESCENT MALE BASKETBALL PLAYERS

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**INTRODUCTION** The influence of maturity status on body size, functional capacities and basketball-specific skills was already evaluated in late adolescent basketball players (Coelho e Silva et al., 2008). However, previous analysis ignored the multivariate nature of morphology, physical fitness and basketball skills. The present study examined the relationships between domains of variables in 80 male basketball players aged 12.0-13.9 years. **METHODS** Height, body mass and two skinfolds (triceps and subscapular) were measured. Functional capacity was assessed with the countermovement jump, 2-kg medicine ball throw, hand grip strength, 60-second sit-ups and endurance shuttle run (Coelho e Silva et al., 2010). Performances on four basketball skills were tested: shooting, passing, dribbling and defensive movements (Kirkendall et al., 1987). Associations among body size, adiposity, functional capacities and skills were evaluated with canonical correlation analysis. **RESULTS** The canonical correlation between morphological indicators and functional capacities was 0.84 ( $rc^2=0.70$ , Eigenvalue = 2.34, Wilks' Lambda = 0.13,  $F=14.31$ ,  $p<0.01$ ). The correlations between variables and the respective first pair of canonical variates suggested that players who were heavier (+0.92) and taller (+0.90) attained better scores in strength and tasks that did not require displacement of the body through space (hand grip: +0.86; 2-kg ball throw: +0.84). The canonical correlation between morphology and sport-specific skills was 0.53 ( $rc^2=0.28$ , Eigenvalue = 0.38, Wilks' Lambda = 0.69,  $F=2.46$ ,  $p<0.01$ ). The pattern of loadings suggested that dribbling (+0.66) and defensive movement (+0.56) were associated with lower levels of adiposity (-0.91). The first linear combination obtained to maximize the correlation between basketball skills and functional capacities showed substantial shared variance ( $rc=0.70$ ,  $rc^2=0.50$ , Eigenvalue = 0.98, Wilks' Lambda = 0.39,  $F=3.89$ ,  $p<0.01$ ). Endurance items, 20-meter shuttle run (+0.88) and sit-ups (+0.71), were the primary contributors to performance on the four basketball skills. **DISCUSSION** Manipulative skills are important components of success in basketball and appeared to be independent of pubertal status (Coelho e Silva et al., 2008). A positive relationship of abdominal muscular strength and aerobic endurance with skills was noted in the present study. Since the tallest basketball players were not more skilled than other players in explosive tasks, the selection of biologically advanced subjects can be myopic. **ACKNOWLEDGMENTS** Partially supported by FCT (SFRH/BD/64648/2009; PTDC/DES/2011) **REFERENCES** Coelho-e-Silva MJ, et al. (2008). Eur J Sport Sci, 8 (5): 277-285. Coelho-e-Silva MJ, et al. (2010). J Sports Med Phys Fitness, 50 (2), 174-181. Kirkendall D, et al. (1987). Measurement and Evaluation for Physical Educators. Champaign, IL: Human Kinetics.

### EFFECT OF IBUPROFEN ON PERFORMANCE IN RUNNERS WITH EXERCISE-INDUCED MUSCLE DAMAGE

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LABORATORY OF HUMAN MOVEMENT (LMH), UNIVERSITY OF CAXIAS DO SUL (UCS), CAXIAS DO SUL - RS, BRAZIL; FEDERAL UNIVERSITY OF RIO GRANDE DO SUL, PORTO ALEGRE, BRAZIL

**Objective:** This double-blind, randomized clinical trial was designed to investigate the effect of prophylactic administration of Non-steroidal anti-inflammatory (NSAID) on the time until reporting fatigue (tlim) in runners with exercise-induced muscle damage. **Methods:** Twenty healthy, young long-distance runners (age  $19 \pm 0.5$  years;  $VO_{2peak}$   $55.5 \pm 5.9$  ml.kg<sup>-1</sup>.min<sup>-1</sup>), participated in this study. They were assigned into two groups (n=10) to perform two time limit to exhaustion trials (tlim), 48h before and after a protocol of exercise-induced muscle damage (isokinetic dynamometry). The ibuprofen group received 1.2g of NSAID ibuprofen orally while the control group received a placebo (microcrystalline cellulose). Immediately before, 24h and 48h after the protocol of exercise-induced muscle damage, participants were asked to report local pain (CR10). **Results:** Participants of both groups reported a significant increase in pain of knee extensor and flexors 48h after the muscle damage protocol. There was a reduction in performance in both groups in terms of time ( $p<0.01$ ), yet without significant interaction ( $p=0.55$ ), indicating the failure of the drug to reduce the impact of pain on performance. **Conclusion:** No evidence of an ergogenic effect of NSAID ibuprofen on the performance of runners with exercise-induced muscle damage was found. This disproves the possibility of improving performance of runners with induced muscle pain by the prophylactic analgesic strategy. **Da Silva ER, De Rose EH, Ribeiro JP, et al. The Use of Non-Steroidal Anti-inflammatory Drugs (Nsaid) In the Xvth Pan-American Games - Rio de Janeiro 2007. Br J Sports Med 2011;45:91–94. Sgherza AL, Axen K, Fain R, et al. Effect of naloxone on perceived exertion and exercise capacity during maximal cycle ergometry. J Appl Physiol 2002;93:2023–2028 Amann M, Proctor LT, Sebranek JJ, et al. Opioid-mediated muscle afferents inhibit central motor drive and limit peripheral muscle fatigue development in humans.**

### MONITORING INTERVAL TRAINING IN MASTER ENDURANCE ATHLETES

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Monitoring interval training in master endurance athletes Carlo Minganti <sup>1,2</sup>, Andrea Ferragina <sup>1</sup>, Laura Capranica <sup>2</sup>, Romain Meeusen <sup>3</sup>, Maria Francesca Piacentini <sup>2,1</sup> Experimental and Clinical Medicine Department, University of Magna Graecia, Catanzaro, Italy <sup>2</sup> Department of Human Movement and Sport Sciences, University of Foro Italico, Rome, Italy <sup>3</sup> Department of Human Physiology and Sports Medicine, Vrije Universiteit Brussel, Belgium **Introduction** In recent years there has been an increased interest in issues related to the enhancement of the performance of master endurance runners (MER). MER adopt different training strategies commonly used by elite athletes such as high intensity interval training (HIT). For these athletes the session-RPE method may provide valuable information to avoid

the maladaptive responses such as overreaching or overtraining phenomena (Foster, 1998) however, recovery time during HIT is a substantial portion of training. Therefore the aim of the present study was to evaluate the effectiveness of the session RPE method as a tool to quantify internal training load during HIT in MER. In addition, we investigated whether it is appropriate to take into account rest periods when calculating the session-RPE (Shannon & Meeusen, 2005). Methods Eight male MER (age:  $45.3 \pm 7.3$  years; stature:  $1.74 \pm 0.06$  m; body mass:  $64.9 \pm 9.1$  kg) were monitored during an IT consisting of  $5 \times 1000$  m with 5 min rest between bouts. Run speed was fixed at 95% of velocity associated with  $\text{VO}_{2\text{peak}}$  ( $v\text{VO}_{2\text{peak}}$ ). Edwards' summated heart rate zone method was used as a reference measure and the session RPE rating was obtained using the CR10 Borg's scale. The individual Session RPE was computed by RPE-based method proposed by Foster et al. (1996) by multiplying the duration of the training session by RPE obtained after 30 min (Rest Session-RPE). Moreover the session-RPE was also computed excluding rest periods (No-Rest session-RPE). Results The relationships between the training load assessment methods were estimated using Pearson product-moment correlation as well as the coefficient of determination ( $r$ =correlation coefficient  $R^2$ =coefficient of determination). Higher correlation ( $r$ : 0.86;  $R^2$ : 0.74) was observed between Edwards' HR and the No-Rest session-RPE compared to Rest session RPE ( $r$ : 0.82;  $R^2$ : 0.67). Discussion Despite the rest periods exclusion from the session RPE computation seem more appropriate, the statistical analysis indicates that there is no significant difference between the two correlation coefficients. These findings suggest that the session-RPE can be a useful tool to monitor internal training load during IT and that the inclusion/exclusion of rest period in its computation needs further investigation. References. Foster C. et al. (1996) *Wiscon Med J*, 95: 370-374 Foster C. (1998). *MSSE*, 30: 1164-1168 Shannon MP. & Meeusen R. (2005). *Med & Sci in Sp & Ex*, 37(5): 47

### ALLOMETRIC SCALING OF PEAK POWER OUTPUT ACCURATELY PREDICTS TIME TRIAL PERFORMANCE AND MAXIMAL OXYGEN CONSUMPTION IN TRAINED CYCLISTS

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Introduction Being able to predict several performances parameters from a single test is important for monitoring purposes in well trained and elite athletes. As performance tests, such as a peak power output test (PPO) and a 40km time trial test (40km TT), generally interfere with the normal training habits of athletes monitoring of a regular basis is difficult. As maximal oxygen consumption ( $\text{VO}_{2\text{max}}$ ) is related to exercise capacity (Arts and Kuipers, 1994),  $\text{VO}_{2\text{max}}$  has become a popular measurement to determine training status in athletes. However, this parameter loses its predictive accuracy in well-trained cyclists (Lamberts et al., 2009). In an attempt to overcome this limitation, Swain (1994) has suggested that body mass should be corrected to the power of 0.32 ( $\text{kg}^{0.32}$ ) when predicting flat time trail performance. Therefore the purpose of this study was to determine if peak power output adjusted for body mass $^{0.32}$  is able to accurately predict 40km TT performance and possibly maximal oxygen consumption. Methods Forty-five trained male cyclists completed a peak power output test, including respiratory gas analysis, and a 40km TT after being familiarized. Performance parameters such as peak power output (PPO), maximal oxygen consumption ( $\text{VO}_{2\text{max}}$ ) and 40km time trial time were measured. Peak power output was normalized for body mass to the exponent of 0.32 ( $\text{W} \cdot \text{kg}^{-0.32}$ ) after which the relationship with 40km TT performance and maximal oxygen consumption was determined. Results As expected, a strong relationship occurred between peak power output and  $\text{VO}_{2\text{max}}$  before adjustment for body mass ( $r = 0.96$  (95%CI:  $0.93 - 0.98$ );  $P < 0.0001$ ). After adjusting PPO for body mass $^{0.32}$  ( $\text{W} \cdot \text{kg}^{-0.32}$ ), there was a strong relationship with 40km TT time ( $r = -0.96$ : 95%CI:  $-0.93 - -0.98$ ;  $P < 0.0001$ ), with a standard error of estimate of 52 s. Although significant relationships were also found between absolute (W) and relative PPO ( $\text{W} \cdot \text{kg}^{-1}$ ) and 40km TT performance, slope analyses showed that the relationships with 40km TT performance were significantly weaker than adjusted PPO ( $\text{W} \cdot \text{kg}^{-0.32}$ ) (both  $p < 0.0001$ ). Discussion This study shows PPO adjusted for body mass $^{0.32}$  ( $\text{W} \cdot \text{kg}^{-0.32}$ ) is able to accurately 40km TT performance in trained cyclists. In addition,  $\text{VO}_{2\text{max}}$  could also be accurately predicted from PPO measured within the same test. The practical relevance of this study is that  $\text{VO}_{2\text{max}}$  and 40km TT performance can be predicted with a reasonable amount of accuracy from just one PPO test. As this possibly can reduce the amount of performance tests throughout the year in well-trained and elite cyclists, this method might possibly allow more regular testing for monitoring purposes. References Arts FJ, Kuipers H. (1994). *Int J Sports Med* 15, 228-231. Lamberts RP, Swart J, Woolrich RW, Noakes TD, Lambert MI. (2009). *Int SportMed J* 10, 33-44 Mujika I, Padilla S. (2001) *Sports Med* 31, 479-87.

### THE RELATIONSHIP BETWEEN THROWING ABILITY ON- WATER AND ON DRY LAND IN ELITE JAPANESE WATER POLO PLAYERS

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Introduction Throwing ability is one of the most important skills in water polo. Further, throwing movement on- water differs from that on dry land, because no ground support is available on- water. Throwing movements in water require the use of highly-complicated under-water techniques, such as sculling (hand movements) and eggbeater kicking (lower leg movements), which are very important. Clarifying the relationship between throwing ability on- water and on dry land makes it easier to estimate water polo players' ability. An understanding of this relationship can be applied to performance tests and identification of talent. Therefore, this study aims to examine the relationship between throwing ability on- water and on dry land, and the relationship between throwing ability and age or having a competitive career. Methods A total of 199 male water polo players participated in this study. The subjects included 55 elementary school water polo players (E-group,  $10.7 \pm 1.1$  years), 53 junior high school players (J-group,  $13.3 \pm 1.0$  years), 49 high school players (H-group,  $16.3 \pm 1.0$  years), 21 college players (Co-group,  $20.0 \pm 1.5$  years), and 21 club players (Cl-group,  $27.1 \pm 4.1$  years). Players from all the groups had participated in Japanese National Championships, and were ranked between the 1st and 4th positions. Furthermore, the group of club players included members of the Japanese national team. The following indicators of throwing ability were used: (1) throwing distance on- water and (2) throwing distance on dry land. Results There was a significant correlation between throwing distance on- water and on dry land ( $r = 0.91$ ,  $p < 0.01$ ). Further, both throwing distance on- water and on dry land were significantly different across all the groups. Throwing distance showed a significant increase with advancing age and having a competitive career. While, a significant decrease was observed in the difference between throwing distance on- water and on dry land with advancing age and having a competitive career. Discussion The correlation between throwing distance on- water and on dry land, revealed that throwing distance on dry land is effective as a test of performance and for dry land training. The comparison of throwing distance between on- water and on dry land indicates that creating specific techniques for throwing movements on- water will help improve throwing ability. In conclusion, the results of this study suggest that the measurement of throwing distance on- water and on dry land is an effective method for evaluating water polo player's throwing ability.

## INDICATORS OF SUCCESS BY U 18 ICE HOCKEY PLAYERS

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**INDICATORS OF SUCCESS BY U 18 ICE HOCKEY PLAYERS** Géczi G., Bognár J., Révész L., Benczenleithner O. Semmelweis University, Faculty of Physical Education and Sport Sciences (TF) Introduction Ice hockey is one of the fastest and multifactorial team sport on the world requires players to possess a number of different attributes (Vescovi et al, 2006). The success mainly depends on not only the player efficacy, but more on team efficacy, understanding, communication, cooperation, and team performance and humble (Feltz & Lirgg, 1998). The purpose of our investigation was to analyze and determine motor and psychometric factors which are the most deciding factors to the successful selection of the U 18 National team and to direct the coaches in the practice, that they should force the adequate skills improvement during the youth development program. Methods All players that attended this try out were preselected and sent by club coaches to participate in the study, so altogether 40 U18 players did all the on-ice and off-ice motor tests and filled out all psychometric measures. From the players that participated in this particular study, 20 were U18 National team Selected members (Mage=16,45, SD=,512) and another 20 Non-selected players (Mage=16,62, SD=,50). 19 on ice and off-ice motor tests were processed. Also, Athletic Coping Skills Inventory (ACSI-28), Perceived Motivational Climate in Sport Questionnaire-2 (PMCSQ-2), Sport Motivation Scale (SMS), State-Trait Personality Inventory (STPI-Y). Descriptive data for all variables are described by mean (M) and standard deviation (SD). Data of Selected and Non-selected ice hockey players were statistically compared and Independent T-test was conducted. Also, Stepwise discriminant analysis was used for differentiating motor and psychometric differences between Selected and Non-selected U18 players. Results According to T-test, there were significant differences between Selected and Non-selected U18 players in the following tests: Crossover test with puck, Passing skill drill (sec), 1500 m track, Freedom from worry and Unequal recognition. Discriminant analysis showed that the discriminating factors were in the sample: Unequal recognition, Concentration, Peaking under pressure, BMI, 36 m backward skating, Freedom from worry, Trait depression and Intra-team member rivalry ( $p < .05$ ). Discussion The main findings of the study were to determine the deciding factors to be successfully selected to the U18 National team (Géczi et al, 2008) and also we confirmed the major deciding factors in the youth development programs. References Géczi G., Bognár J., Tóth L., Sipos K. and Fügedi B. (2008). International Journal of Sport Science and Coaching Science, 2, 277-285. Vescovi J. D., Murray T. M. and VanHeest J. L. (2006). International Journal of Sports Physiology and Performance, 1, 84-89. Feltz D. L. and Lirgg C. D. (1998). Journal of Applied Psychology, 83/4, 557-564.

## A DEMOGRAPHIC PROFILE OF COMPETITORS IN THE COLORLINE SETESDAL TOUR 210KM CYCLE COMPETITION IN NORWAY

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**Introduction** Cycling is one of the fastest growing exercise sports in Norway with growing numbers of participants, races and recently extreme cycle events (Wiik, 2010). Whilst reasons why people compete in extreme sports events have been proposed, e.g. health motives, career promotion, self-realization and as a way of men handling midlife crisis, most are anecdotal at best. The aim of this study was to develop a demographic profile of competitors in one of the most popular cycling competitions in Norway, the Colorline Setesdal Tour (CST), and to explore reasons for participation. **Methods** An online questionnaire was sent via email to the 1370 competitors prior to the 210km CST event during which competitors have to climb 980 altitude meters, 600 meters of which are after 150 km. 433 questionnaires were completed representing a 32% participation rate; 92% were male reflecting the gender representation in the event and mean age was 43.6±8.6yrs. Results 60% of the participants were qualified to a higher education level (University); median income was 68400 per annum (Q1, Q3: 55485, 90324); 84% were married / living with their partner, and 80% had two or more children. On average they trained 4 times per week with a mean session time of 2 hours. The median cost for their cycle and cycle equipments was 3225 and they spent around 1100 per year on maintenance of their equipment and membership fees to gyms etc. 80% considered themselves as 'exercisers', not as competitive athletes, yet 76% had set themselves a time goal for the CST. Important motives for participation were the challenge or "just do it" (27%), positive personal and social motives (19%), and motivation for training and health (16%). Furthermore, 19% reported that participation in cycling competitions had positive work related effects, such as increased work performance (61%), increased mental toughness and concentration (24%), and lower sickness absence (21%). 70% reported that cycling affected their family relationships positively while 12% indicated that it had a negative effect. Discussion Participants had a fair income and were well educated. Even though self-described only as 'exercisers', participants invested a great deal of time, effort and money in cycling. They perceived many positive consequences for themselves and their relatives from cycling per se and as a result of training for and participation in this extreme event. From a public health perspective work to engage lower income, younger adults and females in cycling is required if the broader physical, psychological, social and environmental benefits of recreational and semi-competitive cycling are to be realised in Norway. References Wiik, J. (2010). Treningsmagasinet 5.5 2010

## Poster presentations

### PP-PM59 Children and Physical Activity 3

#### MAINTENANCE OF PHYSICAL ACTIVITY AFTER INTERNET-BASED INTERVENTION IN ADOLESCENTS

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**INTRODUCTION** We developed an Internet-based physical activity program (i-PAP), which has several interactive functions and e-mail tip sheets that promote physical activity. A four-month intervention showed that participants using the i-PAP increased energy expenditure significantly as compared to the control group (Okazaki et al., 2010). The purpose of this study was to evaluate whether the improvement in physical activity following the completion of the four-month intervention was maintained eight months later. **METHODS** A total of 77 Japanese college students (49 intervention: I-Group, 28 control: C-Group) who responded completely to our scheduled inquiries during the intervention and follow-up were studied. A total of 21 students from the I-Group and 17 from the C-Group were not engaged in regular college sports clubs. Students from the I-group were able to use the i-PAP continuously through the follow-up, whereas neither the e-mails nor the web-quiz was newly uploaded. All students answered the International Physical Activity Questionnaire and the Stages of



Change Scale for physical activity (SCSPA) at baseline, that is, 4 months and 12 months respectively. RESULTS The I-group exhibited significant improvement in the SCSPA ( $\chi^2(2) = 15.9$ ,  $p < 0.05$ ), whereas the C-group did not. Further, those groups that did not belong to regular college sports clubs were compared. Those in the I-Group exhibited a significant increase in energy expenditure ( $F(2, 72) = 3.5$ ,  $p < 0.05$ ) as compared to those in the C-Group. DISCUSSION Some reports show that an internet-based intervention for physical activity resulted in a successful increase in the participants' energy expenditure, whereas few controlled studies on the efficacy of follow-up coupled with such intervention are presently available (Marcus et al., 2009; Ciccolo et al., 2008; Vandelanotte et al., 2007; Norman et al., 2007). The i-PAP would promote physical activity through the follow-up. Particularly, the students who did not engage in regular college sports clubs promoted the physical activity. These results suggested that internet-based interactive intervention like the i-PAP had a long-term efficacy of promoting and maintaining the physical activity after the students completed the course. REFERENCES Okazaki K, Okano S, Haga S, Seki A, Suzuki H, Takahashi K. (2010) Educ Technol Res, 33(1), 85-94. Marcus BH, Ciccolo JT, Sciamanna CN. (2009) Br J Sports Med, 43, 102-105. Ciccolo JT, Lewis B, Marcus BH. (2008) Risk Reports, 2, 299-304. Vandelanotte C, Spathonis KM, Eakin EG, Owen N. (2007) Am J Prev Med, 33, 54-64. Norman GJ, Zabinski MF, Adams MA, Rosenberg DE, Yaroch AL, Atienza AA. (2007) Am J Prev Med, 33, 336-345.

## RELATIONSHIP BETWEEN TIME WATCHING TV, COMPUTER USING, ELECTRONIC GAMES, AND TIME PRACTICING PA OF CHILDREN

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Introduction: Due to rapid technological and societal changes, opportunities to undertake convenient and attractive sedentary behaviours as part of a contemporary lifestyle are likely to have increased. Objective: The purpose of this study was to examine the relationship between the time spent watching TV, the use of computer, electronic games, and time practicing physical activity (PA) on week days and weekends, according to gender. Methods: A total of 416 boys (age  $10.7 \pm 0.7$ ) and 386 girls ( $10.6 \pm 0.7$ ), age ranged between 10 and 12 years old, participated in the study. Data was collected using a questionnaire used on international research project on children's lifestyles. Pearson's correlations were applied to identify the relationships between the time spent in watching TV, computer usage, playing electronic games, and the time practicing PA on week days and weekends. Significance level was  $p < 0.05$ . Results: On week days, boys spent more hours than girls in PA ( $3.4 \pm 2.1$  vs  $2.8 \pm 1.9$ ), using computer ( $1.8 \pm 1.3$  vs  $1.6 \pm 1.2$ ) and playing electronic games ( $1.9 \pm 1.4$  vs  $1.3 \pm 0.9$ ), and less hours watching TV ( $2.0 \pm 1.4$  vs  $2.1 \pm 1.3$ ). On weekends, the tendency between genders remains whereas the time in PA decreases ( $1.9 \pm 1.4$  vs  $1.8 \pm 1.2$ ) and increases in using computer ( $2.6 \pm 1.7$  vs  $2.4 \pm 1.6$ ), playing electronic games ( $2.6 \pm 1.8$  vs  $1.6 \pm 1.1$ ), and watching TV ( $2.8 \pm 1.7$  vs  $2.9 \pm 1.7$ ). In both genders no significant correlations were established between PA and the others activities on week days. On weekends only a weak but significant negative correlation was found between PA and time spending watching TV for boys ( $r = -0.176$ ,  $p = 0.049$ ). Regarding the correlation between activities in front of a screen during the week days, positive significant correlations were observed between time spent watching TV and computer usage ( $r = 0.281$  boys, girls  $r = 0.370$ ) and playing electronic games ( $r = 0.416$  boys, girls  $r = 0.183$ ). On the weekends the correlation patterns remain, however with a slight increase. Correlation between watching TV and computer usage was  $r = 0.382$  and  $r = 0.433$ , and between watching TV and electronic games was  $r = 0.321$  and  $r = 0.285$  for boys and girls, respectively. Conclusion: Those who were only interested in computer games and TV-watching were the most inactive, although many computer game players were also physically active.

## INDIVIDUAL, FRIEND AND FAMILY-BASED SOCIAL PREDICTORS OF SCREEN VIEWING AMONG SPANISH SCHOOL CHILDREN

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INDIVIDUAL, FRIEND AND FAMILY-BASED SOCIAL PREDICTORS OF SCREEN VIEWING AMONG SPANISH SCHOOL CHILDREN Hoyos Cillero, I. 1, Jago, R. 2, Sebire, S.J. 2 1: University of the Basque Country (Bilbao, Spain), 2: University of Bristol (Bristol, United Kingdom) Introduction In southern European countries many children exceed suggested screen-viewing guidelines and this is likely to be a risk factor for obesity. Understanding the predictors of screen-viewing may be the first step in designing interventions that target these behaviours, but there is lack of information on predictors of screen-viewing among Spanish children. Therefore, this study aimed to examine associations between individual, friend and family-based social variables and a wide range of screen-viewing behaviours, and how these associations differ by age and gender in a sample of Spanish children. Methods Participants were 247 primary school-aged and 256 secondary school-aged children and their parents from different socio-economic backgrounds. Children reported time spent in screen-viewing and information about individual (self-efficacy and behavioural capability) (Norman et al., 2004) and friend (sedentary group norms and social reasons for sedentary behaviour) (Jago et al., 2009) and family-based social variables (parent rules for screen-viewing). Body Mass Index was assessed and children were classified using International Obesity Task Force cut-off points (Cole et al., 2000). Parents reported sociodemographic characteristics and family co-viewing practices. Statistical analyses: t-test, chi-square and logistic regression models ( $>2$ h/day TV viewing,  $>2$ h/day console playing and  $>2$ h/day overall screen-viewing as outcomes; individual and social factors as exposure variables). Results Older children (TV  $p < 0.001$ ; console  $p < 0.01$ ; overall  $p < 0.001$ ) and males (TV  $p < 0.01$ ; console  $p < 0.001$ ; overall  $p < 0.01$ ) were likely to spend more time screen-viewing. Lower self-efficacy for reducing screen-viewing (console  $p < 0.05$ ; overall  $p < 0.01$ ), stronger sedentary group-norms (TV  $p < 0.001$ ; console  $p < 0.05$ ; overall  $p < 0.05$ ) and stronger social reasons (console  $p < 0.05$ ) were associated with higher screen-viewing in both age groups. For younger children, lower parental rules appeared to be significant predictors for exceeding screen-viewing guidelines while greater co-viewing time was a strong determinant for higher screen-viewing among older children. Discussion Individual and social factors influence children's screen-viewing and operate differently in children of different ages. Increasing self-efficacy may be important for screen-viewing based behaviour changes. Friends and parents play a central role, therefore understanding the dynamics of friends and targeting family influences may be critical to the success of interventions to reduce screen-viewing. References Cole TJ et al. (2000). BMJ, 320(7244), 1240-1243. Jago R et al. (2009). Int J Behav Nutr Phys Act, 6, 67. Norman GJ et al. (2004). Psychol Health, 19(5), 561-575.

## PHYSIOLOGICAL RESPONSE TO WII SPORTS AND MODIFIED WII SPORTS IN YOUNG ADULTS

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**Introduction** The increasing rates of obesity are partly due to decreased physical activity and increased sedentary behaviours (Kay and Fiatarone, 2006). Innovative approaches are required to reverse these behaviours and increase daily energy expenditure. Interactive video games have become popular in recent years but it is not clear if they provide a sufficient stimulus for health enhancing benefits. The purpose of this study was to determine if a modified interactive video game (modified Wii) would elicit a higher cardiovascular and metabolic response than a traditional stationary (Playstation "Burnout 3") or interactive game (Wii Sport: tennis and boxing). **Methods** A total of thirteen healthy subjects (eight women and five men) volunteered for this study. Maximal aerobic capacity (VO<sub>2</sub>max) was measured using an incremental treadmill test and subjects were familiarised with all games prior to testing. Subjects played each of the games at the same time of day, for 46-minutes, in random order, with at least 2-days between trials. The standard Wii Sport was modified by requiring participants to move across a 2.4m distance between tennis shots and 1.3m diagonally and back during the boxing. During the trials oxygen consumption was measured using a portable metabolic system (Cosmed Ltd, Rome, Italy) and heart rate (HR) was measured by radiotelemetry (Polar, Kempele, Finland). These measures were used to calculate relative oxygen consumption (%VO<sub>2</sub>max), heart rate reserve (HRR), metabolic equivalents (METs) and the rate of energy expenditure (REE). **Results** When playing a traditional sedentary game, the HRR ( $5.39 \pm 1.25\%$ ), %VO<sub>2</sub>max ( $8.6 \pm 0.67\%$ ), MET ( $1.43 \pm 0.05$ ) and REE ( $1.84 \pm 0.09$  kcal/min) were all significantly lower than those of the active games ( $p < 0.01$ ). The modified Wii resulted in a significantly greater oxygen consumption ( $41.2 \pm 2.69\%$  vs  $18.9 \pm 2.65\%$ ), HRR ( $46.63 \pm 3.76\%$  vs  $22.43 \pm 2.89\%$ ,  $p < 0.01$ ), METs ( $6.9 \pm 0.48$  vs  $3.28 \pm 0.28$   $p < 0.01$ ) and REE ( $8.40 \pm 0.83$  vs  $4.11 \pm 0.44$  kcal/min,  $p < 0.01$ ) than the standard Wii Sport game. **Discussion** The main finding of this study was that the modified Wii was the only game to meet the American College of Sports Medicine (ACSM) and American Heart Association (AHA) guidelines to promote and maintain health. While interactive video games can increase cardiovascular and metabolic responses, these games need to be carefully designed to provide a stimulus sufficient to meet the ACSM/AHA recommendations for daily physical activity for healthy adults. **References** Kay, S.J., and Fiatarone Singh, M.A. (2006). *Obes. Rev.* 7: 183-200 Shaw, K. (2006) *Cochrane Database Syst. Rev.* (4): CD003817. PMID:17054187

## THE NIE INT-HINT TEST – A LABORATORY-BASED PROTOCOL FOR THE ASSESSMENT OF FITNESS IN YOUTH ELITE SOCCER PLAYERS

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**THE NIE INT-HINT TEST – A LABORATORY-BASED PROTOCOL FOR THE ASSESSMENT OF FITNESS IN YOUTH ELITE SOCCER PLAYERS** Mukherjee, S. & Chia, YHM National Institute of Education Nanyang Technological University Singapore **Introduction** The overall activity pattern of soccer is that of intermittent high-intensity (Int-HINT) type and higher-level players have a greater repeated high-intensity running capability. Therefore, the aim of this study was to develop a laboratory-based protocol on the motorized-treadmill to specifically assess the Int-HINT running capability in youth elite soccer players. **Methods** Twenty youth elite soccer players (mean  $\pm$  SD age,  $17.5 \pm 0.3$  yrs; stature,  $1.73 \pm 0.04$  m; body mass,  $67.2 \pm 7.5$  kg) performed on the laboratory-based test of Int-HINT running on motorized treadmill during the pre-season, early in-season and end mid-season phases of the soccer season. Briefly, the Int-HINT test has alternate periods of high-speed running starting from  $13 \text{ km} \cdot \text{h}^{-1}$  for 12 s and low-speed recovery periods at  $9 \text{ km} \cdot \text{h}^{-1}$  for 8 s. Running speed increased by  $1 \text{ km} \cdot \text{h}^{-1}$  after six alternate repetitions with the recovery run. Performance was measured as total distance covered on the treadmill. The participants also performed the YoYo Intermittent Recovery Test Level 2 and the match play work intensity was also determined using heart rate monitoring for two matches during each phase of the competition season. **Results** The reliability of the Int-HINT test was established during pilot studies ( $n=14$ ; ICC, 0.98; 95% CL, 0.93 – 0.99; CV, 2.1%; 95% CL, 1.4 – 4.4%; ratio limits of agreement (rLOA)  $0.99 \times / \div 1.03$ ). The players covered (Mean  $\pm$  SD)  $2799 \pm 585$ ,  $3084 \pm 636$  and  $3038 \pm 797$  m respectively on the Int-HINT test during the three phases of the season. A positive and significant correlation ( $p < 0.05$ ) was consistently found between the performance in the Int-HINT test and the YoYo IRT L2 performance ( $r = 0.74-0.81$ ) and also with the amount of high-intensity work (HR  $> 90\%$  of HR<sub>max</sub>) performed during soccer matches ( $r = 0.72-0.82$ ). **Discussion** This study supported the understanding that repeated high-intensity running capability in soccer players changes through the season and that the NIE Int-HINT test was sensitive to these changes. Furthermore, the consistently significant correlation of this test performance with the YoYo IRT L2 and the match play work intensity strongly supported the criterion validity of the Int-HINT test with respect to assessment of repeated high-intensity running capability and to evaluate match-related physical capacity in youth elite soccer players. Moreover, the Int-HINT test being a laboratory-based protocol provides the option of measuring the physiological responses to intermittent exercise that might not be feasible during the field-based assessments. More studies are needed to evaluate the applicability of this test in adult elite players and other soccer populations.

## EFFECTS OF ASTAXANTHIN SUPPLEMENTATION ON CHANGE IN ACNE CONDITION IN YOUNG ELITE SOCCER PLAYERS

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**Introduction** The skin is the organ that is most exposed to the effects of environmental factors and parameters of oxidative stress. Physical activity and specificity of soccer make effects on the skin much more pronounced. Astaxanthin (Asx), a red carotenoid pigment, is a biological antioxidant that occurs naturally in a wide variety of living organisms. The aim of this study was to determine the effects of Asx supplementation on young elite soccer players skin. **Methods** Sixty healthy young soccer players have participated in double blind placebo controlled study during three months that monitored effects of Asx supplementation on sports performance. Of that number, 17 athletes (age  $17.5 \pm 0.5$ ) have had skin problems (8 Asx group, 9 P group). The intervention group received 4 mg Asx capsules daily. We monitored skin changes of 17 athletes using Grading Scale for Comedones, Papules and Macules (GS-CPM) and Grading Scale for Overall Severity (GS-OS). Before starting the dietary supplementation, baseline of skin changes for each of the subjects were obtained. Changes in acne condition were graded after 45 and 90 days of supplementation. All athletes were photographed in accordance to recommended standards (Cook et al, 1979). **Results** Any significant changes in acne condition between groups were not observed among the grade values after 45 and 90 days of administration period. In Asx group, there was significant improvement ( $p < 0.05$ ) in GS-OS after 90 days of supplementation (mean stage value  $1.7/1.2$ ). Also, there was significant improvement ( $p < 0.05$ ) in GS-CPM after 45 days of supplementation (mean stage value  $2.1/1.5$ ) and after 90 days of supplementation ( $2.1/1.4$ ). There were no significant changes in

P group. Discussion The present study suggests that Astaxanthin may have beneficial effect on acne condition in young athletes. Limitation of this research was a small number of participants with skin disorders. Larger studies are necessary in order to evaluate a mechanism of Astaxanthin improvement on skin condition. References Cook C., et al. (1979). Arch Dermatol-Vol. 115.

### PHYSICAL ACTIVITY AND PSYCHOSOCIAL ASPECTS AT WORK IN FLEMISH SECONDARY SCHOOL TEACHERS

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Physical activity and psychosocial aspects at work in Flemish secondary school teachers Bogaert, I.I, Zinzen, E.I, De Martelaer, K.I, Deforche, B.2, Clarys, P.2 1 VUB, Movement and Sportstraining, Brussels, Belgium 2 VUB, Human Biometry and Biomechanics, Brussels, Belgium Introduction: Current research indicates an increased rate of absenteeism amongst teachers due to psychological problems. Regular physical activity (PA) is believed to improve physical and mental health. The purpose of this study is to examine PA levels of Flemish secondary school teachers and possibly related psychosocial aspects at work (PAW): job satisfaction(JS), social support(SS) and mental stress(MS). Methods: Moderate-to-vigorous PA (MVPA) measured by the International Physical Activity Questionnaire (IPAQ), PAW and demographics were collected by means of an online survey in a representative sample of teachers (n=413, age 39.6±9.7 years, 69% female). Independent samples t-tests and correlation analyses were performed. Results: Over 60% of the teachers met the current PA guidelines. Male teachers (72.7±61.0 min/dayMVPA) were more active than their female colleagues (57.4±51.3 min/dayMVPA; p<.05), especially during leisure time. The amount of MVPA was not related to age or absenteeism at work, nor to PAW scores. Teachers showed high PAW scores (JS=79.3±16.5; SS=81.7±14.7; MS=81.5±12.3) on a 0-100 scale. Teachers on sick leave for more than 7 days/year had a significantly lower JS (74.3±7.1; p<.05) and show tendency towards higher MS (84.5±13.5; p=0.056) compared to the lower absence group (JS=80.4±15.4; MS=81.0±12). Female teachers were more satisfied (80.4±16.3) and had a more positive perception of SS (83.8±14) at work than the male teachers (JS=76.7±17; SS=77.1±15.5; p<.05). Females' MS was higher (82.7±12.2) than males' (79.0±12.5; p<.05). Discussion: The majority of teachers had a physically active lifestyle (PALS) and high psychosocial scores. Gender-related differences occurred for both MVPA and PAW scores. However, a more PALS was not related to better psychosocial aspects at work.

### SEDENTARY BEHAVIOR IN PORTUGUESE YOUTH: THE SEASONALITY EFFECT.

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Introduction Sedentary behavior (SB) is directly associated with a greater risk of death from cardiovascular problems, cancer and all causes. Moreover, SB is directly associated with obesity in children. This study examined whether there was a significant seasonal variation in objectively measured SB in Portuguese youth across five months of data collection. Methods A total of 344 participants (aged 14.7 ± 2.04), 196 girls and 148 boys, were assessed in five months. SB was assessed with the Actigraph GT1M accelerometer for 7 consecutive days (15 seconds epochs). Gender patterns of SB were assessed for 5 distinct month periods: February; March; April; May; June. The difference in the amount of SB was assessed with a gender-by-month comparison using a ANOVA. Results Participation in SB varied by gender and month of assessment. The ANOVA for SB revealed significant main effects for Gender (F= 22.62 p<.001), Month (F= 7.34 p<.001), and Gender\*Month (F= 2.51 p<.042). Girls were significantly more sedentary (minutes) than boys in these months: 3) 689.49 vs 651.37 (p<.006); 4) 670.86 vs 625.55 (p<.019); 6) 656.89 vs 564.76 (p<.001). In both genders SB decreased from winter to spring, but more marked in boys. Discussion The weather or sunlight exposure cannot be changed, but knowledge of how weather conditions affect youth SB can help to adapt recommendations to diminish its effects. The seasonal patterns suggest that interventions must be modified during different seasons of the year, to specifically decrease SB in winter months.

### PEDOMETER DETERMINED PHYSICAL ACTIVITY, BMI, AND TV-WATCHING BEHAVIOR IN PRESCHOOLERS

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Introduction Nowadays, there is a widespread belief that preschool children are not active enough (Kelly et. al. 2005) and that the amount of physical activity has been decreasing as the opportunities for pleasurable sedentary activities have increased. High levels of physical activity for preschool children can delay the assault of a critical period of adiposity rebound, after the age of six (Moore et al., 2003). The purpose of the current study was to examine the association between pedometer determined PA, BMI, and TV-watching in preschool children. Methods The sample consisted of 1560 preschoolers (783 boys and 777 girls), aged 48 to 79 months (Mean=60.63, SD=7.03 months). PA was assessed for 7 consecutive days using an OMRON HJ-720IT-E2 pedometer, while hours of TV-watching were recorded using a parental questionnaire-diary. Results One-way ANOVA was utilized to detect group differences. When BMI was used as an independent factor, statistical analysis revealed significant effect in steps×week-1 (p<.05) and in km×week-1 (p<.005) but not in hours of TV-watching×week-1. Bonferroni post-hoc analysis showed that "normal" children differed from the "overweight-obese" children in nr. steps×week-1 (p<.05) and in km×week-1 (p<.005). The results of the ANOVA using TV-watching as independent factor revealed statistically significant effect in steps×week-1 (F=5.23, p<.05) and in km×week-1 (F=5.42, p<.05). Children "watching" TV less than 4 hours×week-1 had significantly more steps×week-1 (p<.05) and km×week-1 (p<.05) compared with children watching more than eight hours×week-1. Discussion In contrast with other study (Janz et. Al., 2002), BMI was found to have a significant effect on PA of preschoolers. Additionally, TV-watching appeared to be contributing to low levels of pedometer determined PA. Present findings showed that TV watching was associated with low activity levels but not with BMI. References Janz, K.F., Levy, S.M., Burns, T.L., Torner, J.C., Willing, M.C. & Warren, J.J. (2002). Fitness, Physical Activity, and Television Viewing in Children during Adiposity Rebound Period: The Iowa Bone Development Study. Preventive Medicine, 35, 563-571. Kelly, L.A., J.J. Reilly, S. Grant, and J.Y. Paton. Low physical activity levels and high levels of sedentary behaviour are characteristic of rural Irish primary school children. Irish Med. J. 98:138-141, 2005. Moore, L.L., Gao, D., Bradlee, M.L., Cupples, L.A., Sundarajan-Ramamurti, A., Proctor, M.H., Hood, M.Y., Singer, M.R. & Ellison, R.C. (2003). Does early physical activity predict body fat change throughout childhood? Preventive Medicine, 37, 10-17.

## PHYSICAL ACTIVITY BENEFITS, HARM OF SEDENTARY BEHAVIOUR AND ACTIVITY GUIDELINES FOR TODDLERS – WHAT DO MOTHERS KNOW?

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PHYSICAL ACTIVITY BENEFITS, HARM OF SEDENTARY BEHAVIOUR AND ACTIVITY GUIDELINES FOR TODDLERS – WHAT DO MOTHERS KNOW? Costa S.1, Clemes S.1, Barber S.2, Akhtar S.2, Varela-Silva M.I.1, Griffiths P.1, Cameron N.1 1: Loughborough University (UK), 2: Born in Bradford Cohort Study (UK) Introduction Childhood obesity is a worldwide public health problem. Regular physical activity (PA) is protective against various chronic diseases, while time spent in sedentary behaviour (SB) is considered an independent risk factor for many illnesses. UK South Asians (SA) are at higher risk for several chronic diseases (Forouhi & Sattar, 2006). However, SA are reported to lead a sedentary lifestyle (Forouhi & Sattar, 2006), and SA women have reported lack of knowledge about the health benefits of PA, and the appropriate type or level of PA needed (Srisantharajah & Kai, 2007). The preschool age is considered a key period of life for the establishment of lifestyle behaviours such as PA and SB, for which parents are regarded as the most important influence (Oliver et al, 2009). Guidelines for PA and TV viewing time have been published, but parents' knowledge on this has not yet been assessed. The aim of this research was to assess mothers' knowledge about the health benefits and harms of PA and excessive SB, and the guidelines for PA and TV viewing for toddlers, in an ongoing study of a bi-ethnic population from Bradford. Methods Five focus groups (N= 3 to 6 per group) were conducted to date with White and Pakistani mothers of 2-3 year olds, at Children's Centres. The focus groups were conducted in English or Urdu. Audio recordings were transcribed verbatim and analysed following a Thematic Analysis approach. Results All mothers recognized PA as important to keep healthy. White mothers cited specific health benefits, such as good circulation, or keeps weight low, while Pakistani mothers cited the general concept of its importance for a healthy body. Furthermore, doing too much was recognized as detrimental for health. Feeling lazy and obesity were commonly identified harms of SB. However, half of the mothers also recognized sitting for long periods of time as beneficial, to have a rest. No mothers had knowledge about existing recommendations for PA and TV viewing time. Discussion Although all mothers recognized PA as an important healthy habit, Pakistanis in this sample did not express knowledge of specific health benefits of regular PA. Half of the mothers associated excessive SB with obesity. However, guidelines about PA and TV viewing for toddlers need to be disseminated more effectively to enable mothers to regulate these behaviours and actively have the information to intervene to form healthy activity habits and reduce the risk of their child becoming obese. References Forouhi N.G., Sattar N. (2006) *Atheroscler Suppl*, 7, 11-9 Oliver M., Schofield G.M., Schluter P.J. (2010) *J Sci Med Sport*, 13(4), 403-9 Srisantharajah J., Kai J. (2007) *Fam Pract*, 24(1), 71-76

## PHYSICAL ACTIVITY DURING SCHOOL RECESS

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Escalante, Y.1, Backx, K.2, Saavedra, J.M.1, Garcia-Hermoso, A.1, Dominguez, A.M.1 1: Facultad de Ciencias del Deporte. AFIDES Research Group, Universidad de Extremadura (Caceres, Spain), 2: Cardiff School of Sport. University of Wales Institute (Cardiff, United Kingdom) Introduction One appropriate and convenient setting for the promotion of PA is the school environment because the children spend a large portion of their day in school (Van Sluijs et al., 2007) Physical education and recess provides the two main opportunities for school-based PA (Naylor et al., 2009). Therefore, the aim of this study was to describe the sex specific daily and school recess physical activity of primary school children aged 6 to 11. Methods 783 children (379 boys and 359 girls; age=8.5±1.7 years) participated in the study. Daily PA of each child was measured using a validated questionnaire (Cale, 1994) that was completed by the parents of each child, whilst playground recess PA was measured using uni-axial accelerometer. Results Boys reported higher daily PA levels than girls across all age groups ( $p < 0.001$ ). Measured recess PA was higher for boys compared to girls from the ages of 9 to 11 years. Across age group, higher level of daily PA level were reported by children aged ten compared to those aged six and eight. In contrast the PA measured during recess revealed a higher level count in eight-year olds compared to eleven-year olds. Boys were more active than girls on both measures of PsA (METs  $48.4 \pm 8.0$  versus  $43.8 \pm 7.1$ ,  $p < .001$ ; Counts  $28.0 \pm 11.6$  versus  $23.7 \pm 10.4$ ,  $p < .001$  respectively). Discussion The results showed that boys were more active than girls overall, as well as within each age group (Kimm et al., 2000). The major difference in age was observed at 8 years, where boys reported participating in 16% more daily PA than girls, these results are similar other study. No differences were found in reported PA or measured recess PA across age groups in boys. This finding is in contrast to studies that indicate that after age 9 to 10 a reduction in PA takes place in boys (Troiano et al., 2008). These data provide greater understanding of sex- and age-specific PA patterns and the relative contribution of daily and recess PA in primary school children References Cale L. (1994). *Health Educ J*, 53, 439-453. Kimm SY, Glynn NW, Kriska AM, et al (2000). *Med Sci Sports Exerc*, 32, 1445-1454. Naylor PJ, McKay HA (2009). *Br J Sports Med*, 43, 10-13. Van Sluijs EM, McMinn AM, Griffin SJ. (2007). *Br Med J*, 335, 703-716. Troiano RP, Berrigan D, Dodd KW, et al. (2008). *Med Sci Sports Exerc*, 40, 181-188. Acknowledgments YE was a visiting researcher at the University of Wales Institute, Cardiff (UK), supported with grant awarded by European Social Funds (FEDER Funds) and the Autonomous Government of Extremadura (Junta de Extremadura) (PO10012). This study and presentation was partially funded by same Institution (PRI08A066-GR10171).

## Poster presentations

### PP-PM60 Physiology: Muscle Physiology 2

## EFFECT OF PULSED ELECTROMAGNETIC FIELD EXPOSURE PROCEDURES ON MORPHOLOGICAL, BIOCHEMICAL AND IMMUNOLOGICAL INDICES OF ATHLETES' BLOOD

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Introduction In high performance athletes training, procedures of pulsed EM fields have been started to apply quite recently. It was found that pulsed EM field stimulates aerobic metabolism, enhances the recovery processes after high volume physical loads (Nieman et al., 2000; Kafka, Spodaryk, 2003; Lewis, 2003; Maffiuletti, 2006; Gazurek, Spodaryk, 2008). However, there is a shortage of studies on the efficacy of the application of define intensity pulsed EM in the dynamics of blood morphological, biochemical and immunological indices. Aim of the study was to research the effect of the 14-days-long application of procedures using pulsed electromagnetic field emitting

apparatus BEMER-3000 on the dynamics of some morphological, biochemical and cellular immunological indices of blood in physically active young men's aged 20-21 years. Methods The experimental (E) and control (C) groups comprised 14 healthy, physically active men aged 20-21 years (PE students). Testees from group E for 14 days were exposed to dosed electromagnetic fields emitted by BEMER-3000. Members of the C group were lying on a turned-off mat for the same time. Before, after the 14 days application of the BEMER-3000 and in after the next 2 weeks we have taken venous blood sample and conducted measurements to establish morphological and biochemical composition of the blood, indices of immune state of the blood. Results Positive changes were noticed in leukocyte formula. While leukocyte count decreased, percentage of monocytes increased statistically reliably, and increase of lymphocytes count was not reliable statistically. Increase of granulocytes count also was not statistically reliable. Under the effect of pulsed EM field, cholesterol concentration decreased in blood of testees. After the pulsed EM field procedures of 14 days duration, count of lymphocyte subtypes characteristic for immune response, especially CD3+ (T lymphocytes) and CD19+ (B lymphocytes) had tendency to increase. Due to BEMER-3000 therapy, response of lymphocytes increase when stimulating with mitogene phytolac (PWM), that was statistically reliable and may be considered as quite active. Changes in organism, occurring due to the application of pulsed electromagnetic waves, almost completely disappear in following two weeks. References Gazurek D, Spodaryk K. (2008). *Biology of Sport*, 25 (2), 147-165. Kafka WA, Spodaryk K. (2003). *Fizioterapija*, 11, 3, 24-31. Klopp R. (2008). *Mikrozirkulation im Fokus der Forschung*, 441-446. Lewis MJ. (2003). *J. Sports Sci.*, 21 (10), 793-802. Maffioletti N.A. (2006). *Int. J Sports Physiol Perform*, 1 (4), 406-407. Nieman D, Nehlsen-Cannarella S, Fagoaga O et al. (2000). *Br J Sports Med*, 34, 181-7.

## MODULATION OF NON-RECIPROCAL INHIBITION AT VOLUNTARY MUSCLE CONTRACTION IN TEENAGERS AND YOUTHS

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The purpose of our research was to study non-reciprocal inhibition (NI) of spinal  $\alpha$ -motoneurons in regulation of a voluntary muscle contraction in teenagers and youths. Methods 14-15 (n=10) and 17-18 year-old teenagers (n=10) took part in the research. NI spinal  $\alpha$ -motoneurons was evaluated according to the degree suppression of a testing m. soleus H-reflex amplitude in conditioning stimulation of afferents m. gastrocnemius med. (Pierrot-Deseilligny, 1979) in rest, during and after static effort. The lower the m. soleus H-reflex suppression is, the stronger is the NI. The interval between the conditioning and testing stimuli in 14-15 year-old teenagers was 1 ms, and in 17-18 year-old teenagers it was 6 ms. The subjects performed a isometric muscle contraction (plantar flexion) with a 5% and 25% of maximal voluntary contraction (IVN) effort within 2 minutes in a sitting position in the dynamographic system Biodex (Biodex Medical System, USA). Results In the relative muscular rest condition NI is more intense in 14-15 year-old teenagers (64%), than in 17-18 year-old teenagers (83,50%). During a static 5% of MVC effort NI was practically identical in 17-18 year-old teenagers (74,92%) and in 14-15 year-old teenagers (75,11%). At 25 % of MVC in 14-15 year-old teenagers NI was 63,62%, and in 17-18 year-old teenagers it made 125,09 %, i.e. it was non-reciprocal excitation. After the static 5% and 25% of MVC effort NI is more intense in 14-15 year-old teenagers, (57,29% and 21,45%, correspondingly), than in 17-18 year-old teenagers (70,17% and 74,31%, correspondingly). Discussion The presented changes of NI of  $\alpha$ -motoneurons at the spinal level specify structural change of neuromuscular systems functional condition in a critical ontogenesis period of the human. The teen age is characterized by intensifying of NI in rest, during and after a voluntary muscle contraction, and the youth age characteristics is weakening of NI in the same conditions. According to Stephens, Yang (1996) the decrease of NI can be caused by of m. triceps surae activation, that also took place at plantar flexion performance in our research. According to Pierrot-Deseilligny et al. (1982) and Gossard et al. (1994), a presynaptic component seems to influence reduction of NI during strong voluntary muscle contractions as the current data about of presynaptic inhibition afferents Ib (Lafleur et al., 1992). In our opinion, the difference of the NI intensity in teenagers and youth can be connected with morfofunctional spinal and supraspinal interneural pathways maturation, heterochronism interior cortex structures development and the endocrine system central section activities. References 1. Gossard et al. (1994). *Exp Brain Res*, 98, 213-228. 2. Lafleur J.F, Zytnicki D, Horscholle-Bossavit G, Jami L. (1992). *J. Physiol*, 445, 345-354. 3. Pierrot-Deseilligny E, Katz R, Morin C. (1979, 1982). *Brain Res*, 166, 233, 176-179, 400-403. 4. Stephens M.J, Yang J.F. (1996). *Brain Res*, 743, 24.

## FURTHER STUDY OF THE RELATION BETWEEN MUSCLE HARDNESS AND MECHANOMYOGRAM FINDINGS DURING VOLUNTARY ISOMETRIC CONTRACTIONS

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Introduction: Recently, we have developed a contact-type muscle hardness meter by using an ultra-slim pressure sensor that is capable of continuously assessing changes in muscle hardness (Murayama et al.; 2009, 2010). Muscle hardness is a valuable index of muscle conditioning. In our previous study, the muscle hardness determined using our contact-type device was linearly related to the isometric force level. Additionally, mechanomyogram (MMG), which reflects the intrinsic mechanical activity of the contracting muscle, is also a non-invasive tool used to investigate muscle activity. In the present study, we further examined the relation between muscle hardness and MMG at various muscle contraction levels to understand the utility of muscle hardness as a parameter of muscle mechanics. Methods: The contact-type muscle hardness meter and an accelerometer were placed 2 cm apart on the rectus femoris muscle. The hardness meter was wound to the muscle belly using an adhesive non-elastic surgical tape. The accelerometer was attached to the skin using a double-side adhesive tape. The subjects performed ramp and stepwise isometric knee extensions from 20% to 90% maximal voluntary contraction (MVC). The recording of MMG was rectified and integrated during the contraction period (hereafter, integrated MMG (IMMG)). The mean power frequency (MPF) of MMG was calculated using the fast-Fourier transform method. Results: Muscle hardness increased up to 90% MVC in both ramp and stepwise conditions. However, in the ramp condition, the slope of the regression equation between muscle hardness and %MVC was gentler than that in the stepwise condition. IMMG increased up to 60% MVC and decreased thereafter. MPF of MMG increased up to 90% MVC. Discussion: IMMG increased with an increase in motor unit recruitment but decreased at high contraction levels of isometric force because of the fusion-like mechanical activity of the motor units. The increase in the MPF of MMG can be attributed to an increase in the firing rate of motor units. Ebersole et al. (1999) suggested that a decrease in MMG above 80% MVC could be associated with changes in the intramuscular pressure and muscle stiffness, i.e. the number of attached cross-bridges. The increase in muscle hardness might also be associated with these changes. Therefore, high levels of muscle hardness may lead to a decrease in the MMG amplitude by restricting muscle fibre oscillation. References Ebersole KT et al. (1999). *J Electromyogr Kinesiol*, 9: 219-27. Murayama M et al. (2009). *Proceeding of 14th Annual congress of the European College of Sport Science*, 366. Murayama M et al. (2010). *Proceeding of 15th Annual congress of the European College of Sport Science*, 598.

## FLUTTER KICK SWIMMING VELOCITY IS RELATED TO ISOKINETIC KNEE MUSCLE STRENGTH BUT NOT TO ISOKINETIC TRUNK MUSCLE STRENGTH IN ELITE MALE UNDERWATER HOCKEY PLAYERS

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**Introduction** Underwater hockey is a developing team sport that is played in more than 20 countries on six continents. It has improved and became a very fast-paced dynamic game with strict rules and regulations (Collopy, 1998). Strength for the underwater swimming is generally produced by the lower extremities and swimming fins supply speed and efficiency (Neuhaus et al., 2004). In order to cope with the resistance of the fin, the diver should have adequate leg strength and power (Pendergast et al., 2003). Thus, the purpose of this study was to examine whether swimming performance of participants were differ based on their isokinetic strength scores. **Methods** Twelve elite male underwater hockey players participated in this study. Their isokinetic leg and trunk muscle strength were measured by the Biodex System 3 Pro Isokinetic Dynamometer (Biodex Medical Inc, Shirley, NY) at three different angular speeds for knee (60°/s, 180°/s and 360°/s) and at two angular speeds for trunk (60°/s and 120°/s). Moreover, participants' underwater swimming velocity was measured in a pool. Participants were encouraged to swim 25 m in underwater three times by holding their breath with flutter kicking style at their maximal velocity. Data was collected by three electronic stopwatches. **Results** Findings of this study stated that 360deg/s measurements revealed significant differences. Participants who have higher peak torque/body weight scores (high group) on dominant knee extension, dominant knee flexion and non-dominant knee extension, are significantly faster swimming performance than those who have lower scores on isokinetic knee strength at 360deg/s. **Discussion** The present findings have some implications for further investigations. Firstly, the results seem to suggest that isokinetic knee strength is more critical than isokinetic trunk strength for underwater swimming performance. Secondly, the results also indicated that rather than maximal isokinetic knee strength, explosive isokinetic knee strength is more important for underwater swimming performance. The latter conclusion was based on the present findings that although swimming performance did not change significantly according to participants' maximal strength values measured at 60deg/s (Carus et al. 2009), participants who have higher explosive knee strength measured at 360deg/s (Dvir, 2004) have significantly faster swimming performance than those who have lower explosive knee power. **References** Davis, F., Graves, M., Guy, J., Prisk, K., Tanner, T., (1987). Carbon dioxide responses and breath-hold times in underwater hockey players. *Undersea Biomedical Research*, 14(6), 527-534. Mookerjee, S., Bibi, K., Kenney, G., Cohen, Lee., (1995) Relationship between lower extremity isokinetic strength, flexibility, and flutter kicking speed in female collegiate swimmers. *Journal of Strength and Conditioning Research*, 9(2), 71-74 Pendergast, D., Mollendorf, J., Logue, C., Samimy, S., (2003). Evaluation of fins used in underwater swimming. *Undersea and Hyperbaric Medical Society*, 30(1), 55-71.

## EFFECTS OF HANDGRIP FORCE GENERATION ON THE MAXIMUM ISOMETRIC KNEE EXTENSION

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**[Introduction]** Many activities are performed using both hands and legs in multi-dimensional movements. The integration of muscle activities in the extremities with those in trunk muscles is often required for activities of everyday life and better performance in sports. This believes to be an effective way to stabilize body trunk and to generate larger force in the movements by transferring energy through each joint of extremities. However, despite requiring the integrity of extremities in daily activity, there are only few researches on the study of the integration of extremities on the muscle force generating capacity. The present study investigated the effects of handgrip force generation on the maximum isometric knee extension. **[Methods]** Thirty-eight healthy young individuals (mean $\pm$ S.D.; age, 20.6 $\pm$ 0.8 yr; height, 162.4 $\pm$ 7.8 cm; weight, 55.8 $\pm$ 9.3 kg) participated in this study. In experiment I, maximum isometric knee extension force of the right leg was measured at six different knee angles (90, 110, 130, 150, 170°) with the knee extension dynamometer. During the measurements, subjects placed their arms in front of their chest. Separately, maximum isometric handgrip force of the right and left hand together was measured with a handgrip dynamometer. In experiment II, based on the knee joint angle-force relation in the knee extension movement determined in experiment I, the knee joint angle at optimum force was applied to obtain the maximum isometric knee extension force with the maximum handgrip force. For MVC measurement, subjects exerted maximum force for ~3 seconds. Measurements were repeated three times with at least one-minute rest period between bouts, and the mean value among the measurements was calculated for MVC. Data are presented as mean $\pm$ SD. **[Results]** In experiment I, the knee joint angle-force relation in the knee extension movement was determined. The isometric force exhibited a peak when the knee joint was flexed at 110 degree on average. Based on this result, the joint angle at 110 degree was set for the measurement in experiment II. In experiment II, the maximum isometric knee extension force with the maximum handgrip significantly increased when compared with the maximum isometric knee extension force alone, and these represent 172.47 $\pm$ 57.47 Nm and 151.23 $\pm$ 52.68 Nm ( $p$ <0.001), respectively; however, the maximum handgrip force did not significantly different between the maximum handgrip force together with the maximum isometric knee extension and the maximum handgrip force alone, and these represent 56.82 $\pm$ 19.47 kg and 60.45 $\pm$ 17.74 kg ( $p$ >0.05), respectively. **[Discussion]** The results indicate that the leg muscle force generation integrated with hand force generation is effective to elevate the leg muscle force generation. The mechanism underlying this new phenomenon is not fully understood, but this can be speculated with the stabilizing the trunk through force generation of upper limbs and hands.

## RESPIRATORY KINETICS FOLLOWING CONCENTRIC-ECCENTRIC ISOKINETIC ARM AND LEG EXERCISE

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**Introduction** Assessments of dynamic changes in recovery respiratory kinetics following resistance exercise can provide information on the control and regulation of O<sub>2</sub> transport and utilization. The purpose of this study was to evaluate the effects of intensity and muscle mass on changes in respiratory and metabolic variables during recovery following concentric-eccentric, isokinetic exercise. **Methods** Fourteen healthy male subjects aged 26.9 $\pm$ 3.1 years, performed a 20-repetition isokinetic (combined, concentric and eccentric) arm or leg exercise protocol at 60 °sec<sup>-1</sup>, 150 °sec<sup>-1</sup>, and 240 °sec<sup>-1</sup>, in randomized order. Recovery (150 seconds) breath-by-breath gas exchange data were recorded to determine post-exercise half- time (t<sub>1/2</sub>) for V'O<sub>2</sub>, V'CO<sub>2</sub>, and V'E denoted as the time taken to reach 50% from maximum to resting. Three-way repeated measures ANOVA was used to determine the effect of parameter, exercise intensity and muscle mass, as well as Pearson's r, in combination with a t-test. **Results** The time course of V'O<sub>2</sub>, V'CO<sub>2</sub> and V'E showed a steep increase within the first 10 seconds of recovery. The V'O<sub>2</sub> at 150 °sec<sup>-1</sup> and 240 °sec<sup>-1</sup> velocities following leg exercise, exhibited a second wave with a peak around 20 seconds. V'E declined steeply followed by a slower phase to recovery. Both parameter and exercise intensity

significantly impacted the  $\dot{V}O_2$ . Integrated recovery  $\dot{V}O_2$  was significantly correlated with work intensity (arm:  $r=0.42$ ,  $p<0.05$ ; leg:  $r=0.62$ ,  $p<0.05$ ). Discussion These results indicate that  $\dot{V}E$  is decoupled from  $\dot{V}O_2$  after the initial first 10 seconds of recovery. Even the typical ranking of kinetics with  $\dot{V}O_2$  exhibiting the fastest change and  $\dot{V}E$  as the slowest parameter, cannot be supported in general here. The second increase or stagnation of  $\dot{V}O_2$  indicates the delayed arrival of venous blood from the exercising muscles. This phenomenon can also explain the trend toward a higher  $\dot{V}O_2$  for leg exercise, even though this finding was not statistically significant.

### THE EFFECTS OF WEARING AN UPPER BODY COMPRESSION GARMENT ON MAXIMAL UPPER BODY PERFORMANCE

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**Introduction** Improved performances in lower body activities, whilst wearing compression garments (CG), have been noted in high force/power actions such as jumping (Doan et al., 2003) and sprinting (Higgins et al., 2009). Duffield and Portus (2007) assessed upper body performance whilst wearing full body CG on a cricket ball throw, however no difference was found. Due to the mass of the cricket ball, the performance assessed was at the high velocity end of the force-velocity relationship. Therefore, the aim of this study was to assess whether wearing an upper body compression garment improves a high force action of the upper body. **Methods** Ten male participants (age  $24.2 \pm 6.2$  years, mass =  $77.8 \pm 12.9$  kg, height =  $176.7 \pm 8.8$  cm;  $\mu \pm SD$ ) performed a one-repetition maximum (1RM; Beachle and Earle, 2008) protocol on two separate days (counter-balanced), with and without wearing a commercially available upper body CG. Participants were experienced in weight training and had a minimum of three months experience with the bench press exercise; all participants could bench press their own body mass. **Results** There was a significant increase of  $1.79 \pm 1.75\%$  ( $\mu \pm SD$ ; effect size =  $1.04 \pm 0.93$ ;  $\mu \pm 95\%$  confidence interval) on the participants' 1RM bench press when performed wearing a compression garment (control,  $95.75 \pm 14.24$  kg; compression,  $97.5 \pm 14.94$  kg;  $p < 0.05$ ). Importantly, no participants scored lower whilst wearing the compression garment. **Discussion** Through wearing a commercially available upper body CG, we have shown a small increase in the 1RM bench press. Increased joint stiffness (Doan et al., 2003; Brughelli and Cronin, 2008) and muscle temperature (Duffield and Portus 2007; Racinais and Oksa, 2010) are potential explanations for the increased performance. Further testing is required which looks more at the underlying mechanisms that could cause the increase in high force and power actions. **References** Doan BK, Kwon YH, Newton RU, Shim J, Popper EM, Rogers RA, Bolt LR, Robertson M, Kraemer WJ. (2003). *J Sports Sci*, 21(8), 601-610. Higgins T, Naughton GA, Burgess D. (2009). *J Sci Med Sport*, 12(1), 223-226. Duffield R, Portus M. (2007). *Br J Sports Med*, 41(7), 409-414. Beachle TR, Earle RW. (2008). *Essentials of Strength Training and Conditioning*, 3rd ed, Human Kinetics. Brughelli M, Cronin J. (2008). *Scand J Med Sci Sports*, 18(4), 417-426. Racinais S, Oksa J. (2010). *Scand J Med Sci Sports*, 20(Suppl 3), 1-18.

### THE EFFECT OF THE BENCH PRESS GRIP ON THE UPPER BODY MUSCLE ACTIVITY IN THE BENCH PRESS

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The purpose of this study was to investigate the effect of varying bench press grip on the ECG activity of the upper body muscle during bench press exercise. Twelve male students ( $22.5 \pm 2.7$  yrs) were participated. To assess the electromyography of selected muscles, surface electrodes were attached to pectoralis majors, trapezius, front deltoid and triceps brachii. IEMG (Integral EMG) and NEMG (Normalization EMG) were measured for each muscles. For each variable, one-way repeated ANOVA was used to determine whether these were significant difference among three grips bench press. From the above experiment, this study analyzed muscle activity and participations in wide grip (WD), normal grip (NM), narrow grip (NR) during bench press. When a significant difference was found in three grip bench press, post hoc analysis was performed using Turkey procedure. Significant level was .05. IEMG of triceps brachii muscle was significantly affected depending on the change of bench press grip (WD  $35.42 \pm 9.25\%$  vs NM  $52.68 \pm 11.02\%$ ,  $p < .05$ ). NEMG of pectoralis major was significantly different between WD and NM & NR ( $30.91 \pm 6.93\%$  vs  $17.61 \pm 3.75\%$  &  $15.56 \pm 5.53\%$ ,  $p < .05$ ). NEMG of trapezius was significantly different between WD and NM ( $3.63 \pm 1.21\%$  vs  $10.86 \pm 2.23\%$ ,  $p < .05$ ). NEMG of triceps brachii was significantly different between WD and NM ( $28.17 \pm 4.36\%$  vs  $40.97 \pm 7.53\%$ ,  $p < .05$ ). Conclusively, pectoralis major muscle activity reduced as a grip narrow. And muscle activity of trapezius and tricep brachii increased as a grip narrow.

### NEUROMUSCULAR ADJUSTMENTS TO REPEATED CYCLING SPRINTS

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**Introduction** It has been proposed that a number of adaptations in both the muscular and the nervous systems may compromise fatigue resistance during repeated-sprint exercise (RSE) [1]. To date however, there is conflicting evidence regarding the contribution of central fatigue during RSE [2-4]. The aim of the present study was to investigate the precise locus of impairment in neural drive, if any, after repeated cycling sprints by using trans-cranial magnetic stimulation (TMS), in addition to conventional motor nerve (MN) stimulation. **Methods** Ten active males performed 10, 6-s "all-out" sprints on a cycle ergometer, interspersed with 30 s of recovery, followed, after 6 min of passive recovery, by five 6-s sprints, again interspersed with 30 s of recovery. Neuromuscular tests included motor nerve (MN) and trans-cranial magnetic (TMS) stimulation during brief (5-s) isometric contractions of the knee extensors performed before and after exercise. Root mean square (RMS) was utilized to quantify EMG activity from the vastus lateralis (VL) muscle of the right leg during both the all-out sprints and the warm up (sub-maximal sprints at 70, 80 and 90% of the perceived maximum). The EMG during the warm-up sprints was used to establish the power-EMG relationship and to determine whether the decrease in EMG previously observed during RSE was consistent with the decrease in power output. **Results** The RSE resulted in a decrease in peak power output (-12%), and a decrease in maximal strength (-12%) and the rate of force development (-20%) during briefs isometric contractions ( $P < 0.05$ ). Resting twitch amplitude declined by 42% and 40% (MN and TMS, respectively). Following the RSE there were no significant changes in voluntary activation estimated from either MN (80%) or TMS (90%). Interestingly, there was only a 5.5% decrease in EMG, which was significantly less than that estimated from the power-EMG relationship established during the warm up (-23%). **Discussion** An original finding of the present study is that the decrease in EMG was much less than that which would be predicted from the decrease in power output. This was accompanied by substantial reductions in muscle contractility following the repetition of cycle sprints. These changes, along with the lack of change in muscle activation, suggest that peripheral mechanisms were the predominant cause of fatigue during our repeated-sprint task. **References** 1. Bishop D, Girard O. Repeated-sprint ability. In: Cardinale M, Newton R, Nosaka K, editors. *Strength and conditioning biological principles and practical applications*: John Wiley & Sons, Ltd 2010. p. 223-41. 2. Racinais S, et al. Muscle deoxygenation and neural drive

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### EFFECT OF ACUTE RUGBY SPECIFIC FATIGUE ON WHOLE MUSCLE CONTRACTILE PROPERTIES.

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EFFECT OF ACUTE RUGBY SPECIFIC FATIGUE ON WHOLE MUSCLE CONTRACTILE PROPERTIES. Haslam, S.J.<sup>1,2</sup>, Anestik, M.<sup>2</sup>, Bell, K.<sup>1</sup>, Baxter, T.<sup>1</sup>, Hunter, A.M.<sup>1</sup> <sup>1</sup>University of Stirling, Scotland, <sup>2</sup>SportScotland Institute of Sport Stirling, Scotland Introduction Muscle function of rugby players is currently assessed by tests such as 1 RM (Bevan et al, 2010), isokinetic (Edouard et al, 2009), maximal voluntary contractions and countermovement jumps (Pournot et al, 2010). The disadvantages to such tests are the requirements for: firstly, 100% motivation from the players (Tod et al, 2009) and; secondly, often heavy immobile equipment. We propose an alternative assessment tool tensiomyography (TMG) which is both a passive measure and uses portable equipment. TMG is a measured mechanical response to stimulation of skeletal radial muscle belly (Dm). The aim of this study was to determine the effectiveness of TMG in tracking the fatigue induced following two rugby specific fatigue interventions. Methods 9 university rugby players had Dm recorded for Biceps Femoris (BF) and Rectus Femoris (RF) before and after 2 separate rugby specific fatigue interventions. The first, a sprint intervention (SPR), consisting of 6x6 maximal sprints over 30m (10 sec recovery between reps and 3 min recovery between sets). The second, a contact intervention (CON), consisting of 6x6 maximal tackle bag hits, sprinting from a supine position 5m away (3min recovery between sets). Performance times for each repetition were recorded via light gates. Counter-movement jump (CMJ) and rate-of-perceived-exertion (RPE) were recorded after every set. Results Sprint repetition times significantly ( $p<0.01$ ) declined within and across the sets for both interventions. CON showed a significantly ( $p<0.01$ ) greater rate of fatigue over the sets than SPR (15.8% vs. 7.6%). RPE and CMJ significantly ( $p<0.01$ ) increased and decreased respectively for both interventions ( $p<0.01$ ) across the sets. CMJ declined significantly ( $p<0.01$ ) more and at a greater rate than SPR. There was a significant ( $p<0.01$ ) decline in RF Dm following the sprint sets after CON ( $P=0.041$ ) but a tendency for SPR ( $P=0.058$ ). There was a tendency for BF Dm to decline for CON ( $P=0.073$ ) but not for SPR ( $P=0.13$ ). Discussion It is clear that CON significantly fatigued the participants more than SPR, which was effectively tracked by TMG RF Dm. There was a tendency for decline in RF Dm post SPR, however, it is clear that the extent of fatigue was much less within this protocol than CON. BF Dm remained the same following both interventions indicating that RF contributed to the fatigue shown whereas BF did not. References Bevan HR, Cunningham DJ, Tooley EP, Owen NJ, Cook CJ, Kilduff LP. (2010). J Strength Cond Res, 24, 701-5. Edouard P, Frize N, Calmels P, Samozino P, Garet M, Degache F. (2009). Int J Sports Med, 30, 863-7. Pournot H, Bieuzen F, Duffield R, Lepretre PM, Cozzolino C, Hausswirth C. (2010). Euro J Appl Physiol, 1-9. Tod DA, Thatcher R, McGuigan M, Thatcher J. (2009). J Strength Cond Res, 23, 196-202.

## Poster presentations

### PP-PM61 Physiology: Power

#### HAMSTRING QUADRICEPS RATIOS: THEIR RELATIONSHIP TO HIGH SPEED MOTOR CAPABILITIES AND DIFFERENT FOOTBALL POSITIONS

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HAMSTRING QUADRICEPS RATIOS: THEIR RELATIONSHIP TO HIGH SPEED MOTOR CAPABILITIES AND DIFFERENT FOOTBALL POSITIONS Fletcher, I.1, Mills, D.1 1: UoB (Bedford, UK) Introduction Football has a number of essential motor capabilities, including turning, sprinting, jumping and changing pace (Cometti et al., 2001), with the ability to perform these actions seeming to differ between outfield positions (Hoff & Helgerud, 2004). The aim of this study was to explore if these physiological differences were apparent and whether Hamstring:Quadricep (HQ) ratio varied between positions. Methods 30 male collegiate footballers (age  $22.4 \pm 2.5$ yr., height  $129 \pm 4.9$ cm, mass  $78 \pm 7.8$ kg) were split into equal groupings of defenders, midfielders and attackers before performing a maximum voluntary contractions at angular velocities of  $60^\circ/\text{s}$  and  $180^\circ/\text{s}$  on a Kincom Isokinetic Dynamometer (Chattanooga 125E). HQ ratios were measured by dividing maximal eccentric knee flexion force by maximum concentric knee extension force (Aagaard et al., 1998). On a separate day participants were tested for counter movement jump, flying 30m and Illinois agility test performance. Tests were repeated 3 times with the peak score being used for analysis. Results HQ ratios for defenders, midfielders and attackers were calculated as 0.93, 0.82 and 0.90 at  $60^\circ/\text{s}$  and 1.13, 0.99 and 1.06 at a  $180^\circ/\text{s}$  velocity. No significant difference ( $P>0.05$ ) were found between positions at either velocity. There was no significant differences ( $P>0.05$ ) between the three positions in any of the physical capacity tests used. HQ ratios had no significant relationship with performance tasks accept jump height and  $180^\circ/\text{s}$  ratios ( $P<0.05$ ). Discussion The findings of this study are contrary to a number of other studies. No difference in capacities was observed between positions, possibly due to participants not playing at a high enough level to do enough training specific to their chosen position; players trained or played at least three times a week, but would not have trained at the same volume as elite footballers. Interestingly the functional HQ ratios found in this study were all in the healthy range, above 0.6 (Svensson and Drust, 2005), despite a number of studies finding large muscle imbalances in football populations. It may be that by using a functional measure, where the hamstrings eccentric capacity is compared to the quadriceps concentric force, higher ratios can be achieved. HQ ratios did not seem to be linked to other performance tests at a slow velocity, but the higher ratios achieved at the faster velocity were linked to the simple task of jumping, but not to more complex motor skills. References Aagaard P, Simonsen E, Magnusson S, Larsson B, Dyhre-Poulsen P. (1998). Am J Sports Med, 25, 231-237. Cometti G, Maffiuletti N, Pousson M, Chatard J, Maffulli N. (2001). Int J Sports Med, 22, 45-51. Hoff J, Helgerud J. (2004). Sports Med, 34, 165-180. Svensson M, Drust B. (2005). J Sports Sci, 23, 601-618.



## EFFECTS OF DYNAMIC STRETCHING ON THE HAMSTRINGS-TO-QUADRICEPS FUNCTIONAL RATIO IN RECREATIONALLY ACTIVE FEMALES.

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**EFFECTS OF DYNAMIC STRETCHING ON THE HAMSTRINGS-TO-QUADRICEPS FUNCTIONAL RATIO IN RECREATIONALLY ACTIVE FEMALES.** Ayala, F.I., De Ste Croix, M.2 and Sainz de Baranda, P.3 1:Catholic University of San Antonio (Spain), 2:University of Gloucestershire (UK), 3:University of Castilla La Mancha (Spain). **Introduction** Low hamstring-to-quadriceps isokinetic peak torque ratios have been associated with an increased risk of injury. Since stretching may decrease isokinetic peak torque, it is possible that pre-stretching may adversely affect the hamstrings-to-quadriceps functional ratio. The purpose of this study was to examine the acute effects of a short lower limb dynamic stretching program on knee extension (KE) and flexion (KF) peak torque (PT) and the hamstring-to-quadriceps functional ratio (H/QFUNC) in recreationally active female young adults. **Methods** Twenty-five recreationally active female young adults provided written informed consent to participate in this study. All participants visited the lab three times, one for familiarization and two for testing (stretching and control conditions completed in a random order) with 3-days between sessions. The dynamic stretching program consisted of a 5 different unassisted stretching exercises. Each exercise was designed to stretch one of the major lower limb muscles and was performed twice, bobbing in 1:2-second cycles for 30s with 30s rest between repetition and exercise. In the control condition no stretching was performed. Immediately after the stretching or control condition participants performed 2 maximal efforts on an isokinetic dynamometer to determine maximal PT during CON/CON and ECC/ECC cycles at 60 and 240°/s-1. Participants were placed in a prone position with the hip flexed at 10° and active range of motion was from 0 to 90°. **Results** There were no stretching-related changes in PT during both KE and KF maximal CON and ECC muscle actions at 60 and 240°/s-1 ( $p < 0.05$ ). In addition, no significant changes were found in H/QFUNC between sessions (control and stretching) in both velocities (0.64 v 0.69 and 1.0 v 0.98). **Discussion** Short and contextualized dynamic stretching has no effect on maximal CON and ECC peak torque as well as on H/QFUNC. In addition, it is well known that dynamic stretching routines are effective in improving joint range of motion. Therefore, we suggest that a dynamic stretching routine should be performed as a fundamental part of a typical warm-up because it does not seem to cause stretch induced deficits in strength performance and subsequent dynamic knee stability, as well as its effectiveness for improving range of motion of the muscle stretched. **References** Aagaard P, Simonsen EB, Magnusson P, Larsson B, Dyhre-Poulsen P. (1998). *Amer J of Sports Med*, 26(2): 231-237 Costa PB, Ryan ED, Herda TJ, DeFreitas JM, Beck TW, Cramer JT (2009) *International J of Sports Med* 30(1): 60-5

## EFFECTS OF STATIC STRETCHING ON THE HAMSTRINGS-TO-QUADRICEPS FUNCTIONAL RATIO IN RECREATIONALLY ACTIVE ADULT MALES

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**EFFECTS OF STATIC STRETCHING ON THE HAMSTRINGS-TO-QUADRICEPS FUNCTIONAL RATIO IN RECREATIONALLY ACTIVE ADULT MALES.** Ayala, F.I., De Ste Croix, M.2 and Sainz de Baranda, P.3 1:Catholic University of San Antonio (Spain), 2:University of Gloucestershire (UK), 3:University of Castilla La Mancha (Spain). **Introduction** Low hamstring-to-quadriceps isokinetic peak torque ratios have been associated with an increased risk of injury. Since stretching may decrease isokinetic peak torque, it is possible that pre-stretching may adversely affect the hamstrings-to-quadriceps functional ratio. The purpose of this study was to examine the acute effects of a short lower limb static stretching program on knee extension (KE) and flexion (KF) peak torque (PT) and the hamstring-to-quadriceps functional ratio (H/QFUNC) in recreationally active male young adults. **Methods** Twenty-five recreationally active male young adults provided written informed consent to participate in this study. All participants visited the lab three times, one for familiarization and two for testing (stretching and control conditions completed in a random order) with 3-days between sessions. The static stretching program consisted of a 5 different unassisted stretching exercises. Each exercise was designed to stretch one of the major lower limb muscle and was performed twice, holding the position for 30s with 30s rest between repetition and exercise. In the control condition no stretching was performed. Immediately after the stretching or control condition participants performed 2 maximal efforts on an isokinetic dynamometer to determine maximal PT during CON/CON and ECC/ECC cycles at 60 and 240°/s-1. Participants were placed in a prone position with the hip flexed at 10° and active range of motion was from 0 to 90°. **Results** There were no stretching-related changes in PT during both KE and KF maximal CON and ECC muscle actions at 60 and 240°/s-1 ( $p < 0.05$ ). In addition, no significant changes were found in H/QFUNC between sessions (control and stretching) in both velocities (0.75 v 0.71 and 0.84 v 0.91). **Discussion** Short and contextualized static stretchings have no effect on maximal CON and ECC peak torque as well as on H/QFUNC. In addition, it is well known that short static stretching routines (60s per muscle group) are as effective as longer routines for improving joint range of motion. Therefore, we suggest that a short static stretching routine should be performed as a fundamental part of a typical warm-up because it does not seem to cause stretch induced deficits in strength performance and subsequent dynamic knee stability, as well as its effectiveness for improving range of motion of the muscle stretched. **References** Aagaard P, Simonsen EB, Magnusson P, Larsson B, Dyhre-Poulsen P. (1998). *American Journal of Sports Medicine*, 26(2), 231-237 Costa PB, Ryan ED, Herda TJ, DeFreitas JM, Beck TW, Cramer JT (2009a) *Journal of Sports Medicine & Physical Fitness* 49(4), 401-09

## THE RELATIONSHIP BETWEEN THE BALL VELOCITY AND ANAEROBIC POWER, STRENGTH, ANTHROPOMETRIC CHARACTERISTICS AND REACTION TIME IN TEAM HANDBALL AND SOCCER

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**Introduction:** The aim of this study was to analyse "How is the relation with ball velocity between anaerobic power, specific anthropometric characteristics, motor abilities and reaction time?" **Methods:** Anaerobic power was calculated by Lewis Formula (Fox, 1984). Ball velocity was measured by Sports Radar Gun. Vertical jump and Reaction time were measured by MPS-5001F Kompe System. Correlations were evaluated Pearson Correlation Sig(2 tailed) test. **Results:** Ball velocity of male and female handball players (standing throw after 3 steps) is 72.64±5.32kmh, 72.16±6.92kmh. At the side-foot and close up of foot kicking, the ball velocity of male soccer players is related with foot length ( $p=.028$ ), ( $p=.004$ ). At the close up of foot kicking, the ball velocity of male soccer players is related with arm relaxed girth measurement ( $p=.019$ ), arm flexed girth measurement ( $p=.004$ ), waist ( $p=.042$ ), chest ( $p=.014$ ). Ball velocity of female handball players (standing throw after 3 steps) is related with anaerobic power ( $p=.004$ ), thigh circumferences ( $p=.011$ ), arm span ( $p=.050$ ), vertical jump ( $p=.003$ ). At the same throwing, ball velocity of male handball players is related with hand grip ( $p=.006$ ). Ball velocity of female handball players (vertical

jump throw after 3 step) is related with anaerobic power( $p=.002$ ), leg strength( $p=.003$ ), arm span( $p=.005$ ), vertical jump( $p=.002$ ) and height( $p=.027$ ). Discussion: The present study was the ball velocity of female and male player in handball standing throw after 3 step is  $72.16 \pm 6.92$  km/h and  $72.64 \pm 5.32$  km/h. Ball velocity of female handball player At the same throw, was stated 85 km/h (Joris et al., 1985), and international male handball player was stated 94.08 km/h (Jensen et al., 1999). The present study was the relation with ball velocity (that both standing throw after 3 step and vertical jump throw after 3 step) between arm span and height. Handball players who throw the ball at a higher velocity seem to have a wider arm span related to their body height (Skoufas et al., 2003). Another relation with ball velocity (standing throw after 3 step) of male handball players between hand grip strength. Grip force that is important in handball, from the moment pass is received till the throw is affected from the arm segment isometric muscle force. References: Fox, E.L., Sports Physiology CBS College Publishing, Printed in Japan, 1984. Skoufas D, Kotzamanidis C, Hatzikotoylos K, Bebetos G, patikas D. The relationship between the anthropometric variables and throwing performance in handball. J Hum Mov Sci 2003; 45: 469-84. Jensen, K., Johansen L., Larson B.: Physical Performance in Danish Elite Team Handball Players. 5 th World Congress on Sport Science and Medicine in Sport 1999. Sydney 31 October – 5 November 1999. Joris H.J., van Muyen A.J., van Ingen Schenau G.J., Kemper H.C.: Force, velocity and Energy Flow During the Overarm Throw in Female Handball Players. Journal of Biomechanics, 18(6): 409-14, 1985.

### PEAK POWER AND ANAEROBIC CAPACITY OF THE UPPER BODY IN ELITE IRANIAN MALE CANOE POLO PLAYERS

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This study is supported by National Canoeing, Rowing & Sailing Academy (Tehran, Iran) Introduction Canoe Polo is a strength-power type of sport and competition performance depends on factors such as strength and anaerobic power, physical power, canoe polo technique and tactics. An anaerobic activity is defined as energy expenditure that uses anaerobic metabolism (without the use of oxygen) that lasts less than 90 seconds, utilizing an exhaustive effort (Zupan et al., 2009). This study examines the aspect of upper-body peak power and anaerobic capacity using the 30-second exhaustive Wingate Anaerobic Test (WAnT). Methods The subjects were fifteen elite male canoe polo players from the Iranian National team (Mean  $\pm$  SD: age  $24.6 \pm 3.1$  years, height  $179.4 \pm 5.1$  cm, body mass  $82.9 \pm 7.6$  kg) who competed at the 2011 Asian canoe polo championships in Tehran, Iran. The Wingate Anaerobic Test (WAnT): Peak power output (PPO) and mean power output (MPO) or anaerobic capacity were assessed Wingate test on a mechanically braked cycle ergometer (model 891E, Monark, Sweden). Participants performed a Wingate test against a resistance equivalent to 0.040 kg/kg body mass. Participants were instructed to begin pedaling as fast as possible against the ergometer's inertial resistance, and then the appropriate load was manually applied. Participants were verbally encouraged to continue pedaling as fast as possible throughout the 30-s test. PPO was defined as the highest work output in a 5-second period, and MPO as the average work output for the 30-second test period (Nottle and Nosaka., 2007). Previously determined intraclass correlation coefficient (ICC) for Wingate variables was 0.94 (Bar-Or., 1987). Results Peak power and anaerobic capacity in absolute (W) and relative to body weight (W/kg-1) were determined for the WAnT. Peak power output (Mean  $\pm$  SD: absolute  $413.1 \pm 75.3$  watts (w), relative to body weight  $5.2 \pm 0.9$  watts per kilogram body weight (W/kg-1), and mean power output (Mean  $\pm$  SD: absolute  $281.9 \pm 32.5$  watts (w), relative to body weight  $3.44 \pm 0.3$  watts per kilogram body weight (W/kg-1). Discussion This is the first study to present a detailed analysis of the anaerobic profiles elite Iranian male canoe polo players. Success in many sports requires high upper power and anaerobic capacities. Some sports require absolute power, or the highest power output possible, independent of body size, such as canoe polo linemen, power lifters, or hammer throwers. If 2 players' skill level or techniques are equal, then the more powerful athlete will usually outperform the less powerful opponent. Where the athlete must move his or her body across a field or ice rink with a quick burst of energy, require a high relative peak power and anaerobic capacity. References Bar-Or O. (1987). Sports Med, 4(6), 381–394. Nottle C, Nosaka K. (2007). J Strength Cond Res, 21(1), 145–150. Zupan MF, Arata AW, Dawson LH, Wile AL, Payn TL, Hannon ME. (2009). J Strength Cond Res, 23(9), 2598–2604.

### INFLUENCE OF THE POWER-BALANCE HOLOGRAM ON BALANCE, STRENGTH, FLEXIBILITY AND ENDURANCE

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INFLUENCE OF THE POWER-BALANCE HOLOGRAM ON BALANCE, STRENGTH, FLEXIBILITY AND ENDURANCE Maren Pisch, Stefanie Cappell, Maik Drzensla, Julia Hämel, Holger Neumann, Alexander Ferrauti, Petra Platen Ruhr-University Bochum, Faculty of Sports Sciences (Bochum, Germany) Introduction More and more athletes use the so called "Power-Balance technology" to seemingly improve their sports specific performance. According to Consumer News and Business Channel (CNBC) it was the "Sports Product of 2010" and it was a best-seller on "Amazon.com". In contrast to its widely spread usage in sports there are no scientific studies about the real efficacy of this technology, yet. Therefore, the aim of this study was to examine the influence of the Power-Balance hologram on different skills like balance, strength, flexibility and endurance. Methods 19 (5 female and 14 male) healthy physical education students (age:  $22.5 \pm 1.9$  years; height:  $181 \pm 13$  cm; weight:  $76.2 \pm 15.7$  kg) participated in the study. On three experimental days at least one week apart, subjects took part in a partially blinded cross-over designed study under three conditions: B(-) (placebo, blind without hologram), B(+) (blind with hologram), and NB(+) (not blind with hologram). Parameters were flexibility (stand-and-reach/finger-ground distance (cm)), maximum thorax rotation (degree), strength (dominant hand-grip strength (kg)), balance (regulatory distance on a Posturomed (mm)), and endurance (20 m shuttle-run test (VO2max)). Results No significant differences were found for any parameter between the three testing conditions: stand-and-reach (cm): NB(+):  $3.3 \pm 11.6$  cm, B(+):  $3.0 \pm 10.9$  cm, B(-):  $2.7 \pm 10.8$  cm ( $p=0.50$ ); thorax rotation: NB(+):  $153 \pm 17^\circ$ , B(+):  $154 \pm 21^\circ$ , B(-):  $154 \pm 17^\circ$  ( $p=0.84$ ); grip strength (kg): NB(+):  $43.5 \pm 11.6$ , B(+):  $44.8 \pm 13.9$ , B(-):  $44.1 \pm 13.2$  ( $p=0.58$ ); balance (mm): NB(+):  $0.05 \pm 0.02$ , B(+):  $0.05 \pm 0.03$ , B(-):  $0.06 \pm 0.04$  ( $p=0.34$ ); VO2max (ml/min\*kg): NB(+):  $47.2 \pm 9.9$ , B(+):  $47.3 \pm 9.8$ , B(-):  $47.3 \pm 9.4$  ( $p=1.00$ ). Conclusion Our study clearly demonstrated no influence of the Power-Balance technology on any motor skill like balance, strength, flexibility and endurance. We, therefore, conclude that any individual impression of a positive influence of the hologram on any performance parameter is based on a placebo effect.

## ENHANCEMENT OF POWER IN CONCENTRIC PHASE OF CHEST PRESSES AT DIFFERENT WEIGHTS LIFTED ON STABLE AND UNSTABLE SURFACE

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**Introduction** It has been shown that activation of stretch-shortening cycle (SSC) during countermovement (CM) weight exercise enhances power production in concentric phase compared to lift from the rest. However, it is unknown how this potentiation of power is influenced by stability of support surface. Therefore, the study compares the differences in mean power in concentric phase of chest presses with and without CM at different weights lifted with back supported by stable bench and unstable Swiss ball. **Methods** A group of 16 PE students (age  $23.4 \pm 1.9$  y, height  $181.5 \pm 6.1$  cm, weight  $75.1 \pm 6.1$  kg) performed randomly in different days 8 reps of barbell chest presses without and with CM on the bench and Swiss ball, respectively. Initial weight of 20 kg was increased by 10 kg or 5 kg (at higher loads) until 85% of previously established 1RM. A PC based system FITRO Dyne Premium was used to monitor power in concentric phase of lifting. **Results** As expected, there were higher power outputs during CM than concentric-only chest presses on both stable and unstable surface. This potentiating effect under stable conditions was rather modest at lower weights ( $34.1 \pm 6.2$  W at 20 kg) and become more pronounced with increasing weights reaching a maximum of  $114.8 \pm 16.8$  W at 57.1% 1RM. From this point the power gradually decreased to  $62.2 \pm 10.1$  W at 90 kg. However, during chest presses on Swiss ball the differences between power produced with and without CM were greater at lower weights ( $51.3 \pm 8.3$  W at 20 kg) with maximum of  $104.3 \pm 12.1$  W achieved at 47.6% 1RM. Towards heavier weights this potentiating effect substantially diminished to  $24.9 \pm 6.0$  W at 90 kg. **Discussion** Maximal enhancement of power in concentric phase of lifting due to CM occurred at lower % of 1RM under unstable than stable conditions. Higher weights compromised such potentiation of power more profoundly during chest presses on Swiss ball than on the bench. The mechanism underlying this enhancing effect is usually ascribed to utilization of elastic energy stored in elastic components in combination with reflexively induced neural input. However, during chest presses on Swiss ball, presumably lower amount of energy is accumulated in elastic tissues of muscles and tendons involved and consequently can be utilized for subsequent concentric contraction. This is mainly due to delayed and prolonged amortization phase of SSC. Around the turning point, where the eccentric phase changes into the concentric one, maximal force is produced. At the same time subject must stabilize the torso on unstable surface in order to provide firm support for contracting muscles. This additional task may compromise the contraction of muscles acting on the barbell. Their less intensive contraction not only prolongs the change of movement direction, but because of lower peak force, negatively impairs accumulation of elastic energy. Consequence is lower power in concentric phase of lifting on unstable than stable surface.

## VELOCITY- AND POWER-LOAD RELATIONSHIPS FOR THE BENCH PRESS VS. BENCH PULL EXERCISE

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**VELOCITY- AND POWER-LOAD RELATIONSHIPS FOR THE BENCH PRESS vs. BENCH PULL EXERCISE** Sánchez-Medina, L.1, Pérez CE.2, García-Pallarés J.2 1: UPO (Seville, Spain), 2: UMU (Murcia, Spain) **Introduction** Although less popular than the bench press (BP), the prone bench pull (PBP) is a resistance training exercise commonly used in sport disciplines which require upper-body pulling such as canoeing, rowing, judo or wrestling. However, the PBP has received little research attention and only one study (Pearson et al., 2009) has examined its kinematics and kinetics. This study aimed to analyze the opposing upper-body actions of pushing (BP) and pulling (PBP). **Methods** Seventy strength-trained males [mean(SD): age  $23(5)$  yr, height  $177(7)$  cm, body weight  $76(9)$  kg, body fat  $12(4)\%$ ] performed an increasing loading test up to the 1RM in the concentric BP and PBP. Exercises were performed in random order, separated by 48 h. A linear velocity transducer sampling at 1,000 Hz (T-Force, Ergotech, Spain) was attached to a Smith machine. The load (%RM) that maximized power output (Pmax) was compared using three different variables: mean power (MP), mean propulsive power (MPP) and peak power (PP). Mean propulsive velocity (MPV) attained with each %RM (30-95% RM, 5% increments) and with the 1RM load (V1RM) were also compared. One-way ANOVA was used to detect differences between exercises and power at different loads. **Results** The following variables were significantly different ( $p < 0.001$ ) between exercises: 1RM,  $90.2(16.7)$  kg for BP and  $80.0(12.1)$  kg for PBP; V1RM,  $0.16(0.05)$  m/s for BP and  $0.52(0.05)$  m/s for PBP. MPV attained with each %RM was significantly higher for PBP than BP. Pmax was found to be dependent on the variable used: 56% (BP) vs. 70%RM (PBP) using MP, 38% (BP) vs. 46%RM (PBP) using MPP, and 37% (BP) vs. 41%RM (PBP) using PP. No significant differences were found for loads between 40-70% (BP) or 50-90% (PBP) using MP; 25-60% (BP) or 20-70% (PBP) using MPP; 20-65 (BP) or 20-75% (PBP) using PP. Prediction equations to estimate load from MPV were:  $\%RM = 11.01 \text{ MPV}^2 - 77.66 \text{ MPV} + 113$ ,  $R^2=0.97$ ,  $SEE=4.44\%RM$  for BP; and  $\%RM = 13.89 \text{ MPV}^2 - 94.99 \text{ MPV} + 144.7$ ,  $R^2=0.94$ ,  $SEE=5.98\%RM$  for PBP. **Discussion** Velocity and power were considerably higher for PBP than BP throughout the entire load range. These differences increased as load approach the 1RM, with V1RM for the two exercises being remarkably different. Our findings regarding the power-load relationship support and extend those of Pearson et al. (2009); however, velocities obtained in this study are much higher than those reported by the aforementioned authors which may be due to the counter-weight Smith machine they used. Differences in the Pmax are reduced when choosing MPP or PP over MP (Sánchez-Medina et al., 2010). Differences in velocity and power between BP and PBP are attributable to the differing muscle architecture. **References** Pearson SN, Cronin JB, Hume PA, Slyfield D (2009). Sports Biomech, 8(3), 245-254. Sánchez-Medina L, Perez CE, González-Badillo JJ (2010). Int J Sports Med, 31(2), 123-129.

## LIFTING WEIGHTS CLOSE TO MAXIMAL POWER DIFFERS UNDER STABLE AND UNSTABLE CONDITIONS

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**Introduction** It has been documented (Bosco, 1992) that repetitions performed above 90% of maximal power with particular weight lifted are the most efficient for improvement of maximal strength and explosive power. Decrease of power production throughout repetitions has usually been attributed to fatigue and/or lack of voluntary effort. Provided that the exercise is performed with maximum effort, muscular performance will depend on fatigue. However, its level may differ under stable and unstable conditions due to different demand on neuromuscular system. The study compares the rate of power reduction below the above-mentioned critical level during chest presses and squats on stable and unstable surface. **Methods** A group of 12 PE students (age  $21.7 \pm 2.4$  y, height  $186.4 \pm 9.2$  cm, weight  $82.1 \pm 8.7$  kg) performed randomly in different days a set of a) barbell chest presses on either bench or Swiss ball, and b) barbell squats on either stable support or Bosu ball (all of them with 70% 1RM). A PC based system FITRO Dyne Premium was used to monitor power in concentric phase of lifting. **Results** Power in concentric phase of chest presses on the bench decreased below 90% of the maximum within four reps

(from  $774.9 \pm 14.7$  to  $695.4 \pm 12.4$  W). However, when the same exercise was performed on Swiss ball the power fell below this level within two reps (from  $705.2 \pm 13.5$  to  $633.7 \pm 11.2$  W). Similarly, reduction of power was faster during squats on Bosu ball than on stable surface (from  $789.7 \pm 18.1$  to  $708.3 \pm 15.7$  W within four reps and from  $921.8 \pm 17.9$  to  $824.4 \pm 16.8$  W within seven reps, respectively). Discussion Faster decrease of power below the critical level is most likely due to more pronounced and/or earlier fatigue of neuromuscular system. On unstable surface, subject must stabilize torso in order to provide firm support for contracting muscles. This is an additional task requiring greater co-contractile activity of trunk-stabilizing muscles. This may be corroborated by significantly higher EMG activity of deltoid and abdominal muscles during chest presses (Marshall, Murphy, 2006) and abdominal stabilizers, upper lumbar erector spinae and lumbo-sacral erector spinae muscles during squats (Anderson, Behm, 2005) on unstable than stable surface. Increased EMG activity in the soleus indicates also higher demand on postural muscles. It may be assumed that faster drop of power below the critical level under unstable conditions is a consequence of these challenges in neuromuscular system. This fact has to be taken into account in assessment of individuals, in which the ability to tolerate the fatigue and work close to the maximal power may differ significantly. Hence, information obtained from monitoring of power under stable conditions cannot be simply applied to the exercise on unstable surface. References Anderson K, Behm D (2005). Can J Appl Physiol, 30, 33-45. Bosco C (1992). Leistungssport, 5, 21-28. Marshall PW, Murphy BA (2006). J Strength Cond Res, 20, 745-750.

## ACCELERATION, MAXIMUM SPEED AND AGILITY IN RELATION TO STRENGTH PARAMETERS IN SWISS ELITE WOMEN SOCCER PLAYERS

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Introduction In team sports like soccer, sprinting becomes more and more important. To improve sprint performance, it is crucial to understand its limiting factors. However, little evidence exists about these determinants, especially for elite women soccer players. The aim of this study was to analyze the interdependence of speed abilities assessed in field tests and strength parameters in elite women soccer players. Methods Thirty-eight Swiss national women soccer players ( $19.8 \pm 2.8$  y,  $165.8 \pm 6.2$  cm,  $60.4 \pm 5.5$  kg) completed a 40m all-out sprint. Times were measured for acceleration (t10) and maximum speed (t30-40). A stop-and-go test to assess agility (5m-10m-5m with two 180 degree turns (SGT)) was made. Bilateral (bCMJ) and unilateral (uCMJ) countermovement jumps, squat jumps (SJ) and drop jumps from heights of 20cm, 40cm and 60cm (DJ20, DJ40, DJ60) were performed on a force plate. The bCMJ, uCMJ and SJ were measured at peak power and DJs as "jump height/contact time". Vertical and leg stiffness during the sprint were calculated based on the method used by Morin (2005). Leg tapping was measured on a contact mat. Results The t10 correlated (Pearson) significantly with bCMJ ( $r = -.62^{**}$ ), SJ ( $r = -.52^{**}$ ), uCMJ ( $r = -.40^{*}$ ), tapping ( $r = -.33^{*}$ ), DJ40 ( $r = -.33^{*}$ ) and vertical stiffness ( $r = -.32^{*}$ ). There was no correlation between t10 and leg stiffness. The t30-40 correlated with vertical stiffness ( $r = -.60^{**}$ ), bCMJ ( $r = -.60^{**}$ ), uCMJ ( $r = -.55^{**}$ ), SJ ( $r = -.49^{**}$ ) and tapping ( $r = -.39^{*}$ ). Only DJ20 correlated with t30-40 ( $r = -.37^{*}$ ), DJ40 and DJ60 did not. Contrary to t10, t30-40 correlated significantly with leg stiffness ( $r = -.35^{*}$ ). SGT correlated with bCMJ ( $r = -.45^{**}$ ), uCMJ ( $r = -.43^{**}$ ) and SJ ( $r = -.34^{*}$ ), as well as with DJ20 ( $r = -.43^{**}$ ), DJ40 ( $r = -.48^{**}$ ) and DJ60 ( $r = -.40^{*}$ ). Vertical and leg stiffness did not correlate with SGT. Although the correlation between t10 and t30-40 was high ( $r = .72^{**}$ ), SGT correlated only moderately with t10 ( $r = .45^{**}$ ) and t30-40 ( $r = .46^{**}$ ). Discussion For good acceleration by women soccer players, it seems crucial to have high explosive strength qualities and, for maximum speed, stretch-shortening qualities become more important. For SGT, both explosive and reactive strength are important while stiffness is negligible. A high tapping frequency is only important in linear sprints and not in SGT. Thus, differences do exist in the relationship between strength parameters and the following three speed abilities acceleration, maximum speed and agility. These findings suggest that it is essential to consider different strength parameters when testing and training to improve women soccer players' speed. References Morin, J. B. et al. (2005). J Appl Biomech, 21(2), 167-80.

## COMPARISON OF THREE DIFFERENT METHODS TO EVALUATE MUSCULAR POWER DURING VERTICAL JUMP

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Introduction Traditionally, muscular power is assessed using the Sargent jump (SJ). This method has the advantage of being simple and costless. However, many technical factors associated to this test indicate a possible lack of precision. Another option is to use a Bosco mat (BM). Its principle of operation is to measure the time of flight which can be used to calculate the height of a vertical jump. A timer is activated when the pressure on the mat is zero and is stopped when the feet hit the mat. Although the precision is better when compared to the SJ, the BM is expensive and is prone to mechanical wear and tear because of the repeated feet impacts. Our group has recently developed a new concept based on laser light (LL) which is a low-cost alternative to the BM. The physics equations involved in its operation are similar to that of the BM and the LL yields results that are as accurate. However, in addition to costing less, the proposed system does not deteriorate with repeated use. Thus, the purpose of this study is to compare the three methods to determine the validity and the level of precision of each of them. Methods A total of 41 kinesiology students (18 women, 23 men, mean age  $23.2 \pm 4.5$  years old) have participated in this study. The physical layout was made so that the three systems (BM, LL and SJ) could simultaneously measure the height of each jump. All participants were asked to jump vertically as high as possible using the SJ procedure. The data (height in cm) of the three systems were recorded for each jump. Results No significant differences have been observed between the BM ( $35.9 \pm 8.5$  cm) and the LL ( $35.6 \pm 8.1$  cm). However, significant differences have been noted between both BM and LL versus SJ ( $40.3 \pm 11.1$  cm;  $p \leq 0.000$ ). The correlation coefficient was excellent between the BM and LL ( $r = 0.97$ ). However, correlations were lower for BM and SJ ( $r = 0.90$ ) and for LL and SJ ( $r = 0.87$ ). When gender is taken into account, the correlations between BM-LL and SJ were respectively 0.78 and 0.75 for men 0.80 and 0.69 for women. Discussion The BM and LL present the same precision when assessing jump height. However, SJ overestimates the height by more than 5cm. The difference becomes even larger when the jump is higher. For example, the difference was 2cm (6.4%) for jumps lower than 36cm but was 7cm (14.3%) for jumps over 36cm. The regression equation with the BM as the dependent variable and LL as the independent variable determined that the standard error of estimate is 2.0cm which represents an error of  $\pm 5.6\%$ . Conclusion LL is an excellent alternative to evaluate vertical muscular power. The traditional SJ overestimates the real value for the vertical jump. The accuracy of the SJ is particularly affected for higher jumps.

## THE ROLE OF GRIP STRENGTH AND ISOMETRIC BENCH PRESS STRENGTH ON POWER LIFTING PERFORMANCE

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**Introduction** Grip strength and isometric bench press tests are frequently used to assess the athlete's strength abilities. These tests are easy to perform and show a high correlation to upper body strength and to specific sport performance (Milliken et al., 2008; Platzer et al., 2009). Scientific literature about performance diagnostics in power lifting is scarce. The aim of the study was to find out if these tests are important in power lifting performance and should be part of a test battery. **Methods** 10 elite male power lifters (age 30 +/- 7 years) took part in this study. Tests for grip strength (TKK 5401, Takei, Tokyo, Japan), isometric bench press (Platzer et al., 2009) and 1 RM for squat, bench press and dead lift (raw and equipped) were administered. The subjects mean performances for raw squat, bench press and dead lift were 218 +/- 56 kg, 180 +/- 42 kg and 261 +/- 51 kg respectively. The subjects mean performances for equipped squat, bench press and dead lift were 289 +/- 60 kg, 223 +/- 40 kg and 276 +/- 54 kg respectively. Depending on the discipline, equipment included wrist and knee wraps, bench press shirts, squat or dead lift suits. Pearson's correlation coefficient was used to analyse relationships. **Results** Grip strength showed a significant correlation only to the raw/equipped ratio for 1RM bench press ( $r=0.763$ ,  $p=0.028$ ) but to none of the other variables. Isometric bench press strength elicited no significant correlation to 1 RM bench press or any other variable ( $p > 0.6$ ). **Discussion** Power lifters use wrist wraps because of their performance enhancing and protective abilities. In bench press they support wrist stability and in dead lift they ought to tighten the bar grip (Coutinho, 2007). According to the results grip strength might increase raw performance in bench press but the overall importance in power lifting seems to be minor. It appears that a wrist wrap supports the athlete to achieve the necessary amount of grip strength. For weaker athletes it acts performance enhancing and for stronger power lifters it may be more a psychological and protective aid. The missing correlation between isometric and 1RM bench press implies that the Hill curve does not apply in this power lifting discipline. Isometric bench press can not be used to predict bench press performance in power lifting. **In conclusion** we suggest that grip strength and isometric bench press should not be part of a testing battery in power lifting. Furthermore it is not necessary to focus on grip strength in the training prescription. **References** Coutinho M (2007). URL: <http://i.b5z.net/i/u/230085/i/wwwcoutinho.pdf> accessed 13th February 2011. Milliken LA, Faigenbaum AD, Loud RL, Westcott WL (2008). J Strength Cond Res, 22, 1339-1346. Platzer HP, Patterson C, Raschner C (2009). J Sports Sci, 27, 212-226.

## Poster presentations

### PP-PM62 Physiology: Exercise Training 2

## THE EFFECTS OF A 6-MONTH INTERVENTION WITH INTRADIALYTIC EXERCISE TRAINING AND DOPAMINE AGONISTS IN HEMODIALYSIS PATIENTS WITH RESTLESS LEGS SYNDROME

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**Introduction:** Restless Legs Syndrome (RLS) is a common neurological disorder in hemodialysis (HD) patients. Briefly, RLS is characterized by an urgent need to move the limbs, usually accompanied by unpleasant sensations. The symptoms begin or worsen during inactivity periods while a temporary relief occurs by movement. So far there are no comparative studies available comparing a non-pharmacological treatment to a classical treatment over their effectiveness on syndromes' severity and quality of life (QoL) in HD patients with RLS. **Methods:** In this six-month randomized, partially double-blind, placebo-controlled comparative study, thirty two HD patients with RLS were randomly assigned into three groups: 1) the exercise training group (N= 16, 56.4±12.5 years), 2) the dopamine agonists group (Ropinirole 0.25mg/d) (N= 8, 55.7±10.4 years) and 3) the placebo group (N= 8, 56.8±16.5 years). RLS severity was assessed using the International RLS severity scale, physical performance by a battery of tests, muscle size and composition by computed tomography, body composition by DEXA, while depression score, sleep quality, daily sleepiness and QoL were assessed through validated questionnaires. **Results:** Exercise training and dopamine agonists were effective in reducing the RLS symptoms by 46% and 54% respectively with no significant adverse effects. Both approaches significantly improved QoL, however, only the dopamine agonists significantly improved sleep quality. On the other hand, only the exercise training increased lean body mass, reduced fat infiltration in muscles and improved physical performance. **In contrast** in the placebo group the depression symptoms score became significantly worse after the 6 month intervention. **Discussion:** A 6-month exercise training intervention was as effective as a 6-month low dosage dopamine agonist treatment in reducing RLS symptoms and improving several aspects related to the health related QoL, in HD patients with RLS. However, only exercise training was effective in improving parameters related to patients survival, such as physical performance, muscle and body composition.

## EFFECTS OF ONE WEEK OF SWIM TRAINING ON RESTING HEART RATE VARIABILITY IN YOUNG SWIMMERS

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**Introduction** Researches about training effects on cardiac autonomic control activity, inferred by measurement of Heart Rate Variability (HRV), have been insufficient to generate a sustained relationship between HRV parameters fluctuations and the training process in any sport or physical exercise. The purpose of this study was to investigate the effect of the antepenultimate microcycle of the training season on young swimmers resting HRV parameters. **Methods** 12 swimmers (7 female, 13±0.3 yrs and 5 male, 14±0.6 yrs) undertook HRV recordings and maximal tests at the first (M1) and last (M3) days of 1-wk of swim training and at the 3rd day (M2) for HRV also. Subjects swam an incremental maximal step test (2x200 m front crawl) and blood lactate was monitored. HRV indexes were assessed after awakening in supine position under controlled breathing from 5-min R-R interval (RR) data using the Polar RS800™. Time and frequency domain analyses with HRV Analysis software gave: mean RR interval (RR), standard deviation of normal RR intervals (SDRR), square root of the mean of the sum of the squares of differences between adjacent NN interval (RMSSD), number of interval differences of successive NN intervals greater than 50 ms (NN50) and percent of difference between adjacent NN intervals greater than 50 ms (pNN50). Power spectrum was calculated using a Fast-Fourier Transform determining: very low (VLF; 0.003-0.04 Hz), low (LF; 0.04-0.15 Hz), and high (HF; 0.15-0.4 Hz) frequency bands, which were analyzed in absolute (ms<sup>2</sup>), percentage (%) and normalized units (n.u.) power. The LF/HF ratio was calculated. Parametric T test and non-parametric Friedman and Wilcoxon tests were used ( $p<0.05$ ). **Results** SDRR augmented from M1 to

M3 in both genders and from M2 to M3 in males. RMSSD rise from M1 and M2 to M3 in both genders and from M1 to M2 in males. pNN50 ascended from M1 and M2 to M3 in females and from M1 to M2 in males. In female swimmers RR and HF% augmented from M2 to M3 and HF n.u. from M1 and M2 to M3. On the contrary, LF% declined from M1 to M3 and LF/HF ratio from M1 and M2 to M3. Swimming speed on the 2nd 200 m repetition at M3 was higher than at M1 in females. Discussion Training seems to be the main determinant of the increases on SDRR, RMSSD and pNN50. The variations in HRV frequency domain indexes, suggesting an increased parasympathetic and suppressed sympathetic modulations, occurred only in females. This predominance of vagal influence could be associated with the elevated performance observed following 1-wk of swim training, but both could reflect the cumulative effects of training. Yet, further studies are needed to determine whether these measures can represent fatigue condition during a swimming season and their gender dependency.

### **CARDIOVASCULAR EFFECTS AND QUALITY OF LIFE OF SUPERVISED TRAINING PLUS METFORMIN THERAPY VERSUS METFORMIN THERAPY ALONE IN AN INSULIN RESISTANCE POPULATION**

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Introduction: Insulin resistance (IR) seems to play a major role both in the evolution towards diabetes and in affecting cardiac performance and endothelial function (An and Rodrigues, 2006; Witteles, 2008). It was showed that metformin therapy (MET) can produce benefit to glucidic profile (Anderson, 2005), but can reduce maxVO<sub>2</sub> consumption in healthy population (Johnson et al., 2008). Combining MET with exercise could optimize the treatment efficacy and compliance. Therefore, we evaluated cardiopulmonary performance, endothelial function and health-related quality of life in IR population, after 12-weeks of MET and after 12-weeks of supervised aerobic exercise program plus MET. Methods: 27 patients (18W, 9M age 45±15) with IR (HOMA-IR=4.92±2.8), were randomly assigned to 12-weeks of supervised training plus MET (MEg=13), versus 12-weeks of MET alone (Mg=14). Cardiopulmonary exercise test (CPET), peripheral arterial tonometry to measure the endothelial flow reserve (EFR) and SF-36 to evaluate physical (PSC) and mental (MSC) summary component, were assessed before and after 12-weeks. Results: At enrollment, all patients showed a decreased average peakVO<sub>2</sub> (67%) in comparison with the theoretical values of healthy population. BMI was significantly reduced both in MEg (31.5±3.9 vs 29.5±3.9 p<0.05) and in Mg (30.1±5.1 vs 28.2±5.1 p<0.05), also the increase of EFR was significant in both groups (Mg:1.93±0.5 vs 2.1±0.4 p<0.05; MEg:2.0±0.8 vs 2.2±0.6 p<0.05). The CPET showed a significant reduction of peakVO<sub>2</sub> (1.67±0.39 l/min vs 1.55±0.36 l/min p<0.05) in Mg with a non significant Work reduction (113.5±35.3 vs 109.7±31.4 p=ns), in contrast, a significant increase in MEg (1.46±0.48 l/min vs 1.62±0.43 l/min p<0.05) with a significant Work increase (101.8±32.8 vs 118.6±35.3 p<0.05) at 12-weeks. SF-36 highlighted a significant increase of PSC (56.66±19.09 vs 75.77±14.91 p<0.001) and MSC (58.77±19.11 vs 73.22±17.63 p<0.01) in MEg only. Discussion: These data emphasize that supervised training in combination with MET, is decisive to optimize the IR population treatment. Additional benefits of increasing oxygen consumption and improving HRQoL identify supervised training as a feasible and effective component in the management program for IR population. References An D, Rodrigues B. Am J Physiol Heart Circ Physiol (2006). 291(4):H1489–506 Witteles RM. JACC (2008). 51:93-102 Anderson DC. Ann Pharmacother (2005). 39(1):102-9 Johnson ST, Robert C, Bell GJ, Bell RC, Lewanczuk RZ, Boule NG. Diabetes, Obesity and Metabolism (2008). 10:747-54

### **CORRELATIONS BETWEEN STRENGTH AND HEART RATE VARIABILITY AFTER 16 WEEKS OF CONCURRENT TRAINING IN POSTMENOPAUSAL WOMEN**

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Introduction Heart rate variability (HRV) is an important marker of cardiac autonomic nervous system control and has been used as a risk marker for cardiovascular disease (Heffernan et al., 2007). High fitness level can minimize physiological changes in vagal modulation related to aging process, regardless of gender (De Meersman, Stein 2007). Furthermore, changes pronounced during the aging process of women are decrease in strength (Douchi et al., 2002) and aerobic fitness that is connected to central and peripheral adaptations (Hawkins, Wiswell, 2003). Concurrent training (CT) has shown the same benefits as isolated training, although to a lesser magnitude (Leveritt et al., 1999). This research has the goal of verifying the effects of CT on correlations between strength and HRV. Methods Nine healthy and non-physically active women were analyzed (52 ± 6.14 years old). The CT proposed consists of 16-training weeks (3 d.wk-1), 3 sets of 8-10 maximal repetitions (RM) with 60-90s of rest between sets, 6 exercises, followed by 30 min jogging at 55-85% VO<sub>2</sub>peak. Maximal upper-body (UBS) and lower-body strengths (LBS) were measured by 1-RM test involving two exercises that were part of the training routine (bench press and leg press). The RR intervals were recorded for 20 min at rest in supine position using the Polar® S810, the data was analyzed using FFT algorithm by Polar Precision Performance and the variables of time and frequency domain were calculated. Results Maximal UBS (38.44±5.59 to 46.66±6.20 kg; p=0.008) and LBS (140.11±36.70 to 173.00±36.45 kg; p=0.011) improved after the training program. There were no changes at the HRV markers analyzed. The significant correlation coefficients between UBS, LBS and HRV are: r=0.67 (p=0.04) UBS vs. pNN50 (time domain) before training and r= 0.72 (p=0.02) LBS vs. HF (high frequency domain) after training. Discussion Before, the training correlations were found between UBS and pNN50 suggesting a preserved parasympathetic heart rate autonomic control in this population. After 16wk of CT strength levels it increased without any modification in the autonomic markers. Moreover, the correlation after training between LBS and HF reinforces that the increase in strength did not affect negatively the autonomic control. Perhaps some peripheral changes could have improved some central control that is reflected in the heart. References DE MEERSMAN, RE; STEIN, PK. (2007) Biol Psyc, 74,165-173. DOUCHI, T. et al. (2002) Maturitas, 42, 301-306. HAWKINS, SA; WISWELL, RA. (2003) Sports Med, 33, (12), 877-888. HEFFERNAN, KS; et al. (2007) Am J Physiol Heart Circ Physiol, 293, 3180-3186. LEVERITT, M; et al. (1999) Sports Med, 28, (6), 413-427.

### **EVALUATION OF RISK FACTORS RELATED TO HEALTH IN UNDERWEIGHT AND OBESITY**

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Introduction Both fatness and thinness, two extreme points of body structure, are a risky structural condition. Therefore, the aim of this study was to evaluate the risk factors related to health of those whose body mass index levels are too low, those who are underweight and who are in a high level obesity condition. Method The study was carried out on the people who have attended to a sport-health

group for 5 years and they were in various age groups. Bone lengths, skinfold thickness and circumferences of the participants were measured and anthropometric standardization manual was used as the reference. Yuhazs formula was used for the body composition. They were asked Par- Q test and the questionnaire of the family history and sport habits of the participants. All data was evaluated by SPSS programme. Results There were total 227 participants in the study group and it was formed into two groups. First group was underweight group (N=105 mean age  $26,55 \pm 6,68$ , BMI:  $17,84 \pm 6,3$ ). Second group was obesity group (N= 112, mean age  $29, 41 \pm 9, 12$ ,  $33,37 \pm 2,8$ ), 34.3 % of the underweight group and 25.9 % of the obesity group had never been involved in sport activity. 5.7% of the underweight group had coronary heart disease, 14.3 % of the same group's mothers and 2.9 % of the group's fathers had the same disease while 9 % of the obesity group had this disease and 17.9 % of this group's fathers and 8% of this group's mothers had coronary heart disease. According to the Par Q test results, 14.3% of the underweight group and 12.5% of the obesity group had some chest pain because of the exercise. 3.8% of the underweight group and 4.5% of the obesity group had disorderly heart rate rhythms. The ratio of early heart attack risk in the family was 21.9 % for the underweight group while it was 25.9 % for the obesity group. Discussion The underweight group had done the exercises more than the obesity group and also they smoked and used alcohol more than the obesity group. Obesity group had more vascular heart problems, diabetes and respiratory problems than the other group. Metabolic disease ratio for both groups was similar. According to the Par Q test results, both groups had cardio vascular problems. Joint problems were intensive in the obesity group. Excessive thinness has risk factors like obesity but the risks for fatness more than the risks for thinness. References 1. Ha do T, Feskens EJ, Deurenberg P, Mai le B, Khan NC, Kok FJ. Nationwide shifts in the double burden of overweight and underweight in Vietnamese adults in 2000 and 2005: two national nutrition surveys. BMC Public Health. 2011 Jan 30;11(1):62. 2. Oreopoulos A, Padwal R, McAlister FA, Ezekowitz J, Sharma AM, Kalantar-Zadeh K, Fonarow GC, Norris CM. Association between obesity and health-related quality of life in patients with coronary artery diseases. Int J Obes (Lond). 2010 Sep;34(9):1434-41. Epub 2010 Apr 13.

### EFFECT OF PHYSICAL TRAINING ON BLOOD PRESSURE OF UNMEDICATED HYPERTENSIVE WORKERS

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**Introduction** The employees' health is the concern of large corporations. The Brazilian company Petrobras / RBG, at its CENPES unit, has been promoting a fitness program for six years oriented by the School of Physical Education at Universidade Federal do Rio de Janeiro, Brazil. As part of the risk factors control for non-transmissible chronic diseases, physical exercises are recommended for the prevention, treatment and control of blood pressure (BP). The aim of this study was to investigate the BP behavior after four months of training in unmedicated hypertensive subjects. **Methods** Fifty-seven sedentary subjects participated in the program (time  $\geq 1$  year), divided into a training group (TG) and a control group (CG). All were physically assessed and the TG had three sessions per week, totaling 48 sessions, each lasting 60 minutes. They performed a 25-minute aerobic training between 50 to 70% of heart rate reserve, a strength training in two series ranging from 8 to 12 repetitions, and a flexibility training applying the static stretching method. BP was measured by auscultation at pre- and post training and data were processed by two-way ANOVA using the Scheffé post hoc when needed ( $p < 0.05$ ) for intragroup and intergroup comparison. **Results** The intragroup outcome for the TG showed an 11.4% reduction in systolic BP (SBP) ( $P < 0.05$ ) and 5.3% in diastolic BP (DBP) ( $P > 0.05$ ). The CG showed no changes in BP ( $P > 0.05$ ). Comparing CG and GT, there was a significant difference in SBP in post-training situation, but this did not occur in other measurements. **Discussion** Studies confirm the hypotensive effect after aerobic work (Pescatello et al., 2004), but few have investigated the post-exercise strength hypotension. Martins et al. (2004) followed medicated hypertensives subjected to strength, aerobic and flexibility sessions and after eight weeks they found no significant differences regarding the resting values in both groups; however the BP in the TG showed a tendency to reduction. Despite the methodological differences between our experiment and Martins and co-workers', we found higher reductions in BP, probably because our sample was not medicated and training lasted 16 weeks. With measurements taken 48 hours after the last session aiming to decrease the acute hypotensive effect immediately after exertion, we found a clinically significant reduction in BP at rest. **References** Pescatello LS, Franklin BA, Fagar R, Farquhar WB, Kelley GA, Ray CA. ACSM Position Stand: Exercise and hypertension. Med Sci Sports Exer 2004; 36, 533-53. Martins ACS, Nogueira BRML, Couto FVP, Nicolau MSB, Pontes FL, Simão R, Polito MD. Comportamento da pressão arterial 12 horas após uma sessão de exercícios em hipertensos treinados. Rev Bras Fisiol Exerc 2004; 3,199-207.

### TRAINING, DETRAINING AND NON-ALCOHOLIC FATTY LIVER DISEASE IN RATS FED A HIGH FAT DIET

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**TRAINING, DETRAINING AND NON-ALCOHOLIC FATTY LIVER DISEASE IN RATS FED A HIGH FAT DIET** Moura, LP.1, Silva, AC.1, Araújo, MB.1, Dalia, RA.1, Junior, MC.1, Ribeiro, C.1, Voltarelli, FA.1, Mello, MAR.1. 1: UNESP (Rio Claro-Brazil) **INTRODUCTION** In face to the nutritional transition, fat intake increased significantly in developing countries and this has been associated to fatty liver disease (NAFLD). Regular physical activity is recommended as a nonpharmacological treatment of NAFLD, but little is known on the effects of physical detraining. **OBJECTIVE** The aim of this study was to analyze the effect of exercise training, of detraining and of the administration of a high fat diet (HFD) on body weight (BW), insulin sensitivity (insulin tolerance test-ITT), serum Free Fat Acids (FFA) and triglyceride concentrations in the liver (LTG). **METHODS** Forty weanling rats (28 days) were fed up to 90 days of age with a commercial rat chow. From there, they were divided into four groups: control (C), sedentary rats fed AIN-93M diet (Reeves et al., 1996) from 90 to 160 days of age; High-Fat Diet (HFD) sedentary rats fed a diet containing 35% fat from 90 to 160 days of age; Trained High-Fat Diet (THFD) rats exercised from 28 to 160 days of age, fed a diet containing 35% fat from 90 to 160 days; Detrained High -fat Diet (DHFD) rats exercised from 28 to 90 days, whose exercise training was suspended, fed a diet containing 35% fat from 90 to 160 days. The exercised groups swam at 80% of anaerobic threshold, determined by the lactate minimum test performed every 25 days (Mello et al., 2010). **RESULTS** It was evident that the detraining accelerated BW gain (g) and physical training counteracted this (C:  $429.06 \pm 66.23$ ; HFD:  $461.73 \pm 63.51$ ; THFD:  $394.31 \pm 64.15$ ; DHFD:  $486.57 \pm 60.28$ ). The HFD group showed reduced insulin sensitivity, as estimated by the KITT (%/min) compared to the other groups and this situation is reversed by exercise training (C:  $3.67 \pm 0.61$ ; HFD:  $2.91 \pm 1.24$ ; THFD:  $8.42 \pm 2.72$ ; DHFD:  $3.24 \pm 1.78$ ). HFD rats had higher serum FFA concentrations ( $\mu\text{Eq/L}$ ) compared to the others groups (C:  $554.76 \pm 191.85$ ; HFD:  $747.74 \pm 176.61$ ; THFD:  $564.02 \pm 273.83$ ; DHFD:  $575.74 \pm 230.75$ ). The accumulation of LTG (mg/g) was higher in the groups receiving HFD and detraining worsened the condition (C:  $14.93 \pm 3.62$ ; HFD:  $17.56 \pm 4.44$ ; THFD:  $18.77 \pm 3.35$ ; DHFD:  $20.35 \pm 2.51$ ). **CONCLUSION** The high fat intake induced obesity and led to insulin resistance, increasing circulating FFA and accelerating liver fat accumulation. Detraining aggravates this scenario, contributing to the installation of NAFLD. **REFERENCES** 1. REEVES et al. AIN-93 purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. (1993) 1939-51. 2. MELLO et al. Determination of an-

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### **ASSOCIATIONS BETWEEN FREE LIVING ACTIVITY INTENSITY, ADIPOSITY, AND RISK MARKERS FOR CARDIOVASCULAR AND METABOLIC DISEASE**

KHALID S. ALJALOUD, ADRIENNE R. HUGHES, STUART D.R. GALLOWAY

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Associations between free living activity intensity, adiposity, and risk markers for cardiovascular and metabolic disease. Khalid S. Aljaloud, Adrienne R. Hughes, Stuart D.R. Galloway. Health and Exercise Science Research Group, University of Stirling, SCOTLAND, U.K. Introduction: Vigorous physical activity has been linked to greater longevity, greater loss of body fat mass, and improved insulin sensitivity. Current exercise guidelines now include recommendations for vigorous activity in recognition of these findings. The present study aimed to describe the free living physical activity intensity profile of lean (L) and overweight / obese (O/O) Scottish adults, and to investigate associations between activity intensity, adiposity, and risk markers of disease. Methods: 55 adults (n=33 L and n=22 O/O) attended the laboratory on 2 occasions. On the first session body mass, height, BMI, body fat and resting blood pressure and heart rate (HR) were recorded. Participants were then instructed to wear an ActiGraph accelerometer and HR monitor for two periods of 6 consecutive days to monitor free living activity intensity. Participants then attended the laboratory in the morning after an overnight fast (>10 hrs) to obtain a resting venous blood sample for analysis of cardiovascular and metabolic disease risk markers. Results: There was no significant difference between L and O/O groups in the percentage of registered time spent in sedentary behaviours or active behaviours (L 54.5±1.2%, O/O 54.9±2.1%, for sedentary behaviour). O/O and L adults completed 54.9±3.6 and 47.7±6.5 mins of moderate to vigorous physical activity (MVPA) per day, respectively. No differences were noted for percentage of active time in light or moderate intensity between groups. However, a significant difference (p<0.05) between groups was observed for percentage of active time spent in vigorous and very vigorous activity (L 2.7±0.5%, 65.3±12.3 mins/wk, O/O 1.4±0.4%, 33.4±11.0 mins/wk). O/O adults had higher total cholesterol (p<0.05), higher triglycerides, LDL and VLDL (all p<0.01), and lower HDL (p<0.01) than L. O/O also had higher leptin, insulin, HOMA-IR and hsCRP than L (all p<0.01). BMI and body fat (%) were most strongly correlated with many of these risk markers (r>0.45, p<0.01) but vigorous and very vigorous activity was correlated with HDL (r=0.30, p<0.05), LDL (r=-0.26, p=0.05) and ARA/EPA ratio (r=-0.30, p<0.05). Conclusion: The O/O adults had elevated cardiovascular and metabolic disease risk markers but L adults did not. Both groups achieved 30 min of MVPA per day, but the L group also met current guidelines for vigorous physical activity. Adiposity was strongly associated with disease risk markers, but vigorous activity was also associated with some risk markers. These data suggest that more work is needed to explore the beneficial effects of vigorous intensity exercise on adiposity and cardiovascular and metabolic risk markers.

### **THE EFFECTS OF A 12 WEEK WALKING PROGRAMME ON PHYSIOLOGICAL AND PSYCHOLOGICAL HEALTH.**

HOLLOWAY, K., WAKEFIELD, C., WATT, S.

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The Effects of a 12 Week Walking Programme on Physiological and Psychological Health. K. Holloway, C. Wakefield and S. Watt Faculty of Science and Social Sciences, Liverpool Hope University Background- The World Health Organisation (WHO) recommends that people should aim to walk 10,000 steps per day to improve their health and wellbeing. Many physiological (Bassuk & Manson, 2005) and psychological (Asci, 2003) benefits can be gained through increased physical activity levels. However, few studies have utilised both physiological and psychological measures to gain a holistic view of the benefits of exercise. Therefore, the aim of our study was to determine whether a 12 week walking programme could enhance both physiological and psychological health. Methods- Sixteen health-screened sedentary women (age 46±5years, body mass 72±11kg, BMI 27±4) completed the walking programme after giving their informed consent to the ethically approved procedures. The pedometer based walking programme consisted of each participant completing 10,000 steps per day for 12 weeks. Before, and at the end of the 12 weeks, percentage body fat was measured using bioelectric impedance, blood pressure using manual oscillation, and hip:waist ratio using standard procedures. Maximum oxygen consumption was also measured using the Rockport Fitness Test. Participants also completed the BREQ-2 (Markland & Tobin, 2004), EMI-2 (Markland & Ingledew, 1997), SPAS (Martin et al., 1997), PANAS (Watson et al., 1988) and SMBI (Stunkard et al., 1983). Results- Maximal oxygen consumption increased significantly (P<0.05) by 14% over the 12 week programme. A significant increase (P<0.05) was also found in hip:waist ratio due to a significant (P<0.05) decrease in hip circumference, but no change in waist circumference (P=0.243). Additionally, no significant alterations were found in blood pressure or percentage body fat. Positive affect decreased (P<0.05) and difference in weight showed a significant negative correlation (r=-.585, P<0.05) to current silhouette rating. Conclusion- This 12 week walking programme showed improvements in physical fitness but no indication of chronic disease risk reduction or a decline in body fat. The relationship between weight and current perception of body image indicates that focussing on a programme of this kind can raise awareness of current weight status. We conclude that walking 10,000 steps a day at a relatively low intensity can improve fitness, but contrary to WHO recommendations, is not sufficient to achieve improvements in health and psychological well being. Bassuk, S.S. & Manson, J.E. (2005). JAP, 99, 1193-1204 Asci, F. H. (2003). PSE, 4, 255-264 Markland, D. & Ingledew, D.K. (1997). BJHP, 2, 361-376 Markland, D. & Tobin, V. (2004). JSEP, 26, 191-196 Martin, K. A. et al. (1997). JSEP, 19, 359-367 Stunkard, A. et al., (1983). The genetics of neurological and psychiatric disorders, p.115-120. New York:Raven Press Watson, D. et al.. (1988). JPSP, 47, 1063-1070

## **Poster presentations**

### **PP-PM63 Physiology: Vascular**

#### **CALF AND FOREARM VENOUS COMPLIANCE IN ENDURANCE- AND RESISTANCE-TRAINED MEN**

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Venous compliance of the extremities is a major determinant of the amount of blood that may be translocated to the central region, because small changes in peripheral blood volume can greatly impact cardiac filling pressure and subsequently cardiac output. Aerobic exercise as well as resistance exercise has become a popular modality of exercise performed by most populations, and has become an



integral component of exercise recommendations endorsed by a number of national health organizations. The purpose of the present study was to determine the calf and forearm venous compliance in daily endurance- and resistance-trained, age-matched sedentary control men. Fifteen endurance-trained (ET; age,  $21.0 \pm 0.4$  yrs; height,  $173.9 \pm 1.1$  cm; body weight,  $61.0 \pm 1.3$  kg), 12 resistance-trained (RT; age,  $20.8 \pm 0.6$  yrs; height,  $170.1 \pm 2.0$  cm; body weight,  $80.2 \pm 4.0$  kg), and 11 age-matched sedentary control men (SC; age,  $22.1 \pm 0.3$  yrs; height,  $172.5 \pm 2.1$  cm; body weight,  $66.0 \pm 2.4$  kg) were studied. Changes in calf and forearm volume were measured noninvasively using strain-gauge plethysmography at the maximal forearm circumference. Calf and forearm venous compliance were measured in supine subjects by inflating a venous collecting cuff, placed around the thigh and upper arm, respectively. After keeping cuff pressure 60 mmHg for 8 min, the cuff pressure was decreased at 1 mmHg/s to 0 mmHg. Venous compliance was determined using the first derivative of the pressure-volume relation during cuff pressure reduction (compliance =  $\beta_1 + 2 \cdot \beta_2 \cdot \text{cuff pressure}$ ). Maximal oxygen consumption was higher in ET ( $60.8 \pm 1.7$  ml/kg/min) compared with RT ( $37.1 \pm 1.7$  ml/kg/min) and SC groups ( $42.7 \pm 1.5$  ml/kg/min; both  $p < 0.05$ ). Calf and forearm muscular cross-sectional area measured by magnetic resonance imaging, was greater in RT ( $81.2 \pm 3.1$  cm<sup>2</sup> and  $47.2 \pm 1.1$  cm<sup>2</sup>) compared with ET ( $72.0 \pm 2.0$  cm<sup>2</sup> and  $32.2 \pm 1.3$  cm<sup>2</sup>) and SC ( $74.3 \pm 1.7$  cm<sup>2</sup> and  $36.1 \pm 1.0$  cm<sup>2</sup>; both  $p < 0.05$ ) groups. Calf venous compliance at 20 mmHg cuff pressure was 91% and 41% greater in ET ( $0.129 \pm 0.009$  ml/dl/mmHg) compared with RT ( $0.067 \pm 0.007$  ml/dl/mmHg) and SC groups ( $0.091 \pm 0.010$  ml/dl/mmHg; both  $p < 0.05$ ), respectively. Forearm venous compliance was not different between 3 groups. We concluded that venous compliance of the lower extremities were increased by habitual endurance training and decreased by resistance training, but unchanged upper extremities by these training in young men.

## EFFECTS OF AN INVERTED BODY POSITION ON MUSCLE FORCE AND CARDIOVASCULAR PARAMETERS

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**Introduction** Previous research has shown that significantly higher force production can be generated during a maximal voluntary contraction (MVC) in an upright vs. inverted postural position. It is suggested that this difference could be related to alterations in sympathetic nerve stimulation, which could alter cardiovascular (CV) responses (Paddock & Behm 2009). Our purpose was to determine the effects of postural changes on CV responses during MVC. We hypothesized that inversion would elicit a significantly different effect on selected CV parameters. **Methods** Twelve male subjects (age =  $22.5 \pm 1.6$  yr; mass =  $82.1 \pm 17.1$  kg; BMI =  $22.3 \pm 3.5$ ) completed three postural trials in random order on separate days: upright seated (U), supine seated (S), and inverted seated (I) position in a specially designed inversion chair. At baseline, a five-second MVC was performed using the dominant thigh (rectus femoris muscle) positioned at 90 degrees. The subject was then positioned for 150 sec in each posture, followed by a 30sec MVC (MVC30). During each trial, stroke volume (SV), cardiac output (CO), heart rate (HR) and mean arterial blood pressure (MAP) measurements were recorded using continuous monitoring finger plethysmography (Finometer). MVC force (N) was averaged over the 30sec. Results ANOVA showed no statistical differences in MVC force ( $U = 288.1 \pm 66.9$  N;  $S = 316.3 \pm 84.7$  N;  $I = 277.0 \pm 61.9$  N) but approached significance ( $p = 0.10$ ). Statistical differences were found for CV variables (SV, MAP, HR) from baseline to MVC30. While HR showed significant increase from baseline to MVC30 for each postural position ( $U = 33\%$ ;  $S = 34\%$ ;  $I = 25\%$ ), SV showed a corresponding significant decrease ( $U = 30\%$ ;  $S = 36\%$ ;  $I = 33\%$ ), resulting in no statistical changes in CO. Only HR showed differences between postural conditions post-MVC30, i.e., U ( $110 \pm 9.8$  bpm) and S ( $109.8 \pm 13.6$  bpm) vs. I ( $92.6 \pm 14.8$  bpm; 17%, 16% respectively). However, decreases in MAP (11%,  $p = 0.08$ ) and CO (18%,  $p = 0.08$ ) approached statistical significance from U vs. I. **Discussion** There are a number of scenarios where individuals may have to perform muscle contractions under inverted conditions (e.g., overturned submerged helicopter or motor vehicle, military operations). Research has shown that MVC force is impaired in a seated inverted position (Paddock & Behm 2009) ( $p = 0.10$  in our study), and this impairment was related to neuromuscular activation. Collectively, the CV results presented here suggest that the reduction in HR (17%,  $p = 0.003$ ), MAP (11%,  $p = 0.08$ ) and CO (18%,  $p = 0.08$ ) may be related to an inversion-induced inhibition of sympathetic stimulation (Bosone et al. 2004; Hearn et al., 2009). Further research is warranted to investigate whether prolonged inversion has an effect on neuromuscular and cardiovascular parameters. Paddock N, Behm D. Appl Physiol Nutr Metab, 34:673-680, 2009 Bosone et al. Funct Neurol, 19: 31-35, 2004 Hearn et al. Eur J Appl Physiol, 106:139-147, 2009 Support: NSERC Canada (JPN, DGB)

## CUTANEOUS MICROVASCULAR FUNCTION FOLLOWING ECCENTRIC EXERCISE IN HUMANS

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Muscle damage induced by eccentric exercise (i.e. the lengthening of a muscle under tension) can induce inflammation and oxidative stress. Inflammation and oxidative stress are associated with vascular dysfunction. The purpose of the present study was to test the hypothesis that eccentric exercise induced muscle damage would cause short term (24-48 hr) microvascular dysfunction. Ten healthy, non-weight trained males (mean age  $19 \pm 0.2$  yr) performed eccentric exercise (50 repetitions at 110% concentric 1 repetition max) with the knee extensors of the non-dominant leg. Cutaneous microvascular responses to iontophoresis of acetylcholine (1%, endothelial-dependent vasodilatation) and sodium nitroprusside (1%, endothelial-independent vasodilatation) were assessed with laser Doppler flowmetry. Heart rate, blood pressure, whole limb blood flow (venous occlusion plethysmography) and leg muscle pain were also assessed. All measurements were made pre-exercise (baseline), 24 and 48 hr post exercise. Rating of leg muscle pain was increased 24 and 48 hr post exercise ( $P < 0.05$ ). Endothelial-dependent cutaneous vasodilatation tended to increase at 24 hr ( $P = 0.16$  vs. baseline), but was unchanged at 48 hr ( $P > 0.05$  vs. baseline). Heart rate, arm blood flow and leg blood flow remained unchanged 24 and 48 hr post eccentric exercise. Blood pressure was reduced at 48 hr ( $< 5$  mmHg,  $P < 0.05$  vs. baseline). Our preliminary data suggest that muscle damage following single-legged knee extensor eccentric exercise does not induce cutaneous microvascular dysfunction in humans.

## INDUCED PERIPHERAL AUTONOMIC SURFACE POTENTIALS OF ELITE ATHLETES

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**Introduction** Induced peripheral autonomic surface potentials (PASP) are the change of electrodermal activity in response to a stimulus. Analysis of PASP allows getting the information on the status of vegetative nervous system (VNS). Goal of the study was to investigate PASP in elite athletes and young male non-athletes. **Methods** PASP were studied with use of a hard- and software complex VNS-Spectrum. There were taken measures of the PASP: latent period (s) - LP PASP; A1 (mV) - first phase amplitude, S1 (s) - duration of the first phase, A2 (mV) - second phase amplitude, S2a (s) - duration of the ascending portion of the second phase, S2b (s) - duration of de-

scending portion of the second phase. Twenty-five judoists (experimental group) and fifteen healthy male non-athletes (control group) have been examined. Results At electric stimulation, the LP was similar in both groups (experimental group –  $1.40 \pm 0.05$ s, control group –  $1.39 \pm 0.12$ s). Amplitude of the first phase (A1 –  $0.83 \pm 0.15$ mV) and second phase (A2 –  $3.01 \pm 0.36$ mV) in the experimental group was significantly higher than in the control group (A1 –  $0.39 \pm 0.10$ mV, A2 –  $1.16 \pm 0.31$ mV, respectively) ( $p < 0.05$ ). Durations of S1 and S2a were the same in both groups (S1 –  $0.82 \pm 0.10$ s in the experimental group and  $0.81 \pm 0.09$ s in the control group; S2a –  $1.22 \pm 0.15$ s and  $1.24 \pm 0.16$ s, respectively). S2b in the experimental group at electric stimulation was somewhat higher as compared with the control group (S2b –  $2.65 \pm 0.23$ s and  $1.96 \pm 0.25$ s, respectively), while at spatial stimulation (electric + acoustic stimulation), these indicators were equal (S2b –  $2.79 \pm 0.17$ s and  $2.63 \pm 0.19$ s, respectively). At spatial stimulation the A1 and A2 were somewhat higher in both groups as compared with electric stimulation (A1 – experimental group –  $1.12 \pm 0.12$ mV, control group –  $0.65 \pm 0.14$ mV, A2 – experimental group –  $0.65 \pm 0.14$  mV, control group –  $2.64 \pm 0.27$ mV), and the athletes also had a significantly higher figures. A1 increases at parasympathotonia and decreases at sympathicotonia. A2 reflects activity of the above-the-segment (primarily hypothalamic) ergotropic centers. Based on the above date, one can suggest a well balance of parasympathetic and sympathetic parts of VNS in athletes. Conclusion Amplitudes of the first and second phase of PASP in athletes are higher as compared with young male non-athletes but such increase is synchronous and evidences to a higher level of VNS function at maintaining the balance between its parasympathetic and sympathetic parts.

## REGIONAL DIFFERENCES IN BLOOD FLOW, GLUCOSE UPTAKE, AND FATTY-ACID UPTAKE WITHIN QUADRICEPS FEMORIS MUSCLE GROUP DURING DYNAMIC KNEE-EXTENSION EXERCISE

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Regional differences in blood flow, glucose uptake, and fatty-acid uptake within quadriceps femoris muscle group during dynamic knee-extension exercise Laaksonen, M.S. 1, Kemppainen, J. 2, Knuuti, J. 2, Nuutila, P. 2, Kalliokoski, K.K. 2 1: Swedish Winter Sports Research Centre, Mid Sweden University, Sweden, 2: Turku PET Centre, University of Turku, Finland Introduction During exercise the deeper muscle parts (vastus intermedius; VI and vastus medialis; VM) of quadriceps femoris (QF) seem to have higher blood flow (BF) compared to the more superficial parts (vastus lateralis; VL and rectus femoris; RF) (1, 3). In the present study we tested the hypothesis that glucose (GU) and free fatty acid uptake (FFAU) are similarly dispersed between QF muscle parts as blood flow during dynamic knee-extension exercise. Methods Totally 17 healthy male subjects were studied during 70 min low-intensity dynamic knee-extension exercise at 5 W. BF, GU and FFAU were measured in the four parts of the QF muscle group using positron emission tomography, and [ $^{15}\text{O}$ ]H $_2$ O, [ $^{18}\text{F}$ ]FDG and [ $^{18}\text{F}$ ]FTHA tracers. Results Muscle BF was higher ( $p < 0.05$ ) in VI ( $46 \pm 17$  mL 100g $^{-1}$  min $^{-1}$ ) than in VL ( $30 \pm 13$  mL 100g $^{-1}$  min $^{-1}$ ), but not significantly different compared to the other two parts (RF  $35 \pm 16$  and VM  $37 \pm 15$  mL 100g $^{-1}$  min $^{-1}$ ). In contrast, GU was highest in RF ( $40 \pm 31$  mikromol 100g $^{-1}$  min $^{-1}$ ) and significantly higher than in VL ( $15 \pm 6$  mikromol 100g $^{-1}$  min $^{-1}$ ) and VM ( $18 \pm 10$  mikromol 100g $^{-1}$  min $^{-1}$ ), both  $p < 0.01$ , but not significantly in comparison to VI ( $25 \pm 14$  mikromol 100g $^{-1}$  min $^{-1}$ ). FFAU was similar in all muscle areas (VL  $1.8 \pm 0.8$ , RF  $1.8 \pm 0.9$ , VI  $2.4 \pm 0.9$ , VM  $2.1 \pm 0.8$  mikromol 100g $^{-1}$  min $^{-1}$ ; ns). Calculated extraction of glucose was significantly higher in RF than in all other areas, but FFA extraction was not different between the QF parts. Discussion According to the present results there are regional differences in muscle BF and metabolism within the working muscle during exercise. Interestingly, BF seems to be highest in VI, while GU was highest in RF. This resulted in significantly higher glucose extraction in RF than in VI and other two muscles. The reason for this is unknown, but we can speculate that it might be due to i) different fiber type distribution between the studied muscles leading to different fuel selection (5), ii) differences in sarcolemmal glucose transport (2) or iii) different muscle activation and its relation to BF between these muscles (4). An important methodological point from these results is that one sample of an individual part of QF does not represent the response in the entire QF muscle group, since the dispersion between parts may vary according to measured parameters. References 1. Kalliokoski et al. (2003) Int J Sports Med 24: 400-3 2. Kristiansen et al. (1997) Am J Physiol 272:E385-9 3. Laaksonen et al. (2003) Am J Physiol Heart Circ Physiol 284: 979-86 4. Laaksonen et al. (2006) Clin Physiol Funct Imaging 26: 99-105 5. Saltin et al. (1977) Ann N Y Acad Sci 301:3-29

## COMPARISON OF VARIATIONS OF SYSTOLIC AND DIASTOLIC TIMES ON INCREASING HEART RATE DURING ERGOMETRY TESTS ON HEALTHY ATHLETES VS. SEDENTARY SUBJECTS HAVING STRESS-INDUCED ISCHEMIA.

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The purpose of this study is to compare the variations in systole duration and diastole duration during increasing intensity exercise in two different populations: sedentary subjects having stress-induced ischemia vs. healthy athletes. Methods: the population of our study is formed by two different groups. The first one consists of 23 healthy asymptomatic male athletes. The second group is formed by 24 sedentary subjects who had a stress induced ischemia when undergoing the stress test. The individuals of the first group were screened obtaining a 12 lead electrocardiography (ECG), as well as an incremental ergoespirometry on cycle-ergometer. The second group underwent an incremental ergometry on treadmill with Bruce protocol. During stress tests, we continuously monitored the heart with a 12-lead ECG as well as blood pressure. All the subjects of the second group had stress-induced electrocardiographic signs of ischemia, so, to avoid false positive cases, a nuclear imaging procedure was carried out, confirming the ischemia. All the subjects of this group had positive results in both tests. Results: in both groups diastole time experienced a much larger decrease from resting heart rate to maximal heart rate than systole. It becomes especially remarkable from resting heart rate to approximately 50% of the maximal theoretical heart rate. Thereafter diastole time becomes slightly shorter than systole time until heart rate begins to slow down on recovery phase. This trend is very similar in some other studies. Even though, interaction between health status group and stress-induced ischemia group was found ( $p < 0.001$ ), since healthy subjects were found to have higher systole and diastole durations at rest, but lower durations at maximal effort. Rest and maximal-effort differences parameters were higher for healthy subjects ( $p < 0.001$ ). Conclusions: the duration of the cardiac cycle reduces at the expense of a bigger decrease in diastole time than systole time in both groups. Still, there are significant differences between systole and diastole duration in the two groups, which might be useful to help predict or diagnose ischemia after further research. Bibliography: Bombardini T, Gemignani V, Bianchini E, Venneri L, Petersen C, Pasanisi E, Pratali L, Alonso-Rodríguez D, Pianelli M, Faita F, Giannoni M, Arpesella G, Picano E. Diastolic time - frequency relation in the stress echo lab: filling timing and flow at different heart rates. Cardiovasc Ultrasound. 2008 Apr 21; 6:15. Chung CS, Karamanoglu M, Kovacs SJ. Duration of diastole and its phases as a function of heart rate during supine bicycle exercise. Am J Physiol Heart Circ Physiol 287: H2003-H2008, 2004.

**ORTHOSTATIC EFFECTS ON ECHOCARDIOGRAPHIC MEASURES OF VENTRICULAR FUNCTION**

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Introduction Orthostatic-induced alterations in Doppler echocardiographic measures of ventricular function have not been well-defined. Identifying such changes may provide useful insights regarding the responses of these measures to variations in ventricular loading conditions. Methods Standard assessment of mitral inflow velocity and tissue Doppler imaging of left ventricular longitudinal myocardial velocities was performed on 14 young males (mean age  $17.9 \pm 0.7$  years) in the supine position and then five minutes after assuming a sitting position with legs dependent. Results Upon sitting, average values of stroke volume and cardiac output fell by 28 percent and 18 percent, respectively, while heart rate increased from  $64 \pm 10$  bpm to  $73 \pm 12$  bpm (+14 percent) and calculated systemic vascular resistance rose from  $12.9 \pm 2.2$  to  $16.4 \pm 3.1$  units (+27 percent). Mitral E peak velocity declined from  $87 \pm 16$  cm/s to  $64 \pm 16$  cm/s, and average TDI-E' and TDI-S both decreased (by -44% and -20 percent, respectively). The magnitude of these declines were similar when values were adjusted for left ventricular size. Discussion These findings suggest that a) decreases in TDI measures when assuming the upright position reflect responses to increases in systemic vascular resistance (afterload) rather than changes in ventricular filling (preload), and b) values of E/E' do not reflect alterations in ventricular preload which occur during an orthostatic challenge.

**EFFECT OF BLOOD FLOW RESTRICTION ON ECCENTRIC CONTRACTION INDUCED-MUSCLE FIBER DAMAGE AND HYPERTROPHY SIGNALING PATHWAY IN RAT MODEL**

SUDO, M., KANO, Y.

PHYSICAL ACTIVITY

Mizuki Sudo 1 and Yutaka Kano 2 1. Institute for Physical Activity, Fukuoka Univ., Fukuoka, Japan. 2. Department of Engineering Science, Bioscience and Technology Program, Univ. of Electro-communications, Chofu, Tokyo, Japan. Introduction Resistance exercise containing eccentric contraction (ECC) is an effective training method that can improve muscle mass compared with isometric / concentric contraction exercise. Also it is well known that ECC training occurs higher muscle fiber damage. Recently, low-intensity muscle contraction with blood flow restriction (BFR) has been shown to stimulate muscle hypertrophy signaling and muscle protein synthesis (Fry et al., 2010). However, the effect of BFR on ECC induced-muscle fiber damage and hypertrophy signaling pathway is unclear. Thus, we hypothesized that ECC with BFR activates hypertrophy-signaling pathway despite suppressed muscle damage due to low-intensity muscle tension. The purpose of present study was to investigate 1) the effects of ECC with BFR on degree of skeletal muscle fiber damage, 2) the activation level of muscle hypertrophy-signaling pathway in rat model. Methods In anesthetized rats (Wistar, male, 12 weeks old), the right tibialis anterior muscles were subjected to 40 times-repeated ECC with/without occlusion pressure (BFR: 120, 140, 160, 200 mmHg, by the cuff for occlusion). ECC was evoked by surface electric stimulation (100 Hz, ~ 10 V) while the muscle was being stretched by an electromotor. Three days after BFR+ECC, the muscle damage was evaluated from hematoxylin-eosin stained cross-sections as relative number of damaged fibers in relation to intact fibers. Protein phosphorylation of hypertrophy factor (S6K-Thr 389) was measured by Western blot. Results and Discussion The muscle fiber damage occurred in ECC with 120 mmHg BFR ( $26.1 \pm 1.4\%$ ,  $n=4$ ) and ECC ( $28.6 \pm 1.2\%$ ). However, the collapsed/obstructed muscle fibers were not observed in the 140 ( $2.6 \pm 0.7\%$ ,  $n=4$ ), 160 ( $2.7 \pm 1.2\%$ ,  $n=4$ ), 200 ( $3.1 \pm 0.3\%$ ,  $n=6$ ) BFR+ECC. These results reveal that muscle damage is inhibited depending on BFR level. This inhibition may be related with a reduction of muscle force level during 40 times-repeated ECC. In fact, the average tension was significantly reduced in BFR conditioning (ECC:  $7.47 \pm 0.75$  mNm, 200 ECC+BFR:  $4.56 \pm 0.53$  mNm). Interestingly, we also found that phosphorylation of p70S6K at Thr 389 significantly increased both BFR+ECC (290%) and ECC (279%) groups compared with non-exercise muscle. These results imply that activation of muscle growth factor signal independent of muscle damage. Conclusions We conclude that 1) ECC-induced skeletal muscle damage was suppressed by combination of BFR, 2) BFR+ECC activated the muscle hypertrophy-signaling at the same level as ECC without BFR. ECC in combination with BFR is a novel and effective approach for muscle mass developing. Reference Fry CS, Glynn EL, Drummond MJ, Timmerman KL, Fujita S, Abe T, Dhanani S, Volpi E, Rasmussen BB. (2010). J Appl Physiol, 108, 1199-1209.

**THE RELATIONSHIP BETWEEN SKIN-GAS NITRIC OXIDE AND SERUM NITRITE CONTENTS AFTER MUSCLE-DAMAGING EXERCISE**

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Introduction Muscle damage-induced reduction in force generation is accompanied by increased nitric oxide (NO) content in human skeletal muscle (Radák et al. 1999). Previously, we (Ohkuwa et al. 2006) have been detected NO emanating from human skin (skin-gas), however, no one has confirmed the relationship between skin-gas NO concentrations and serum nitrite concentrations after muscle damage-induced exercise. Therefore, we examined whether skin-gas NO concentrations on the surface of damaged muscle would relate in serum nitrite concentrations or not in human after muscle-damaging exercise. Methods Seven healthy male students volunteered as the subjects. None of them had performed muscle-damaging exercise at least six months prior to the experiment. The subjects performed 8 sets of 15 repetition-maximum (RM) knee flexion-extension exercise (left leg only) consisting of predominantly isokinetic eccentric contractions. The skin-gas samples were obtained from the surface of the belly muscle of the rectus femoris before exercise and 1, 2, 3, 7 days after exercise. The skin-gas NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Nagoya, Japan). Knee extension muscle strength (1RM), circumference of the thigh, muscle soreness (visual analog scale; VAS) of exercised left leg, and serum nitrites were also measured. Results Both the skin-gas NO concentration and the serum nitrite concentration significantly increased 2 days after the exercise compared to pre-exercise values ( $p < 0.01$ ). Thus, there was a significant relationship between the skin-gas NO concentration and the serum nitrite concentration ( $p < 0.05$ ). Muscle strength significantly ( $p < 0.05$ ) decreased, and VAS significantly ( $p < 0.05$ ) increased compared to the pre-exercise values 1-3 days after exercise, although no significant difference was found in the circumference of the exercised thigh during experimental period. Discussion In this study, the exercise induced mechanical muscle damages and pathological changes such as fiber necrosis and inflammatory cell infiltration that become apparent a few days later (Maruhashi et al. 2007). Moreover, delayed reactive oxygen species (ROS) production to inflammatory reactions induced in damaged muscle (Close et al. 2004). Therefore, increased skin-gas NO concentrations in this study may due to activation of induced NO synthase in the damaged muscle cells or in activated macrophages, and increased serum nitrite concentrations. Conclusions Skin-gas NO concentrations on the surface of damaged muscle increased and closely related to increasing serum nitrite concentrations after

muscle-damaging exercise. References Close, G. I. et al. (2004) *Eur J Appl Physiol* 91, 615-621. Maruhashi, Y. et al. (2007) *J Physiol Sci.* 57, 211-216. Ohkuwa, T. et al. (2006) *Int J Biomed Sci.* 2, 100-104. Radák, Z. et al. (1999) *Free Radic Biol Med.* 26, 1059-1063.

### THE EFFECT OF MUSCLE METABOREFLEX ON THE SUPERFICIAL VENOUS VASCULAR RESPONSE OF THE INACTIVE LIMB

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**Introduction** Blood vessels of the superficial vein in the inactive limb constrict sympathetically during exercise (Lorentsen 1975). However, this mechanism is unclear. One of the mechanisms which cause the increase in sympathetic nerve activity during exercise is thought that accumulation of metabolites within the muscle triggers chemosensitive afferents (metaboreflex). In addition, it is reported that this reflex causes the decrease in venous blood volume of the inactive limb (Duprez et al. 1992). Thus, the purpose of this study was to test our hypothesis that superficial venous vessel constriction in the inactive limb may be modulated by the sympathetic excitation via muscle metaboreflex. **Methods** Twelve young subjects performed 1.5-min static handgrip exercise at 45% of maximal voluntary contraction (MVC), and then had 2-min recovery period, which their exercising upper arm was occluded over 220 mmHg to activate metaboreceptors (OCCL) and was not occluded as control condition (CONT). Measurements were heart rate (HR), mean arterial pressure (MAP) and cross sectional area (CSA) in the basilic vein of the inactive upper arm. Venous CSA measurement, using B-mode ultrasound technique, was made under a congestive pressure of 50 mmHg by inflating a cuff placed on the inactive upper portion. **Results** During handgrip exercise, HR and MAP increased and venous CSA decreased from baseline level at both CONT and OCCL. During recovery period, HR returned baseline level at both conditions. However, the increase in MAP and the decrease in venous CSA were maintained during recovery period at OCCL, although MAP and venous CSA returned baseline level during recovery period at CONT. **Discussion** In this study, during recovery period at OCCL, the increase in MAP was maintained, suggesting that muscle metaboreceptors were stimulated by metabolites. In this time, the decrease in venous CSA was kept at OCCL, although venous CSA returned baseline level at CONT. During recovery period, central command and mechanoreflex, which is thought to cause the increase in sympathetic nerve activity during exercise, do not act. Thus, our result suggests that superficial venous vascular response might be modulated by the sympathetic nerve system via muscle metaboreflex. **References** Duprez DA, De Buyzere M, De Sutter JM, Deman SA, De Pue NY, Clement DL. (1992). *Eur J Appl Physiol Occup Physiol*, 65, 94-98. Lorentsen E. (1975). *Scand J Clin Lab Invest*, 35, 789-794.

### PASSIVE EXERCISE WITH BLOOD FLOW RESTRICTION INCREASES CROSS-SECTIONAL AREA AND STRENGTH IN THIGH MUSCLES

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**Introduction** The high-intensity exercise must be done to increase muscle volume and strength generally, however, it cannot be applied for person who is impossible to perform any active exercises. Therefore, we aimed in this study to clarify the effects of passive exercise with blood flow restriction on cross-sectional area (CSA) and strength of thigh muscles. **Methods** Seven male college swimmers (Age: 19.1 ± 1.1 yr, Height: 176.1 ± 5.9 cm, Weight: 70.9 ± 5.4 kg) volunteered for this study. The right leg of all subjects was assigned to a control condition (CON) and the left leg of them was assigned to a passive exercise with blood flow restriction condition (PEB). In the PEB legs, the passive exercise was performed 3 days per week for 8wk. The passive exercise consisted of 3 or 4 sets of repeated (150 times) passive knee extension and flexion using a Biodex unit, separated by 3 min interval. Before and after the experimental period, knee extensor-flexor muscle strengths were evaluated in following settings: concentric contraction at angular speeds of 60, 180 and 300 deg/s (CC60, 180 and 300), eccentric contraction at angular speeds of 60 and 180 deg/s (EC60 and 180), and isometric contraction. In addition, both knee extensor and flexor muscle CSA were analyzed with MRI before and after the experimental period. All the subjects had participated in usual training programs of their swimming team throughout current experimental period. **Results** In knee extensor torque, the extent of increase in strength at CC60 was significantly higher ( $p < 0.05$ ) in the PEB legs ( $16.1 \pm 11.5\%$ ) than in the CON legs ( $4.6 \pm 4.8\%$ ). Although CSAs in knee extensor and flexor muscles were significantly increased after the experimental period in the both legs ( $p < 0.01$  respectively), the percent changes in the CSA of knee extensor muscles were significantly ( $p < 0.05$ ) higher in the PEB legs ( $5.2 \pm 2.5\%$ ) than in the CON legs ( $2.5 \pm 1.5\%$ ). **Conclusion** A passive exercise with blood flow restriction is an effective intervention to increase both the muscle volume and strength. **References** Takarada Y, Takazawa H, Ishii N. (2000). *Med Sci Sports Exerc*, 32(12), 2035-2039. Kubota A, Sakuraba K, Sawaki K, Sumide T, Tamura Y. (2008). *Med Sci Sports Exerc*, 40(3), 529-534.

### AEROBIC EXERCISE-INDUCED CHANGES OF ANKLE BRACHIAL PRESSURE INDEX AND MENSTRUAL CYCLE-DEPENDENT INFLAMMATION

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**Introduction** Nitric oxide (NO) is the most important mediator, and its intrinsic vasodilator function is commonly used as an index of endothelial function. Shear stress on endothelial cells is a stimulus for endothelial nitric oxide synthase (eNOS) during acute exercise (Boo YC & Jo H, 2003). NO has vasodilatory effects and increases blood flow, which facilitates the delivery of glucose to the capillary of skeletal muscle. Meanwhile, inducible nitric oxide synthase (iNOS) is mainly expressed in leukocytes (Niess et al., 2000), which express high-levels of sustained NO synthase when cells are activated. However, the role of iNOS in exercise depending on the menstrual cycle is still not clear. The aim of this study was to examine the hypothesis that exercise-induced vascular reactivity decreases through NO which is increased by leukocyte activation. We investigated exercise-induced changes in variables of the ankle brachial pressure index (ABPI), NO production and leukocyte activation during the normal menstrual cycle. **Methods** Ten healthy sedentary females (aged 20.5±0.7 years, mean ± SD) performed 60 min of cycling at 75% of their individual anaerobic threshold (AT) at three phases of the menstrual cycle (menstrual, follicular and luteal phases). ABPI was evaluated before and after exercise. ABPI is a measure of the blood pressure in the arteries supplying legs relative to central, aortic pressure (approximated by measuring the blood pressure in the arm). Capillary blood samples were collected at three time points: before, immediately after and 30 min after exercise. We measured the concentrations of plasma nitrotyrosine as a marker of NO production, interleukin (IL)-6 and calprotectin as markers of inflammation and leukocyte activation. **Results** ABPI decreased after exercise in the menstrual phase ( $p < 0.01$ ), whereas no changes were observed in follicular and luteal phases. IL-6 increased following exercise in all phases and calprotectin increased immediately after exercise in the menstrual phase ( $p < 0.05$ ). A

positive correlation was observed between exercise-induced changes in nitrotyrosine and calprotectin in the menstrual phase only ( $r=0.49$ ,  $P<0.01$ ). Conclusion This study shows the possibility that aerobic exercise induces leukocyte activation, and NO which is produced by leukocyte activation might affect vascular reactivity after exercise, especially in the menstrual phase. References Boo YC, Jo H. (2003) *Am J Physiol Cell Physiol*, 285, 499–508. Niess AM, Sommer M, Schlotz E, Northoff H, Dickhuth HH, Fehrenbach E. (2000) *Med Sci Sports Exerc*, 32(7), 1220–1225.

#### EFFECT OF DIFFERENCE OF WATER TEMPERATURE ON ARTERIAL STIFFNESS DURING SUPINE POSITION IN WATER

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INTRODUCTION: It is known that heart rate, oxygen uptake and body temperature are affected by the physical characterization of water (water temperature, buoyancy, viscosity, etc). Previous studies demonstrated that increase of venous return by physical characteristics of water caused decrease of heart rate, cardiac vagal activity was enhanced and sympathetic nervous activity was suppressed during supine floating set to a water temperature of 30 degrees Celsius. Core body temperature was changed by water temperature. Therefore, we hypothesized that cardiac autonomic nervous activity, heart rate and blood pressure could change. The purpose of this study was to make clarified the effect of difference of water temperature on arterial stiffness during supine position in water. METHODS: Healthy young Japanese males ( $n=6$ ) volunteered to participate in this study. We had informed consent prior to participation in this study. The age, body weight and body height of subjects were 21 (SD: 0.75) years old, 69.3 (SD: 14.3) kg and 171.8 (SD: 6.8) cm, respectively. This study was consisted in two water temperatures. One was 30 degrees Celsius, the other was 36 degrees Celsius. Subjects were measured baPWV (brachial-ankle pulse wave velocity), heart rate and blood pressure after supine position in water for 5 minutes. RESULTS: The baPWV at 30 degrees Celsius was significantly higher than at 36 degrees Celsius (30 degrees Celsius  $1187\pm 75$  cm/s, 36 degrees Celsius  $1071\pm 68$  cm/s;  $P<0.05$ ). Heart rate and blood pressure were no difference between 30 degrees Celsius and 36 degrees Celsius. DISCUSSION: Heart rate and blood pressure are potentially influential factor of the baPWV. These results did not find a clarified relationship between heart rate and blood pressure. It is suggested that the baPWV was influenced by difference of water temperature during supine position in water. CONCLUSION: Arterial stiffness is influenced by difference of water temperature during supine position in water. REFERENCE: Nishimura M, Onodera S.: Relaxative effects of supine floating on heart rate, blood pressure and cardiac autonomic nervous (correction of nervous) system activity. Japanese journal of aerospace and environmental medicine. 37(3):49–56, 2000. (in Japanese)

## Poster presentations

### PP-PM64 Physiology: Altitude and Hypoxia 1

#### HYPOXIA MEDIATED INCREASES IN BASAL MONOCYTE EXPRESSED HSP32.

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HYPOXIA MEDIATED INCREASES IN BASAL MONOCYTE EXPRESSED HSP32. Taylor, L.1,2, Hillman, A.2, Midgley, A.2, Christmas, B.2,1, Peart, D.2, McNaughton, L.3. 1: University of Bedfordshire (ISPAR) (UK) 2: University of Hull (UK) 3: Bond University (Australia) Introduction Inducible haem oxygenase-1 or heat shock protein 32 (HSP32) is known to be inducible under conditions of oxidative stress. Eccentrically exercised rat muscles (Essig et al., 1997), and human leukocytes post endurance exercise (Niess et al., 1999), have shown increases in HSP32 post exercise. However, the in vivo monocyte HSP32 (mHSP32) response to hypoxia (elevated altitudes) has not been investigated. Such hypoxia mediated changes in mHSP32 may be related to in vivo alterations in redox balance; therefore, changes in redox balance were assessed in tandem with measures of mHSP32. Methods Eight healthy recreationally active male subjects (mean  $\pm$  SD age  $20.8\pm 3.2$  years, height  $1.77\pm 15.7$  cm, body mass  $72.1\pm 11.0$  kg) consented to take part in the study. The hypoxic exposure (75 min, 2980 m) was administered once daily for five consecutive days at rest, commencing and ceasing at 0930 and 1045 respectively. Hypoxia was generated via a hypoxicator. Blood samples were obtained pre day one and post day five of the hypoxic period. mHSP32 was analysed via Flow Cytometry. Reduced (GSH), oxidised (GSSG) and total (TGSH) glutathione as well as TBARS were assessed using commercially available kits. Results In comparison to pre exposure values (pre hypoxia day one) there were significant increases in mHSP32 ( $p = 0.03$ ), GSSG ( $p < 0.001$ ) and TBARS ( $p = 0.001$ ), whereas no significant changes were observed for GSH ( $p = 0.22$ ) and TGSH ( $p = 0.25$ ) post hypoxic exposure period (post hypoxia day 5). Discussion To our knowledge this is the first study to show the in vivo effects of hypoxia (75 min, 2980 m) on mHSP32 expression. This increase in mHSP32, may, through further work, be attributed to the increase in markers associated with negative changes in redox balance (GSSG and TBARS). This increase in mHSP32 is in line with previous hypoxia mediated increases in inducible heat shock protein 72 (Taylor et al., 2010; Taylor et al., 2011). The increase in basal mHSP32 values may confer cellular protection to subsequent challenges to redox balance, in line with in vitro models of cellular preconditioning, postulations such as these require further investigation. References Essig, D. A., Borger, D. R. & Jackson, D. A. (1997). *American Journal of Physiology-Cell Physiology*, 272, C59–C67. Niess, A. M., Passek, F., Lorenz, I., Schneider, E. M., Dickhuth, H. H., Northoff, H. & Fehrenbach, E. (1999). *Free Radical Biology and Medicine*, 26, 184–192. Taylor, L., Midgley, A., Christmas, B., Hillman, A., Vince, R. V., Madden, L. & McNaughton, L. (2011). *Amino Acids*, 40, 393–401. Taylor, L., Midgley, A., Christmas, B., Madden, L., Vince, R. V. & McNaughton, L. (2010). *European Journal of Applied Physiology*, 109, 849–855.

#### ACUTE MOUNTAIN SICKNESS DURING A NATURAL ALTITUDE TRAINING CAMP IN ELITE SWIMMERS

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Introduction Altitude training (AT) has great potential for improving athletic performance but it may also be associated to some potential health risks, as those related to acute mountain sickness (AMS). The aim of this study is to analyze the prevalence and features of AMS in

a group of elite athletes training at moderate natural-terrestrial altitude. Methods 29 elite swimmers of two national teams (14 women, 15 men), mean age 21.2 (SD 2.2), lived and trained during 3 weeks at 2320 m (Altitude Training Center of Sierra Nevada, Spain). Each day subjects filled in the AMS Lake Louise questionnaire (LL, 5 items, 0-3 score), and a modified, extended version (TSF10, 10 items, 1-7 score) of the Total Score of Fatigue questionnaire (Atlaoui 2004). In both cases mean and 50-percentile (P50) was calculated (LL-score and TSF10-score). Training load was quantified during each individual session by the Training Impulses method (Banister 1991) and estimated for total daily training (TRIMPS-d). Results All subjects experienced AMS symptoms, main of all fatigue, headache and sleep disturbances. In most cases AMS was mild, but 24% of the swimmers experienced some severe symptoms. Mean LL-score was 2.03 (SD 1.96), with no gender differences but with great individual variability (0 to 11 points). The highest LL-score value was observed the first day (mean=2.43, P50=3), while the lowest was at the end of the first week (day 7, mean=1.37, P50=1). A positive correlation was found between LL-score and TSF-score ( $r=0.60$ ,  $p<0.001$ ) but not between LL-score and TRIMPS-d. Discussion AT in competitive athletes is associated with a relatively high prevalence of AMS, generally of mild severity (Bartsch 2008), although some swimmers can experience severe symptoms. LL and TSF10 questionnaires may be helpful in detecting and quantifying clinical symptoms related to altitude exposure and training load, particularly during the early stage of the acclimatization period. Nevertheless AMS seems to be independent of training load estimated by the TRIMPS method. References Atlaoui D, Duclos M, Gouarne C, Lacoste L, Barale F, Chatard JC (2004). The 24-h urinary cortisol/cortisone ratio for monitoring training in elite swimmers. *Med Sci Sports Exerc* 36, 218-24. Banister EW (1991) Modeling elite athletic performance, in: HJ Green, et al (Eds), *Physiological Testing of Elite Athletes*, Human Kinetics, Champaign, IL. pp. 403-424. Bartsch P and Saltin B (2008). General introduction to altitude adaptation and mountain sickness. *Scand J Med Sport* 18, S1-10.

## DOES SHORT DURATION INTERMITTENT HYPOXIC TRAINING IMPROVE REPEATED SPRINT CYCLING PERFORMANCE?

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Introduction Altitude training has been used to aid performance for the past forty years. However, altitude training studies have traditionally used prolonged exposures of several hours per day over three to four weeks (Vallier et al., 1996; Levine and Stray-Gundersen, 1997). The focus of these studies has primarily been on haematological improvements and endurance based performance. Few studies have looked at shorter durations and high intensity intermittent exercise. It was therefore the purpose of this study to investigate the use of short duration hypoxic training (HT) on repeated sprint cycling performance. Methods Fourteen male participants (age 27.5  $\pm$  8.5 yrs; stature 179.4  $\pm$  4.49 cm; mass 72.9  $\pm$  8.55 kg) were randomly assigned to either a normoxic training group (NT) or a hypoxic training group (HT). All participants completed an intermittent performance test (IPT) on an SRM cycles ergometer. This consisted of 6 x 3 min efforts at 65% of each individual's maximal aerobic power, interspersed with 6 x 10 s maximal sprint efforts. Participants then cycled for 15 min on a Monark 834E cycle ergometer three times per week for three weeks. The NT group performed the sessions under normoxic conditions, whilst the HT group performed them at a simulated altitude of 3048 m using a hypoxic generator. Following the intervention participants repeated the IPT. Differences in mean power (Wmean) and peak power (Wpeak) averaged over all sprints were analysed using a 2 (HT, NT) by 2 (pre and post-intervention) repeated measures ANOVA. Where a significant interaction effect was found, post-hoc comparisons were performed. Significance was set at  $p \leq 0.05$ . Results No significant interaction effect was found for Wmean ( $p = .21$ ). However, the HT group showed a pre to post-intervention increase of 11.99% compared to 3.75% by the NT group. A similar trend was also reported for Wpeak ( $p = .17$ ), with the HT group increasing 11.82% pre to post-intervention compared to 3.45% by the NT group. Discussion Despite no significant differences in Wmean and Wpeak between groups, the HT group increase both more than the NT group. The non-significant nature of these results may in part, be due to the low number of participants. However, hypoxic training may have resulted in greater cardiorespiratory adaptations and thus enhanced recovery between sprints. References Levine, B.D. and Stray-Gundersen, J. (1997) 'Living high-training low': effect of moderate-altitude acclimatization with low-altitude training on performance. *J App Physiol*, 83 (1), 102-112. Vallier, J.M., Chateau, P. and Guezennec, C.Y. (1996) Effects of physical training in a hypobaric chamber on the physical performance of competitive triathletes. *Euro J App Physiol*, 73(5), 471-478.

## THE EFFECT OF SIMULATED ALTITUDE EXPOSURE VIA REBREATHING ON INTERVAL PERFORMANCE

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THE EFFECT OF SIMULATED ALTITUDE EXPOSURE VIA REBREATHING ON INTERVAL PERFORMANCE Baldwin, C., Walsh, M., Cox, R., Massie, B., Harper, E. Miami University, Oxford, Ohio Introduction Altitude training became popular during the 1968 Olympic Games held in Mexico City. Since then, there has been extensive research conducted on the effects of altitude on cardiovascular endurance. The goal of this study is to examine the effects of simulated altitude via rebreather training on maximal interval performance. Methods Subjects had blood drawn at the Miami University Health Center for analysis of red blood cell (RBC), hemoglobin (HGB) and hematocrit (HCT) levels. For the duration of the study subjects were asked to maintain their current workout regime. Subjects performed pre exercise performance tests, which included a VO2max and a 90% repeated interval performance test. During the 90% repeated interval performance test subjects ran at the last stage of their VO2max for 3 minutes or until failure. At this time the subjects returned to a 0% grade at a speed of 1.56 m/s for 3 minutes. They repeated this for a total of 5 sets. Following the exercise performance tests, subjects used rebreathing apparatuses developed by Alto2 Lab for 15 minute sessions, five days a week for three weeks. The three weeks were divided into three O2 saturation levels, 90%, 87%, and 84%. Following this simulated exposure to altitude, subjects performed a post 90% repeated interval performance test and a post blood draw. A repeated measures ANOVA was conducted to analyze RBC, HGB, HCT, and total time to exhaustion. The experiment controlled for a treatment effect and exhaustion. Results A significant difference was found between the control and experimental groups in the total time run. The experimental group ran 642.67 seconds for the pretest compared to the 759.33 seconds for the posttest. The control group ran 780 seconds for the pretest compared to the 779.60 seconds for the posttest. However, no significant difference was found between the RBC, HGB, and HCT levels. Discussion At moderate altitudes physiological adaptations occur which may improve performance. Living at moderate altitude and training at low altitude elicit beneficial effects for aerobic performance (Levine and Stray-Gundersen, 1997). These beneficial effects may be transferred over into interval performance. The experimental group showed marked improvements in the total time run during the 90% interval treadmill test. On the other hand, the control group maintained their current performance level. The changes in RBC, HGB, and HCT levels were not found to be significant; however, that may be due to the low subject pool. With more subjects a significance of blood values may be found between the two groups. References Levine, B. D. & Stray-Gundersen, J. (1997). Living high-training low': Effect of moderate-altitude acclimatization with low-altitude training on performance. *Journal of Applied Physiology*, 83(1), 102.

**METABOLIC AND THERMAL RESPONSES TO COMBINED HYPOXIC AND THERMAL CHALLENGE**

WHITE, A., SARGEANT, A., PARRY, S., MORGAN, C., MOLPHY, J., LANGAN-EVANS, C., IMPEY, S., FLOWER, D., CRIGHTON, B., CABLE, N.T., HULTON, A.

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Metabolic and thermal responses to exercise in the heat are elevated compared to exercise in the cold (Hargreaves & Febbraio, 1998) and exercise in hypoxic conditions also causes an exaggerated cardiorespiratory response compared with sea level (Reeves et al. 1992). As athletes are often exposed to the combined challenge of exercise in hypoxic and hot conditions, this study investigated the combined effect of these challenges on the cardiorespiratory and thermal response to exercise. Nine healthy well trained males participated in this ethically approved study. Following assessment of VO<sub>2</sub> peak on a recumbent cycle ergometer, subjects attended the laboratory on 3 separate occasions, exercising for 15 min at 70% VO<sub>2</sub> peak in the following 3 climatic conditions; SL at 32°C, 2300m at 18°C and 2300m at 32°C. Rectal temperature (RT) was measured using a grant thermometer and skin temperature measured at 4 sites using squirrel thermistors and data logger. Blood lactate was measured using a Lactate Pro and glucose was measured and plasma volume changes were assessed. HR and SaO<sub>2</sub> were measured using Dynamap. Sweat production rate was measured by changes in nude body mass and urinary osmolality assessed by osmometry. Statistical differences assessed by two way ANOVA with repeated measures. There was no significant difference ( $p > 0.05$ ) in RT between the conditions, although there was a significant effect of time ( $p < 0.05$ ). There was no significant ( $p > 0.05$ ) effect of time of skin temperature, but there was a condition effect ( $p < 0.05$ ) and interaction ( $p < 0.05$ ). Mean ( $\pm$ SD) skin temperature values before exercise for SL at 32°C, 2300m at 18°C and 2300m at 32°C, were  $32.88 \pm 0.88$ ,  $32.87 \pm 0.70$  and  $30.06 \pm 1.26$  respectively alternating to levels of  $34.22 \pm 0.80$ ,  $33.91 \pm 0.98$  and  $28.04 \pm 1.31$  after the 15 minute exercise protocol. There was no significant difference in sweat production rate between the three conditions as ( $p > 0.05$ ). There was a significant difference in blood lactate concentrations over time ( $p < 0.05$ ), increasing from baseline with mean ( $\pm$  SD) values of  $1.27 \pm 0.56$  (SL at 32°C),  $1.4 \pm 0.57$  (2300m at 18°C) and  $1.51 \pm 0.70$  (2300m at 32°C) to peak levels of  $7.23 \pm 2.57$  (SL at 32°C),  $7.41 \pm 2.83$  (2300m at 18°C) and  $6.88 \pm 3.26$  (2300m at 32°C) respectively at termination of exercise. However, there was no difference between conditions. Blood glucose changed over time ( $p < 0.05$ ). This data suggests that the combined influence of exercise at altitude and in the heat causes no greater metabolic or thermal strain, compared with either heat or altitude alone. The absence of effect may relate to the relatively short exercise duration. Hargreaves, M. and Febbraio, M. (1998). Limits to exercise performance in the heat. *Int J Sport Med*. 19: S115 – S116. Reeves, J., et al. (1992) Oxygen transport during exercise at altitude and the lactate paradox: Lessons from operation Everest II and pikes peak. *Am Coll Sports Med*. 20: 275-296.

**EFFECT OF ACUTE HYPOXIA ON MUSCLE OXYGENATION AND NEUROMUSCULAR ACTIVITY DURING REPEATED SPRINT CYCLING**

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**Introduction** The previous study have shown that repeated sprint cycling training effectively improve muscle oxidative potential and cycle endurance capacity (Burgomaster et al., 2005). We speculated that this exercise in hypoxia may provide more stimuli especially to local muscle. So, the purpose of this study was to examine whether acute hypoxia affects muscle oxygenation and neuromuscular activity during repeated sprint cycling. **Methods** Seven cyclists performed five, 30-s sprints with 240 s of rest under normoxic (21%O<sub>2</sub>, 79%N<sub>2</sub>) and acute hypoxic (16%O<sub>2</sub>, 84%N<sub>2</sub>) conditions. Mean power output was recorded by cycle ergometer, and arterial O<sub>2</sub> saturation (SpO<sub>2</sub>) was estimated via pulse oxymeter with adhesive optodes placed on the forehead. The relative concentrations of oxy-hemoglobin (O<sub>2</sub>Hb) in the right vastus lateralis (VL) muscle were monitored continuously by near-infrared spectroscopy. In the present study, the resting level of O<sub>2</sub>Hb was defined as 100% (baseline) of oxygenation, and the minimum plateau level of O<sub>2</sub>Hb was obtained by arterial occlusion and was defined as 0% of oxygenation. Surface electromyogram (EMG) of VL was also recorded. Root mean square (RMS) was utilized to quantify EMG activity. For each sprint, the RMS was normalized to the first sprint value, which was assigned the value of 100%. Results SpO<sub>2</sub> under hypoxic condition was significantly lower than that under normoxic condition ( $p < 0.05$ ) while mean power output was not different in both conditions. During exercise, significant differences were not observed in oxygenation level of VL in both conditions. However oxygenation level of VL in hypoxia was significantly lower than that in normoxia immediately after exercise. Normalized RMS values were significantly decreased over the five sprints in normoxia ( $p < 0.05$ ) while no change was observed in hypoxia. As a result, RMS in hypoxia was significantly higher than that in normoxia in third, fourth and fifth sprint ( $p < 0.05$ ). Conclusion These findings suggest that repeated sprint cycling in hypoxia require greater neuromuscular activity and cause delay in muscle re-oxygenation after exercise. References Burgomaster, K. A., Hughes, S. C., Heigenhauser, G. J., Bradwell, S. N., Gibala, M. J. (2005). *J Appl Physiol*, 98(6), 1985-90.

**Poster presentations****PP-PM65 Physiology: Jumping Performance****THE RELATIONSHIP BETWEEN 1 RM BACK SQUAT AND VERTICAL JUMPING IN YOUNG WOMEN**

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Ferunaj, P., Erindi, A. Derveni, A University of Sports, Tirana (Albania) **Introduction** In today's fitness industry, strength and power, in addition of cardiovascular fitness, flexibility and body composition, are key components. One study (1) reported that double leg press power was related to vertical jump performance in young women. Other studies have shown improvement in explosive jumping actions (2,3) produced by combination of both maximal and explosive strength development. Therefore, we hypothesized that the maximal strength for lower extremities would lead to higher vertical jump in young women. **Methods** Eighteen young women in Tirana, participated in this investigation and were divided into 2 groups based on 1-repetition maximum (1-RM) back full squat exercise adjusted to body mass (4): an Active group (AG; age 19  $\pm$  0.3 years) and a non active group (NAG; age 19  $\pm$  0.5 years). Weight and height were measured using standard methods. Peak power for both squat jump (SJ) and counter movement jump (CMJ) was measured using the ergo jump. Results Back squat 1RM was  $74.76 \pm 4.88$  kg for the active group and  $65.72 \pm 1.91$  kg for non active group. Squat jump (SJ) and counter movement jump (CMJ) were respectively  $30.24 \text{ cm} \pm 3.29$  and  $41.19 \text{ cm} \pm 7.19$  for AG and  $29.29 \pm 4.54$  and  $34.55 \pm 9.03$  for NAG. **Discussion** Our

results suggest that 1RM full squat does not influence the SJ, but has better correlation with CMJ in AG. In contrast, the data gathered in NAG showed that 1 RM back squat can significantly influence the power, expressed in vertical Jump for both SJ and CMJ. Consequently, the 1RM back squat is an easily applied, inexpensive test and can provide fitness instructors and strength and condition coaches with relevant information concerning the maximal strength and power of lower extremities in young women. References 1.Thomas M, Fiatarone MA, Fielding RA. Leg power in young women: relationship to body composition, strength, and function. *Med Sci Sport Exerc.* 1996 Oct;28(10):1321-6. 2. Bobbert, M. A., and A. J. Van Soest. Effects of muscle strengthening on vertical jump height: a simulation study. *Med. Sci. Sports Exerc.* 26:1012-1020, 1994 3. Häkkinen K, Kallinen M, Izquierdo M, Jokelainen K, Lassila H, Mäkiä E, Kraemer WJ, Newton RU, Alen M.(1998) Changes in agonist-antagonist EMG, muscle CSA, and force during strength training in middle-aged and older people. *J Appl Physiol* 84:1341-1349. 4. [http://en.wikipedia.org/wiki/Sinclair\\_Coefficients](http://en.wikipedia.org/wiki/Sinclair_Coefficients)

### **HIGH-IMPACT LOW-REPETITION JUMP TRAINING IS EFFECTIVE IN PREVENTING THE REDUCTION MID-DIAPHYSEAL FEMORAL BONE GEOMETRY SEEN IN POST-MENOPAUSAL WOMEN**

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**Objective** The hypothesis of the present study was that low-repetition high-impact jump training would be effective for enhancing bone cross-sectional geometry rather than increasing DXA measured BMC and aBMD in post-menopausal women. **Methods** Thirty-three middle-aged post-menopausal women (mean age,  $61.2 \pm 5.6$  years; range, 53-74 years) were divided into two groups: jump training group and control group. The Jump group jumped 20 times per day, twice a week for 12 months on a shock absorbing pad. Main outcome measures Dual energy X-ray absorptiometry (DXA) was used to measure BMC and aBMD in the lumbar spine and proximal femur. Magnetic resonance imaging (MRI) determined bone geometric characteristics in the mid-femur, such as femoral mid-diaphyseal cross-sectional area, periosteal and endosteal perimeters and maximum and minimum second moment of area. **Results** The postmenopausal middle-aged women who undertook the jump training intervention displayed a significantly greater femoral mid-diaphyseal maximum second moment of area than the control group after 12 months. Although, no significant differences were found after 12 months for the DXA measured BMC and aBMD at the lumbar spine, total proximal femur and femoral neck between the jump training and control groups. **Conclusions** In middle-aged postmenopausal women, aBMD measures were not related to jump training effects which supports the notion that long bones tend to change their size and geometry rather than amount of mineral in order to meet the increased functional demands associated with low-repetition high-impact loading.

### **EFFECTS OF LANDING TRAINING ON JUMP HEIGHT, KINETICS AND KINEMATICS DURING LANDING-TO-JUMP MOVEMENT**

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**Introduction** In landing-to-jump movement (L-J), the technique in not only jumping movement but also landing movement is an important factor influencing jump performance. Hewett et al. (1996) demonstrated that jump training program intended to decrease landing impact (peak of vertical ground reaction force) decreased landing impact and increased jump height. Furthermore, Iida et al. (2009) showed that the jump height of L-J has a significant negative correlation with the magnitude of landing impact. These findings indicate that technique for absorbing landing impact may be associated with the performance of the latter jump movement. The purpose of this study was to clarify the effects of landing training (without jumping movement) on jump performance of L-J. We hypothesized that landing training decreases the landing impact in L-J and increases the jump height of L-J. **Methods** Twenty-one healthy young adults were randomly assigned to control group (CG: n=11) or training group (TG: n=10). TG performed landing training intended to decrease impact force for 2 weeks (6 sessions). Ground reaction forces (GRFs) and kinematic data were obtained in landing (LAND) and L-J from 35 cm-high, and squat jumps (SJ) before and after the intervention. **Results** In TG, the peak vertical GRF up to 100 ms after ground contact relative to body weight (impact index) significantly decreased (Pre:  $3.04 \pm 0.74$  vs. Post:  $2.41 \pm 0.42$ ,  $P < 0.05$ ), and L-J height significantly increased (Pre:  $46.1 \pm 5.8$  [cm] vs. Post:  $47.8 \pm 5.8$  [cm],  $P < 0.05$ ). Ground contact time in L-J and the SJ height unchanged in both groups. For TG, the maximal flexion angle of hip, and joint torque, power and work of hip joint in propulsive phase significantly ( $P < 0.01$ ) increased after training. **Discussion** Previous studies showed that landing training decreased landing impact (McNair et al., 2000; Onate et al., 2001; Prapavessis et al., 2003), but it is unknown that whether landing training improves jump performance of L-J. The current finding shows that the landing training improves not only technique for absorbing landing impact but also L-J performance itself, and supports our hypothesis. The increase of L-J height may be due to an increase in force generation around the hip joint, rather than improve jump ability. **Reference** Hewett TE., Stroupe AL., Nance TA., Noyes FR. (1996). *Am J Sports Med*, 24, 765-773 Iida Y., Inaba Y., Fukushima S., Kanehisa H. (2009). *Tokyo J Phys Educ Hlth Sport Sci (in Japanese)*, 1, 5-12 McNair PJ., Prapavessis H., Callender K. (2000). *Br J Sports Med*, 34, 293-296 Onate JA., Guskiewicz KM., Sullivan RJ. (2001). *J Orthop Sports Phys Ther*, 31, 511-517 Prapavessis H., McNair PJ., Anderson K., Hohepa M. (2003). *J Orthop Sports Phys Ther*, 33, 204-207

### **DIFFERENCES IN THE BILATERAL DEFICIT IN VERTICAL JUMPING BETWEEN BOYS AND GIRLS**

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**Introduction** The bilateral deficit in vertical jumping occurs when the summed unilateral jump height is greater than the bilateral jump height. This phenomenon has been described mainly for muscle strength in adult populations, while there is a lack of information in very young individuals and especially females. Therefore, the aim of this study was to examine whether a bilateral deficit in jumping exists in children and to compare boys and girls of the same age and training background. **Methods** One hundred and twenty-five schoolchildren (59 boys and 66 girls, aged  $10.6 \pm 0.1$  y, height:  $144 \pm 1$  cm, body mass:  $41.2 \pm 0.9$  kg) performed one-leg and two-leg counter movement jumps (CMJ) without arm swing on a contact mat. Jumps were performed after full familiarization and the best of three efforts was recorded. The bilateral jump deficit index was calculated as:  $1 - (\text{right} + \text{left leg jump height}) / \text{two-leg jump height} \times 100$ . Peak leg power output during jumping was calculated using the equation of Sayers et al. (1999) and was scaled with body mass. Differences between boys and girls were analyzed using analysis of variance (ANOVA) with repeated measures on one factor or unpaired t-tests, whenever it was appropriate ( $p < 0.05$ ). **Results** are mean  $\pm$  standard error. **Results** Jump height and leg peak power were similar in boys and girls



( $21.8 \pm 0.7$  vs.  $20.1 \pm 0.5$  cm and  $59.1 \pm 2.2$  vs.  $56.1 \pm 1.9$  W, respectively). The two-leg CMJ was significantly higher than the sum of the right and left leg jumps only in boys ( $P < 0.01$ ), as shown by the positive bilateral index of  $9.2\% \pm 2.2\%$ . In contrast, girls showed neither bilateral deficit nor facilitation, since the bilateral index was not different from zero ( $1.7 \pm 2.2\%$ ), indicating equal two-leg and sum of two legs jumps. The bilateral indices of boys and girls were significantly different ( $p < 0.02$ ). Discussion The main finding of the present study was the lack of a bilateral deficit (negative bilateral index) in both boys and girls around 11 years old. The fact that the summed unilateral jump height was not greater than the bilateral jump height in both groups may be due to a decreased ability to activate motor units during pre-puberty (Paasuke et al., 2000). Differences in the bilateral index between the two genders have been previously observed during sprint cycling (Dunstheimer et al., 2001) and may be explained by a possibly superior motor skill ability (i.e. balance on one leg and jump) of girls over boys in that age. References Dunstheimer D, Hebestreit H, Staschen B, Strabburg HM, Jeschke R (2001). Eur J Appl Physiol 84, 557-561. Paasuke M, Ereline J and Gapeyeva H (2000). Eur J Appl Physiol 82, 459-464. Sayers SP, Harackiewicz DV, Harman EA, Frykman, PN, Rosenstein MT (1999). Med Sci Sports Exerc 31, 572-577.

## THE RELATIONSHIP BETWEEN KNEE EXTENSOR MUSCLE STRENGTH AND VERTICAL JUMP PERFORMANCE: EFFECT OF LOAD

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Introduction One of the fundamental mechanical properties of skeletal muscles is the force-velocity-power (FVP) relationship. Power output of a skeletal muscle depends on both muscle force and a velocity of shortening. Since they are inversely related, power output at higher external loads should be dependent on muscle strength and vice versa. Accordingly, the heavier the load that has to be overcome during movement, the more important is muscle strength for power production and performance. In this study we examined the relationship between knee extensor muscle strength and vertical jump performance with different loads. Methods Sixty-six young and healthy men volunteered in the study. After standardized warm up, each subject performed countermovement jumps (CMJ) under 5 loading conditions: no load (1BW), negative loads (0.85 and 0.7BW), and positive loads (1.15 and 1.3BW) on a force plate. CMJ was followed by the measurement of subject's maximal concentric knee extension torque at 60 deg/sec on an isokinetic dynamometer. The relationship between strength and jumping performance with various loads was assessed by Pearson's correlation coefficients (CC) and partial CC after controlling for body mass. Results Knee extensor muscle strength correlated significantly ( $r = 0.78-0.79$ ; all  $p < 0.01$ ) with peak power output during CMJ at all loading conditions. When controlled for body mass, the corresponding CC were reduced but still remained highly significant ( $r = 0.62-0.65$ ; all  $p < 0.01$ ). Considerably lower CC ( $r = 0.18-0.43$ ;  $p = 0.01-0.15$ ) were observed between knee extensor muscle strength and CMJ height at all loading conditions. Removing the effect of body mass increased the CC at all loading conditions ( $r = 0.37-0.51$ ; all  $p < 0.01$ ). We have also observed that subjects changed their depth of countermovement during performance of CMJ with different loads. Discussion The first main finding is that there are no significant changes in CC between knee extensor muscle strength and CMJ peak power under different loads applied. The lower body power output during CMJ with various loads depends not only on the FV relationship, but also on changes in leverage of leg extensors and muscle's force-length relation. As subjects changed their movement kinematic pattern during CMJ with different loads, the relationship between leg extensors muscle strength and power output during CMJ didn't behave as expected from FVP relationship. The second main finding is an increase of the CC between knee extensor muscle strength and jump height after removing the effect of body size. This is in line with our previous study (1) which suggests that CMJ height could be a body size independent measure of a muscle power. References 1 Markovic G, Jaric S (2007) J Sport Sci 25(12) 1355-63

## RELATIVE FATIGUE IN REPEATED SPRINT ABILITY IS RELATED TO JUMP AND FULL SQUAT MAXIMAL POWER IN SOCCER PLAYERS

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RELATIVE FATIGUE IN REPEATED SPRINT ABILITY IS RELATED TO JUMP AND FULL SQUAT MAXIMAL POWER IN SOCCER PLAYERS López-Segovia, M.1, Palao, JM.2, González-Badillo, JJ.3 1: Research Center of Murcia Soccer Federation (Murcia, Spain), 2: University of Murcia (Murcia, Spain), 3: University of Pablo de Olavide (Seville, Spain). Introduction The ability to execute repeated sprints (RSA) is important for a soccer player's performance (Impellizzeri, et al, 2008). This capacity is influenced by aerobic aspects such as the maximum oxygen consumption (Meckel et al, 2009) as well as anaerobic aspects such as phosphocreatine degradation (Gaitanos et al, 1993) and muscle buffer capacity (Edge et al, 2006). However, the relationship between RSA and lower-body power exercises done by the soccer player in training sessions (full squat (FS) and countermovement jump (CMJ)) is not known. The objective of the present study was to assess the relationship between RSA and lower-body power in FS and CMJ for the soccer player. Methods Eighteen field players from a soccer team from the Spanish Third Division were analyzed. The RSA protocol consisted of executing 40m series (with photoelectric cells placed at 0m and 40m) with 2' of recovery between series, until 3% of the speed from the best series of each player is lost. The number of series executed was recorded as the indicator of RSA. One week later each player completed both a countermovement jump (CMJ) and progressive full squat test with loads (FSL) (López-Segovia et al, 2010). The maximum average power generated in the concentric phase with each load until the maximum power was achieved was recorded for both exercises. For data analysis, Pearson correlation and t-test were used. The alpha level was set at  $p < 0.05$ . Results RSA was significantly related to the average maximum power per kg of weight for FS ( $r = 0.539$ ,  $p \leq 0.05$ ) as well as with the profile of maximum power for each player (sum of the average power in 20, 30, and 40kg) for the CMJ ( $r = 0.577$ ,  $p \leq 0.05$ ). Discussion The results found indicate that the power obtained in the FS and CMJ partially explain the loss of performance in RSA. The relationship found constitutes a starting point for the relationship between RSA and power in soccer players. Future studies should assess the level of contribution of aspects that affect RSA and determine how much a specific strength conditioning program affects RSA. References Edge, J., Bishop, D., Hill-Haas, S., Dawson, B., and Goodman, C. (2006). Eur J Appl Physiol, 96: 225-34. Impellizzeri, F.M., Rampinini, E. Castagna, C. Bishop, D. Ferrari Bravo, D., Tibaudi, A., and Wisloff, U. (2008). Int J Sports Med, 29: 899-905. Mendez-Villanueva, A., Hamer, P., and Bishop, D. (2008). Eur J Appl Physiol, 103: 411-419.

## CHANGES OF POWER-VELOCITY RELATIONSHIP IN FEMALE VOLLEYBALL PLAYERS

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**Introduction** Volleyball players' fitness relies on their strength, power output and jumping ability (Smith et al., 1992). The players' power output is often measured on a cycloergometer (Buško, 2009). In the literature, there is no publication for changes on the force-velocity and power-velocity relationship in female volleyball players during the training. The aim of the study was to follow the changes of power-velocity relationship in female volleyball players during training. **Methods** Twelve female volleyball players (age  $21.6 \pm 1.6$  years, body height  $177.2 \pm 6.1$  cm, body mass  $71.6 \pm 6.4$  kg, and training experience  $8.9 \pm 3.3$  years) volunteered to participate. Force-velocity and power-velocity (P-v) relationship were determined from five maximal cycle ergometer exercise tests, 10 s each, with increasing external loads amounting to 2.5, 5.0, 7.5, 10.0, 12.5% of body weight (BW). There were 2-min breaks between the tests. The measurements were performed before the preparatory period (I), after the end of preparatory period (II) and after the end of first competitive season (III). The results were statistically processed using analysis of variance (ANOVA) with repeated measures (post-hoc Scheffé test). **Results** The relative power output at the load of 2.5% and 5.0% BW significant increased between the measurements I and II by 8.2% and 6.1%, respectively. The relative power output at the load of 7.5% BW increased from  $8.85 \pm 0.46$  W/kg (I) to  $8.98 \pm 0.65$  W/kg (II) and  $9.42 \pm 0.84$  W/kg (III,  $p < 0.05$ ). The relative power output at the load of 10.0% BW was observed from  $8.31 \pm 1.11$  W/kg (I) to  $9.26 \pm 1.17$  W/kg (II,  $p < 0.05$ ) and  $9.64 \pm 0.96$  W/kg (III,  $p < 0.05$ ). The relative power output at the load of 12.5% BW insignificant increased between the measurements I and II by 10.0%, and I and III by 16.0%. **Discussion** Training of motor skills in volleyball players has its principal place during the preparatory period. In the competitive season the main emphasis is on improving the technique and tactics, and training of motor skills are reduced (Häkkinen, 1993). In this paper, volleyball training insignificant improved the female players' P-v characteristics during the preparatory period. After the first phase of the competitive season significant, "parallel" shift of P-v curves was observed. Busko (2009) described similar changes of the P-v relationship in male volleyball players during one years training. **Acknowledgements** The study was supported by Ministry of Science and Higher Education (Grant No. AWF - Ds.-150). **References** Buško K. (2009). Human Movement, 10(2), 149-152. Häkkinen K. (1993). Sports Med Phys Fitness, 33, 323-332. Smith DJ, Roberts D, Watson B. (1992). Sports Sci, 10(2), 131-138.

## A RELIABILITY ANALYSIS OF THE VERTICAL COUNTERMOVEMENT JUMP TEST

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**Introduction** The vertical countermovement jump (CMJ) test has been reported as a highly reliable measure of functional power output with Intraclass Correlation Coefficients (ICC) ranging from 0.78 to 0.98 (Robbins & Docherty, 2005). However, absolute measurement statistics are not usually included in CMJ reliability analysis; this is a significant limitation when attempting to identify small performance changes between conditions [e.g. in Post-Activation Potentiation (PAP) research]. Therefore, this study aimed to identify the degree of random error, due to performance variation, in the CMJ test. **Methods** Five trained males (age:  $20.8 \pm 1.1$  years, height:  $1.79 \pm 0.06$  m, mass:  $81.5 \pm 6.5$  kg) who regularly took part in jumping activities were recruited. The design of the study comprised one familiarisation and two identical testing sessions separated by 48 hours. The testing sessions consisted of: a 15-min warm-up, 2 practice CMJs and 5 tested CMJs performed on a Kistler force plate (1000Hz). The jump height was calculated from the force-time curves using two different methods: the take-off velocity method (TOV) and the flight time method (FT). Three statistical methods for assessing reliability were used after the data were assessed for heteroscedasticity: 95% Limits of Agreement (LOA), Coefficient of Variation (CV) and ICC (3, 1) consistency. Reliability results were obtained as follows: a) reliability based on the average score of the 5 jumps (R5); b) reliability based on the best jump performance (RB). **Results** Both methods, TOV and FT, produced almost perfect ICC values of 0.99 and 1.00 ( $p < 0.001$ ) respectively for both R5 and RB. However, the TOV method for R5 demonstrated a random error of 10% of the grand mean with LOA (Bias  $\pm$  Random Error):  $0.00 \pm 0.04$  m, whereas the FT method demonstrated a lower relative random error of 6.5% with LOA:  $-0.01 \pm 0.03$  m. Interestingly, when the best score was used for the analysis the relative random error for TOV increased to 12.5% with LOA:  $0.00 \pm 0.05$  m, whereas the FT method produced a relative random error of 2% with LOA:  $-0.01 \pm 0.01$  m. The CV values based on the R5 data were 2.6% for TOV and 2% for FT while the respective values for RB were 3.2% and 0.9%. **Discussions** The ICC results demonstrate a very high reliability between the sessions; however the measures of absolute reliability suggest that the random error could reach noteworthy levels (4-5 cm). It appears that when the calculations involve the best trial analysed by the FT method the random error is reduced considerably. The estimation of the random error is of high importance particularly in PAP studies where changes in jump performance range from 2-8% (Tillin & Bishop, 2009). **References** Robbins D, Docherty D. (2005) J Strength Cond Res, 19(4), 898-902. Tillin N, Bishop D. (2009) Sports med, 39(2), 147-166.

## DETERMINANTS OF STANDING LONG JUMP PERFORMANCE IN CHILDREN

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**Introduction** Standing long jump (SLJ) is commonly used test to assess explosive leg power. It is often employed for talent selection and prediction of potential in different sports (Burr et al. 2008). However, body dimensions of the jumper may have implications in leg power assessment, since taller persons may jump longer (Chamari et al., 2008). Also, individuals with different body masses may have the same SLJ performance, while leg power generated may be widely different. Therefore, the aim of this study was to identify the most significant variables that contribute to SLJ performance in young boys and girls. **Methods** One hundred and nineteen schoolchildren (58 boys and 61 girls, aged  $10.7 \pm 0.1$  y, height:  $144 \pm 1$  cm, body mass:  $41.2 \pm 0.9$  kg) were tested on two separate occasions following full familiarization. Testing included measurement of SLJ, 10 m and 30 m sprint times with photocells, vertical counter movement jump (CMJ) without arm swing on a contact mat and anthropometric measurements. To assess the influence of technique during the SLJ, an experienced investigator rated technique in each SLJ by giving a mark from 1 to 10. Differences between boys and girls were analyzed using unpaired t-tests. After bivariate correlation analysis, multiple linear stepwise regression analysis was performed with SLJ performance as the dependent variable. **Results** No differences were found in all variables measured between boys and girls and therefore all subsequent analyses were performed for the pooled data. SLJ performance was  $1.40 \pm 0.02$  m, CMJ was  $0.21 \pm 0.04$  m and 10 m and 30 m sprint times were  $2.21 \pm 0.01$  and  $5.72 \pm 0.04$  s, respectively. SLJ was significantly correlated with 10 m time ( $r = -0.66$ ,  $p < 0.01$ ), 30 m time ( $r = -0.68$ ,  $p < 0.01$ ) and CMJ ( $r = -0.58$ ,  $p < 0.01$ ). Stepwise multiple linear regression analysis revealed that the most significant predictors of SLJ were 30 m time, CMJ, age and the mark for jump technique (adjusted  $R^2 = 0.77$ ,  $SEE = 0.09$ ,  $p < 0.001$ ). **Discussion** This study showed that per-

formance in SJL in young boys and girls can be predicted by sprint ability, vertical jump performance and technique level. Height and weight did not play a significant role in performance of the SJL in this relatively homogeneous group of individuals. It is important to note that vertical jump performance explains only a small part of the variance in performance of SJL. This may be because SJL is a more complex motor task that requires combination of vertical and horizontal leg power in combination with a full-body coordinated movement. References Chamari K, Chaouachi A, Hambli M, Kaouech F, Wisløff U, Castagna C (2008). *J Strength Cond Res* 22, 944-950. Burr JF, Jamnik RK, Baker J, Macpherson A, Gledhill N, McGuire EJ. (2008). *J Strength Cond Res* 22, 1535-1543.

## Poster presentations

### PP-PM66 Diet and Health

#### THE INFLUENCE OF EXERCISE ON SENSORY PERCEPTIONS OF SPORTS DRINKS

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Background: So as to enable efficient delivery of both water and energy, most sports drinks contain approximately 6-9% CHO. However, in more recent years 'flavoured-water' drinks, with reduced energy (1-3% CHO) content, have become available on the market. Anecdotal information from competitive runners and triathletes suggests these beverages, or simply water, are preferred during exercise relative to traditional sports drinks. Purpose: The aim of this study was to examine perception of the sensory properties of different formulations of sports drinks when consumed before, at various points during, and following exercise in recreational runners. Methods: Following familiarisation, 14 recreational runners underwent four trials in a single blind counterbalanced design. Each trial utilised one of four different solutions: 7.5% carbohydrate, 421 mg/L electrolyte (HiC-HiE); 7.5% carbohydrate, 140 mg/L electrolyte (HiC-LoE); 1.3% carbohydrate, 421 mg/L electrolyte (LoC-HiE) and water. Subjects were provided with 50-ml samples to ingest and then rate (using a 100-mm line scale) the intensity of sweetness, saltiness, thirst-quenching ability and overall liking before (-30 min), during (0, 30 and 60 min) and following (90 and 120 min) treadmill running exercise. Exercise was performed at 70-80% of age-predicted maximum heart rate; subjects were seated for the pre- and post-exercise sampling periods. Results: Ratings of sweetness for all energy-containing drinks were higher during exercise relative to pre- and post-exercise conditions ( $P < 0.05$ ); ratings also increased with duration of exercise ( $P < 0.001$ ). Sweetness ratings for LoC-HiE increased during exercise ( $P < 0.05$ ) but remained the same for other beverages. Ratings of saltiness decreased for all energy-containing drinks during exercise relative to pre-exercise ( $P < 0.05$ ); ratings decreased with duration of exercise in these drinks ( $P < 0.05$ ). Ratings of thirst quenching ability ( $P = 0.106$ ) and overall liking ( $P = 0.077$ ) showed a trend to be higher during exercise than non-exercise conditions; thirst-quenching ability ( $P = 0.039$ ) and overall liking ( $P = 0.013$ ) increased with duration of exercise with all beverages. Conclusions: Significant changes in sensory perception occur when consuming various formulations of sports drinks during exercise relative to non-exercise conditions. Temporal changes also occur during exercise itself which leads to enhanced liking of all beverages. The low-carbohydrate solution showed the greatest changes in sensory perceptions between non-exercise and exercise conditions indicating that what is preferred at rest may not be true during exercise.

#### NUTRITIONAL STATUS OF MAGNESIUM IN RATS SUBMITTED TO MAGNESIUM DIETARY DEFICIENCY AND PHYSICAL ACTIVITY

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INTRODUCTION: Marginal dietary magnesium (Mg) deficiency is a common problem worldwide. The importance of Mg in physical activity is also recognized. However, there is little information about Mg deficiency in regular physical activity. OBJECTIVE: To evaluate serum, erythrocyte and tissue concentrations of magnesium in animals submitted to physical activity and dietary Mg deficiency. MATERIALS AND METHODS: Male Wistar rats (initial weight of 280 g) were divided into control (CON,  $n=9$ ), exercised control (CONEX,  $n=9$ ), sedentary Mg deficient (DEF,  $n=9$ ) and exercise Mg deficient (DEFEX,  $n=9$ ). The control diet contained 500 mg of Mg/Kg diet and the Mg deficient diet contained 200 mg of Mg/Kg diet. The animals were fed ad libitum during 6 weeks of experiment and swam 1 hour per day during 5 days every week. The removal of the tissues took place 24 hours after the last exercise session. Total Mg concentration in the serum, erythrocyte, gastrocnemius and soleus muscles, liver, brain and kidneys was determined by atomic absorption spectrophotometry. RESULTS: Mg concentration in the serum of animals in the DEFEX group was significantly lower ( $p < 0.05$ ) than in the EX group ( $2.3 \pm 0.4$  ug Mg /mL and  $3.1 \pm 0.07$  ug Mg /mL, respectively). In the erythrocyte, Mg concentration in the SED group presented values 30% higher than in the other groups ( $p < 0.05$ ). In the gastrocnemius muscle, Mg concentration was higher ( $p < 0.05$ ) in the EX group compared to the DEFEX group ( $120.9 \pm 48.0$  ug Mg /mg dry matter and  $63.3 \pm 14.5$  ug Mg /mg dry matter, respectively), whereas in the soleus muscle no significant differences between the EX and DEFEX groups were found ( $154.5 \pm 30.3$  ug Mg /mg dry matter and  $156.7 \pm 30.2$  ug Mg /mg dry matter, respectively). In the liver, no significant differences were found. Mg concentration in the kidneys of exercised animals was significantly higher ( $p < 0.05$ ) in comparison to SED and MARG groups. Concerning the brain, Mg concentration was higher ( $p < 0.05$ ) in the EX group compared to the DEFEX group ( $67.9 \pm 7.5$  ug Mg /mg dry matter and  $48.7 \pm 12.3$  ug Mg /mg dry matter, respectively). CONCLUSIONS: The dietary consumption of Mg below the recommended levels reduced the concentration of the mineral in serum, brain and tissues toughly demanded during physical activity like the gastrocnemius muscle. Mg concentration in the soleus muscle and in the kidneys was maintained in animals of the DEFEX group. ACKNOWLEDGEMENTS: CAPES for financial support

#### POST-EXERCISE WATER IMMERSION INCREASES SHORT TERM FOOD INTAKE IN ACTIVE MEN

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Introduction The performance of exercise while immersed in cold water has been shown to influence energy intake in the subsequent meal (White et al., 2005). In addition, cold water immersion has been shown to reduce the concentration of the hormone leptin, high concentrations of which signal satiety (Zeyl et al., 2004). Taken together, these findings raise the question of whether the common practice of post-exercise cold water immersion (CWI) by athletes acutely affects energy intake. Hence, this study investigated the acute effect of CWI following exercise on subsequent energy intake and macronutrient preferences, as well as the circulating levels of a range of appe-

title-related hormones. **Methods** Ten physically active men participated in three randomised, counterbalanced trials each consisting of 40 min of treadmill running (70% VO<sub>2</sub>peak), followed by 20 min of either cold water immersion (CWI: 15°C); neutral water immersion (NWI: 33°C) or a resting control with no immersion post-exercise (CON). Participants were then given 30 min access to a buffet-type breakfast of precisely known quantity and nutrient composition from which they could consume ad libitum. Blood samples were collected pre-exercise; post-exercise; post-immersion and post-breakfast to determine the response of leptin, insulin, active ghrelin, pancreatic polypeptide and peptide tyrosine tyrosine. **Results** Participants consumed significantly more energy in the post-exercise meal following both CWI (4893 ± 1554 kJ, *p* = 0.006) and NWI (5167 ± 1975 kJ, *p* = 0.010) compared to CON (4089 ± 1585 kJ). However, there was no significant difference in total energy intake between the CWI and NWI trials (*p* = 0.595). Absolute carbohydrate and protein intake were significantly higher following both CWI and NWI compared to CON (*p* < 0.05), with no difference between the two immersion protocols (*p* > 0.05). These changes were associated with a significant interaction effect of time and trial on the circulating concentrations of both leptin (*p* = 0.045) and active ghrelin (*p* = 0.046). **Discussion** Post-exercise water immersion is associated with higher energy intake in the subsequent meal compared to a resting control. This is an important consideration for athletes using water immersion as a method of recovery from exercise. **References** White LJ, Dressendorfer RH, Holland E, McCoy SC, Ferguson MA. Increased caloric intake soon after exercise in cold water. *Int J Sport Nutr Exerc Metab.* 2005;15(1):38-47. Zeyl A, Stocks JM, Taylor NA, Jenkins AB. Interactions between temperature and human leptin physiology in vivo and in vitro. *Eur J Appl Physiol.* 2004;92(4-5):571-8.

## HYDRATION STATUS AND FLUID INTAKE HABITS IN SKI TOURERS DURING A SKI TOUR

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**Introduction** Dehydration (i.e., a decrease in body fluid from euhydrated state) and hypohydration may result in a decrease in performance, decrease in overall health as well as death (1). It is well known that many athletes finish a race with a fluid deficit of more than 2% of their body weight because they do not drink enough to compensate the fluid loss (2). High-intensity exercise and hot conditions, and especially in winter sports such as ski touring, clothing and altitude may contribute to higher sweat rates (1). **Purpose** The purpose of this study was to determine the hydration status in ski tourers before and after a physically demanding (ascending and descending) ski tour. **Methods** 15 ski tour racers (14 males, 1 female, age 36.8 yrs ± 7.6 yrs, body mass 74.7 kg ± 13.7 kg) volunteered to participate in this study after providing written informed consent. Subjects completed a diet record the day before the testing session and on test day to control their fluid intake. They were instructed to follow their usual pre-race diet and to abstain from heavy exercise the 24h before the trial. Subjects provided a urine sample before and after the ski tour (distance 8.8 km, elevation gain 760 m) in order to determine urine specific gravity (Usg) and pH. Usg ≥ 1.020 was used as the cut-off point for dehydration. Additionally, body mass (on a digital scale in dry underwear or without clothes), total body water (TBW), lactate (La) and rate of perceived exertion (RPE) were evaluated before and after exercise. During the trial, ingestion of fluids was at will. However, the volume ingested was recorded to correct post-exercise body mass. **Results** 6 Subjects (40%) appeared to be inadequately hydrated pre-exercise. Results showed statistically significant differences in weight (*p* < .001, ES = .73), TBW (*p* < .05, ES = .25), La (*p* < .001, ES = .50), pH (*p* < .05, ES = .32) and RPE (*p* < .001, ES = .87). Mean values for Usg showed no statistical significance between pre- and post-trial values. **Conclusion** More than one third of ski tourers started exercise dehydrated and no subject consumed enough to match fluid losses, and only two consumed fluids during the trial. Given that races in ski touring are usually longer than the 8.8 km distance of this trial, these results highlight the need to provide more information about proper hydration pre-, as well as during exercise since performance will be affected even more by dehydration during longer races. 1. Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS. (2007). *Med Sci Sports Exerc*, 377-390. 2. Sharp RL. (2006). *J Am Coll Nutr*, 25: 231S-239S.

## ENERGY EXPENDITURE AND DIETARY INTAKE DURING HIGH- AND LOW VOLUME TRAINING PERIODS AMONG ENDURANCE ATHLETES

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**Energy Expenditure and Dietary Intake during High- and Low Volume Training Periods among Endurance Athletes** Drenowatz C. 1, Eisenmann JC. 1, Carlson JJ. 2 1 Human Energy Research Laboratory, Michigan State University (USA) 2 Radiology & Osteopathic Medicine, Michigan State University (USA) **Introduction** Energy balance and appropriate nutritional intake are established contributors to athletic performance. Previous research, however, has not evaluated differences in energy expenditure in response to different training regimens or only assessed exercise energy expenditure (EEE), rather than considering total daily energy expenditure (TDEE) when examining dietary intake. The purpose of this study was to examine dietary intake in endurance trained athletes during a week of high-volume (HV) and low-volume (LV) training while measuring EEE, resting metabolic rate (RMR) and non-exercise energy expenditure (NEAT) and to evaluate if endurance athletes meet current nutrition recommendations. **Methods** Energy expenditure and dietary intake was measured in 15 male endurance athletes (age 23.6 ± 2.4) during non-consecutive weeks of HV and LV training. Anthropometric measurements including %fat via BodPod were taken according to standard procedures at the beginning and end of each week. TDEE was calculated by summing RMR, measured via indirect calorimetry, NEAT, measured with the SenseWear Armband, and EEE, using heart rate telemetry. Dietary intake was assessed with an online food frequency questionnaire which was completed at the end of the HV and LV week. **Results** No change in body composition was observed during either week of training, which suggests that athletes maintained energy balance. While TDEE was significantly higher during the HV week (4824 ± 773 vs. 4080 ± 637 kcal/day) no differences in energy intake were observed (2662 ± 1299 vs. 2487 ± 1213 kcal/day). Macronutrient composition of the diet also remained unchanged with carbohydrates (CHO), fat, and protein contributing 51%, 33%, and 16%, respectively. With respect to recommendations for endurance athletes the reported CHO intake of 4.5 g/kg body weight was well below recommendations, while fat intake (1.3 g/kg) was above, and protein met recommendations. Key micronutrients met or exceeded recommendations with the exception of potassium. **Discussion** Dietary intake was not altered in response to changes in training volume or TDEE. The reported dietary intake was significantly lower than TDEE. This discrepancy was attributed to underreporting rather than an energy deficit. The high fat intake, low fiber consumption, and high sodium intake suggests that these athletes were generally consuming a typical Western diet. Nevertheless, micronutrient intake exceeded current recommendations supporting that endurance athletes are able to meet recommendations without the utilization of supplements. Overall, these endurance athletes may not pay sufficient attention to their dietary intake in order to optimize their performance.

**EFFECT OF SPICES ON GASTRIC MOTILITY AND APPETITE SENSATIONS**

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**EFFECT OF SPICES ON GASTRIC MOTILITY AND APPETITE SENSATIONS** Nagai, N.1, Wakisaka, S.1, Takagi, A.1, Yamaguchi, M.1, Moritani, T.2 1: Graduate School of Human Science and Environment, University of Hyogo (Hyogo, Japan) 2: Graduate School of Human and Environmental Studies, Kyoto University (Kyoto, Japan) **Introduction** The gastric electrical activity paces the contractions of the stomach and can be measured noninvasively using surface electrodes placed on the abdomen (Verhagen 1999, Parkman et al. 2003). Our previous studies (Wakisaka et al. 2009, 2011) have clearly demonstrated that gastric motility was transiently increased after water ingestion, while hot water (>150 ml, 65 °C) accelerated the pace of the normal range of gastric motility (normogastria). By means of our newly developed electrogastrography (EGG) recording and analysis methods, we investigated the response of the gastric motility and appetite sensations (feeling of hunger, fullness, desire to eat, and satiety) to spice (yellow curry powder)-containing soup or isoenergetic, flavorless placebo soup (43kcal, 150 ml, 65 °C) in 12 healthy female volunteers (19-23 yrs). **Methods** Each subject was tested on two separate days in a randomized order at 9 a.m. after overnight fast. The gastric motility, eardrum temperature, and heart rate were measured for 20 min in the fasting state and 40 min after consuming the soup in sitting-up position. Appetite sensations were measured 3 times (fasting, right after and 40 min after). To determine the gastric motility, we assessed the component of bradygastria (1-2 cpm), normogastria (2-4 cpm), tachygastria (4-9 cpm), and each power ratio (post/pre) of EGG frequency power spectrum. **Results** Each EGG power ratio tended to increase following spice-containing soup as compared with placebo soup (bradygastria,  $4.1 \pm 0.6$  vs.  $2.2 \pm 0.7$  times; normogastria,  $6.5 \pm 1.9$  vs.  $2.3 \pm 0.5$  times; tachygastria,  $7.6 \pm 2.7$  vs.  $2.5 \pm 0.8$  times, mean  $\pm$  S.E.). As to the appetite sensations, fullness ( $p < 0.05$ ) and satiety ( $p < 0.01$ ) scores significantly increased after spice-containing soup with different time courses ( $p < 0.001$ ). Delta-increase in eardrum temperature right after consuming the spice-containing soup was significantly greater than that of placebo soup ( $0.40 \pm 0.05$  vs.  $-0.05 \pm 0.17$  °C,  $p < 0.05$ ), while similar increase in heart rate ( $7.9 \pm 0.9$  vs.  $8.4 \pm 1.3$  bpm, NS) was observed after both soups. **Discussion** The present results suggest that the spices contained in curry powder enhances gastric motility and fullness and satiety feelings while increasing eardrum temperature when compared with placebo soup trial. **References** Verhagen MAMT, Van Schelven LJ, Samsom M, Smout AJPM. (1999) *Gastroenterology*, 117, 453-460 Parkman HP, Hasler WL, Barnett JL, Eaker EY. (2003) *Neurogastroenterol Motil*, 15, 89-102 Wakisaka S, Matsumoto T, Nagai H, Mura E, Moritani T, Nagai N. (2011) *J Jpn Soc Nutr Food Sci*, 64, 19-25 Wakisaka S, Kobashi R, Hishikawa M, Yamamoto Y, Ikeda M, Sakane N, Matsunaga T, Moritani T, Nagai N. (2009) *J Jpn Soc Nutr Food Sci*, 62, 297-304

**EFFECTS OF EATING BREAKFAST ON HEART RATE AND ORAL TEMPERATURE AFTER EATING LUNCH**

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**Introduction:** In the subjects who ate breakfast every day (breakfast group), the heart rate increased for duration of one hour after eating lunch. The heart rate of subjects who ate breakfast only two times or less during the week (skipping group), however, showed no significant difference between the rates before and after lunch. Eating is accompanied by increased blood flow to facilitate digestion. These results suggest that the increase of blood flow for the skipping group is low even after lunch. The purpose of this study was to determine the effects of eating breakfast on heart rate, cardiac parasympathetic reactivation and oral temperature after eating lunch in the skipping group. **Method:** There were two regimens. One was the regimen of skipping breakfast (C group) and the other was the regime of eating breakfast no later than 9:00AM (SB group). All subjects ate lunch between 11:45AM and 12:15PM. All subjects ate the same diets. Oral temperatures were measured before lunch and once every hour for four hours after lunch. Cardiac autonomic nervous system activity was calculated using Maximum Entropy Calculation Methodology (MemCalc) and evaluated by using high frequency (HF; 0.15-0.4Hz) in R-R intervals. Heart rate and HF were measured for five minutes before lunch and immediately, at 20min, at 40min, at one hour, at two hours, at three hours and at four hours after lunch. **Results:** The difference in oral temperature before and after lunch of the SB group was greater than that of the C group (ANOVA:  $p < 0.05$ ). In the C group, oral temperatures at one and three hours after lunch were lower than before lunch ( $p < 0.05$  before  $36.84 \pm 0.18$ °C, 1 hour  $36.71 \pm 0.18$ °C, 3 hours  $36.66 \pm 0.21$ °C) and the temperatures of half of the subjects fell at four hours after lunch. Heart rate of the SB group increased significantly for two hours after lunch ( $p < 0.05$ : before  $66.4 \pm 13.2$ bpm, immediately  $74.4 \pm 15.9$ bpm, 20min  $74.2 \pm 14.1$ bpm, 40min  $73.9 \pm 12.9$ bpm, 1 hour  $70.41 \pm 11.7$ bpm, 2hour  $70.4 \pm 11.7$ bpm), and the heart rate of C group showed no significant differences between measurements before and after eating. **Discussion:** Diet-induced thermogenesis (DIT) which increases core body temperature, is generated by eating. These study results suggest that the DIT of C group is low and therefore unable to induce a rise in oral temperature. These results suggest that eating breakfast prevented hypothermia in persons in the skipping group. When subjects ate breakfast only one day, blood flow increased. It is possible that increase of blood flow could be induced post-prandial hypotension. So it is necessary to study further the differences between results in a group regularly eating breakfast and a group eating breakfast only once.

**DOES HIGH CARDIORESPIRATORY FITNESS ASSOCIATED WITH HEALTHY DIETARY INTAKE IN EUROPEAN ADOLESCENTS: THE HELENA STUDY?**

CUENCA-GARCIA, M.1, ORTEGA, F.B.1,2, RUIZ, J.R.3, HUYBRECHTS, I.4, SJÖSTRÖM, M.2, GONZÁLEZ-CROSS, M.5, MORENO, L.A.6, DE HENAUW, S.4, KERSTING, M.7, CASTILLO, M.J.1, ET AL

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**Does high cardiorespiratory fitness associated with healthy dietary intake in European adolescents: The HELENA study?** Cuenca-Garcia, M.1, Ortega, F.B.1,2, Ruiz, J.R.3, Huybrechts, I.4, Diaz, L.E.5, Ciarapica, D.6, Molnar, D.7, Sjöström, M.2, Gotthard, F.8, Widhalm, K.9, González-Cross, M.10, Moreno, L.A.10, De Henauw, S.4, Kersting, M.12, Castillo, M.J.1 1:FM-UGR (Granada, Spain), 2:PREVNUT-KI (Huddinge, Sweden), 3:FCAFD-UGR (Granada, Spain), 4:UZ (Ghent, Belgium), 5:CTAN/CSIC (Madrid, Spain), 6:INRAN (Rome, Italy), 7:AOK (Pécs, Hungary), 8:FACHRU (Lille, France), 9:MEDUNIWIEN (Vienna, Austria), 10:PUM (Madrid, Spain), 11:UNIZA (Zaragoza, Spain), 12:FKE (Bonn, Germany) **Introduction:** Cardiorespiratory fitness (CRF) and diet have been related to healthier cardiovascular profile. Despite the importance of these two factors, little is known about the relationship between them. The aim of this study was to study the relationship between CRF and diet in European adolescents. We also examined whether having a high CRF is associated with compliance to the recommendations. **Methods:** The study comprised 1492 adolescents (770 female) from eight European cities participating in the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. Dietary intake was self-registered by the adolescents using a computer-based tool

24-h dietary recalls (HELENA-DIAT) on 2 non-consecutive days. CRF was assessed by the 20-meter shuttle run test. Weight and height were measured, and body mass index (BMI) was calculated. The adolescents were grouped by low and high CRF levels according to the FITNESSGRAM Standards. Multilevel analyses and logistic regression analyses adjusted by center, age and BMI were performed. Results: Higher CRF was related to higher total energy intake in boys ( $p=0.003$ ). No association was found between CRF and macronutrients, yet some positive associations were found with daily intake of bread/cereal in boys and milk products in both boys and girls (all  $p<0.003$ ), regardless of center, age, and BMI. CRF was inversely related to sweet beverage consumption in girls. These findings were overall consistent when CRF was analyzed according to the FITNESSGRAM categories (high/low CRF). CRF was not related to compliance of dietary guidelines/recommendations, except for sweet beverages which was lower in girls with high CRF. Discussion: Overall, the associations between CRF and diet was weak and non-consistent, yet participants with higher CRF showed higher intake of some healthy foods, i.e. more bread/cereal, milk products and less sweet beverage. Funding: The HELENA Study was carried out with the financial support of the European Community Sixth RTD Framework Programme (Contract FOOD-CT-2005-007034). The content of this article reflects only the authors' views, and the European Community is not liable for any use that may be made of the information contained therein.

## Poster presentations

### PP-PM67 Cardiovascular Health 2

#### BLOOD PRESSURE OF UNMEDICATED HYPERTENSIVE WORKERS AND PHYSICAL TRAINING

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UFRJ - UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

**Introduction** The employees' health is the concern of large corporations. A Brazilian company has been promoting a fitness program for six years oriented by the School of Physical Education at Universidade Federal do Rio de Janeiro, Brazil. As part of the risk factors control for non-transmissible chronic diseases, physical exercises are recommended for the prevention, treatment and control of blood pressure (BP). The aim of this study was to investigate the BP behavior after four months of training in unmedicated hypertensive subjects. **Methods** Fifty-seven sedentary subjects participated in the program (time  $\geq 1$  year), divided into a training group (TG) and a control group (CG). All were physically assessed and the TG had three sessions per week, totaling 48 sessions, each lasting 60 minutes. They performed a 25-minute aerobic training between 50 to 70% of heart rate reserve, a strength training in two series ranging from 8 to 12 repetitions, and a flexibility training applying the static stretching method. BP was measured by auscultation at pre- and post training and data were processed by two-way ANOVA using the Scheffé post hoc when needed ( $p < 0.05$ ) for intragroup and intergroup comparison. **Results** The intragroup outcome for the TG showed an 11.4% reduction in systolic BP (SBP) ( $P < 0.05$ ) and 5.3% in diastolic BP (DBP) ( $P > 0.05$ ). The CG showed no changes in BP ( $P > 0.05$ ). Comparing CG and GT, there was a significant difference in SBP in post-training situation, but this did not occur in other measurements. **Discussion** Studies confirm the hypotensive effect after aerobic work (Pescatello et al., 2004), but few have investigated the post-exercise strength hypotension. Martins et al. (2004) followed medicated hypertensives subjected to strength, aerobic and flexibility sessions and after eight weeks they found no significant differences regarding the resting values in both groups; however the BP in the TG showed a tendency to reduction. Despite the methodological differences between our experiment and Martins and co-workers', we found higher reductions in BP, probably because our sample was not medicated and training lasted 16 weeks. With measurements taken 48 hours after the last session aiming to decrease the acute hypotensive effect immediately after exertion, we found a clinically significant reduction in BP at rest. **References** Pescatello LS, Franklin BA, Fagar R, Farquhar WB, Kelley GA, Ray CA. ACSM Position Stand: Exercise and hypertension. Med Sci Sports Exer 2004; 36, 533-53. Martins ACS, Nogueira BRML, Couto FVP, Nicolau MSB, Pontes FL, Simão R, Polito MD. Comportamento da pressão arterial 12 horas após uma sessão de exercícios em hipertensos treinados. Rev Bras Fisiol Exerc 2004; 3,199-207.

#### TRAINING LOAD EFFECT IN HAEMATOLOGY IN ELITE CANOEISTS DURING A TRAINING SEASON

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**Introduction** The volume and intensity of exercise has significant acute effects on the relative concentration of erythrocytes, haematocrite and haemoglobin through changes in plasma volume, and also on the absolute concentration and function of some leukocyte subsets via cell movement circulation and lymphatic organs. The aim of this study was to monitor the response to training load on haematological markers in elite canoeists during a training season. **Methods** This study took place during the training season that culminated with the participation in the 2008 Olympic Games. The sample was composed by 11 canoeists athletes 22,0 $\pm$ 4,3 years old, 66,2 $\pm$ 4,4Kg and 164,5 $\pm$ 4,2cm. Initial VO<sub>2</sub>max was 64,9 $\pm$ 4,8 ml.Kg.min<sup>-1</sup>. Blood samples were collected by venopuncture. For the blood collection a time lapse of 48 hours of rest after the last training session was respected. The moments controlled were: the beginning of the season, after an off training period of 6 weeks (t1), the 11th week after the application of high weekly training volumes (t2), week 26 after a cycle of intense training (t3), the 31th week of the training season and the end of this tapering phase (t4). Leukocyte, monocyte, granulocytes, erythrocyte, platelet concentration (Plt), haematocrite, haemoglobin (Hb) and mean corpuscular haemoglobin (MCHC) were measured with a full blood count. **Results** After the increase in volume training (t2), a reduction in the number of leukocytes, lymphocytes and platelets was observed, while the number of granulocytes increased. Small increases in MCHC, hemoglobin, hematocrite were also observed. After the intense training period (t3) leukocytes continued to decrease, as well as lymphocytes. Unlike the observed in t2, the number of granulocytes was reduced below the baseline. Erythrocytes, platelets and MCHC increased. Before the competition period (t4), values returned to the initial ones. **Discussion** Cross-sectional studies that have compared leukocyte numbers and functions in blood samples taken from athletes more than 24 h after their last training session with those of sedentary individuals have generally report very few differences (Gleeson, 2007). Other have found that Ironman triathletes showed significantly lower Hb, MCHC and Plt than untrained men most of the year, and that there were significant differences month-to-month for both groups in these parameters (Broadbente, 2011). Our research verifies that the volume and intensity chronic training cause hematologic change. Reducing load and intensity similar values than the baseline one were founded again. **References** Broadbente S. (2011). Eur J Appl Physiol, 111,93-100. Gleeson M. (2007). J Appl Physiol, 103,693-699.

## EXAMINATION OF NON-INVASIVE MEASURING METHOD OF DOG HEART RATE USING HUMAN HEART RATE MONITOR.

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**Introduction** The Human Animal Bond (HAB) is a mutually beneficial and dynamic relationship between people and animals that is influenced by behaviors. Each influences the psychological and physiological state of the other. The positive association between pet ownership and various physiological and psychological health outcomes was reported (Dembicki D et al., 1996; DeMello LR, 1996; Oka et al., 2009). Dog is the most popular pet. There were invasive and non-invasive method in the measurement of dog heart rate. In HAB studies, invasive method couldn't use for pet. And common non-invasive method could not use for various size dogs. The objective of this study was to measure non-invasively heart rate from various size dogs. **Methods** Dog heart rate was measured using the sport heart rate monitor (Polar) designed for use in human. This monitor was consisted of an electrode belt with built-in transmitter and remote monitoring receiver. Various size dogs (small, medium, big) were measured. Dog heart rate was measured during 35 min. This 35 min consisted of 5 sections and the 5 sections were as follows: walking time (5 min), relax time (5 min), playing time with a toy (5 min), relax time (5 min), in house (15 min). Measurements were made on the 1 min setting. Attachment of the electrode belt was performed at least 30 min before recording. The receiver contained in a wristband was strapped to the dog lead. **Results** In each size dog, heart rate could be measured. The important points to measure dog heart rate using human heart rate monitor were five. 1 Before the electrode attachment, skin site was exposed using the comb. 2 The gel for the ultrasonography was spread between the electrode and the skin. 3 There was no space between the electrode and skin. 4 The electrode was attached on the left dorsal. 5 The electrode and transmitter was secured by a self-adherent wrap (Coban, 3M) or an elasticated band (Stockinet plus, 3M). **Discussion** In dogs, thick hair disturbed contact of the skin and the electrode. And movement of the chest with respiration made space between the electrode and the skin. This method resolved these problems. Without shaving the hair, heart rate of various size dogs could be measured non-invasively by this method. In HAB studies, this method would be useful. **References** Dembicki D, Anderson J (1996) J Nutr Elder, 15, 15-31 DeMello LR (1999) Psychol Health, 14, 859-868 Oka K, Shibata A (2009) J Phys Act Health, 6, 412-418

## TRENDS OF ELEVATED SYSTOLIC BLOOD PRESSURE LEVELS IN A SAMPLE OF YOUTH. RELATIONSHIP WITH CARDIO-RESPIRATORY FITNESS, BODY MASS INDEX AND PHYSICAL ACTIVITY

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**Objective:** To analyse the association of being assigned to a high blood pressure (HBP) group with changes in body mass index (BMI), physical activity index (PAI) and cardiorespiratory fitness (CRF) for one year in a sample of youth. **Methods:** Longitudinal study with 221 youth aged 8-17 (85 boys and 136 girls). Blood pressure (BP) was assessed in fasting state using an automated oscilometric sphygmomanometer. Students were invited to measure anthropometric variables, sexual maturation and perform 20m Shuttle and Run Test (Fitnessgram Battery Test). PAI was assessed using a standard questionnaire. Changes over time were calculated:  $\Delta = T1 - T0$ . Subjects were classified in a high level of BP if their values were above percentile 75, adjusted by gender and age. **Results:** For one year, approximately 6.5% of the subjects moved from normal to HBP group, while 4.3% moved from HBP group to normal. The risk of being assigned for the group of HBP for one year was associated with being male (OR: 4.33; 95% CI: 1.74; 10.79) and overweight/obese at baseline (OR: 8.16; 95% CI: 3.40; 19.58). High levels of CRF at baseline were inversely associated with risk of HBP values (OR: 0.31; 95%CI: 0.11; 0.88) when BMI was included on the model. The differences of BMI, CRF and PAI between time 1 and time 0 did not show significant association with the risk of being in HBP group. **Conclusions:** Our results suggest that number of children which moved from normal to HBP group was higher than the number of subjects that left the HBP group. Overweight/obese seems to be the main risk associated with early development of HBP values in children and adolescents

## CARDIORESPIRATORY FITNESS AND FATNESS ARE ASSOCIATED WITH POSITIVE HEALTH IN CHILDREN AND ADOLESCENTS

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**Introduction** Positive health is likely a buffer against physical and mental illness. Positive health may explain some of the health benefits associated with increasing cardiorespiratory fitness and decreasing fatness in youth. We examined the association of cardiorespiratory fitness and fatness with positive health indicators in 684 (365 boys and 319 girls) Spanish children aged 6 to 17.9 years. **Methods** Positive health indicators were self-reported using items of the Health Behavior in School-aged Children questionnaire. The study health indicators were: perceived health status, life satisfaction, quality of family relationships, quality of peer relationships and academic performance. Weight and height were measured and body mass index was computed. We also measured triceps and calf skinfolds thickness and body fat percentage was estimated. Cardiorespiratory fitness was measured by the 20m shuttle-run test. **Results** Cardiorespiratory fitness was positively associated with life satisfaction in children and adolescents. Fatness was inversely associated with perceived health status in children and adolescents, whereas fatness was inversely associated with life satisfaction, quality of family relationships and academic performance only in children. **Conclusion** These findings suggest a link between cardiorespiratory fitness and fatness and positive health indicators, suggesting that improving both fitness and fatness could exert a favorable effect on positive health during childhood and adolescence.

## CARDIORESPIRATORY FITNESS, FATNESS, HEALTH COMPLAINTS AND HEALTH RISK BEHAVIORS IN YOUTH

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**Introduction** Less is known whether cardiorespiratory fitness is associated with health complaints and health risk factors in youth. Likewise, studies examining the association of fatness with health complaints and health risk factors in youth are scarce and the results

contradictory. Therefore, the aim of the present study was to examine the association of cardiorespiratory fitness and fatness with health complaints and health risk behaviors in 691 (323 girls) Spanish children aged 6-17.9. Methods Health complaints and health risk behaviors were self-reported using items of the Health Behavior in School-aged Children questionnaire. Weight and height were measured and body mass index was computed. Body fat percentage was estimated from triceps and calf skinfolds thickness. Cardiorespiratory fitness was measured by the 20m shuttle-run test, and youth categorized as fit/unfit. Results Unfit children and adolescents were more likely to report health complaints sometime (OR: 2.556, 95% CI: 1.299-5.031; and OR: 1.997, 95% CI: 1.162-3.433, respectively) than their fit counterparts. Likewise, overweight-obese children and adolescents and those with high fat levels were more likely to report health complaints (OR: 1.732, 95% CI: 1.019-2.945; and OR: 1.983, 95% CI: 1.083-3.629, respectively). The analysis of the combined influence of fitness and fatness revealed that fit youth had lower health complaints index than the fat-unfit and unfat-unfit groups (all  $P < 0.05$ ). Conclusions Low fitness and overweight-obesity increased the risk of having health complaints in youth, yet high levels of cardiorespiratory fitness might overcome deleterious effects of overweight-obesity on health complaints.

## HEART RATE VARIABILITY AS A COMPREHENSIVE ASSESSMENT TOOL IN A PHYSICAL ACTIVITY PROGRAM FOR SCHIZOPHRENIA

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**Introduction** An Autonomic Nervous System (ANS) dysfunction mediated by sympathetic hyper-arousal and vagal withdrawal has been described in Schizophrenia (SCZ) independent of medication effects (Henry et al., 2010). Physical Activity (PA) has been proposed as a non-pharmacological strategy to improve the ANS functioning through a better coordination on the sympathetic afferent autonomic controls and the improvement in vagal responses (Negrao et al., 2008). Therefore, our purpose is to analyze some main HRV indices in order to consider them as previous control variables to classify participants in Experimental (E) or Control (C) Group within a three months Leisure-Time PA Program (PAP) held in Dr. Esquerdo Mental Health Centre. **Methods** 35 patients (16 male; 19 female; age:  $44.86 \pm 10.33$ ; years ill:  $23.29 \pm 8.87$ ; Smoking: Non-9, medium-5, heavy-20) were randomly distributed between Experimental (E=14) and Control (C=21) group. HRV data (Polar Electro RS800) were registered after shower, 10 min lying with no breathing control, before breakfast. Best central 5 min were retained for treatment (Kubios 2.0) and Statistical analysis (SPSS 15.0). After K-S test, (ln) was considered for skewed data. Results Mancova considering Gender, Group and Tobacco as co-factors; and RRI, Age and Years ill as Co-variables, showed no significant differences when comparing Gender or Groups for the linear indices. Meanwhile, the non-linear indices, now without the covariable RRI, revealed a strong and significant gender influence in SampEn, and a trend in  $\alpha 1$  (male vs. female; SDNN:  $21.76 \pm 4.34$ ,  $22.77 \pm 3.26$ ; pNN50:  $3.57 \pm 3.52$ ,  $5.83 \pm 2.640$ ; lnRMSSD:  $2.60 \pm 0.23$ ,  $2.80 \pm 0.17$ ; lnHF:  $3.81 \pm 0.45$ ,  $4.63 \pm 0.34$ ; lnLF/HF:  $1.18 \pm 0.42$ ,  $0.46 \pm 0.31$ ; SampEn:  $1.03 \pm 0.13$ ,  $1.55 \pm 0.97$ ;  $p < 0.05$ ;  $\alpha 1$ :  $1.41 \pm 0.13$ ,  $1.10 \pm 0.95$ ;  $p = 0.067$ .) **Discussion** Our results matched to the already described autonomic impairment with markers of very high cardiovascular risk. Also, they point to a better capacity of non-linear approaches to detect subtle changes, as much as gender influence. The absence of significant Group differences may allow to analyze the changes in HRV along the Leisure-time PAP. There is still great lack of information about the awaited benefits of PAP for SCZ and about training variables like doses, frequency, etc. The multimodal origin of the above mentioned ANS dysfunction and the direct relation between cardiac functioning improvement and Exercise, suggests the feasibility of HRV as a comprehensive and complementary tool in PAP. **References** Henry BL, Minassian A, Paulus MP, Geyer MA & Perry W. (2010). J Psychiatr Res, 44(3), 168-176. Negrao CE & Middlekauff HR. (2008). Heart Fail Rev, 13(1), 51-60.

## CORRELATIONS BETWEEN STRENGTH AND HEART RATE VARIABILITY AFTER 16 WEEKS OF CONCURRENT TRAINING IN MIDDLE-AGED MEN

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**Introduction** Heart rate variability (HRV) is a risk marker for cardiovascular disease (Heffernan et al., 2007) and has been recently used for measurement of physical training improvement of the cardiovascular system. High fitness level can minimize physiological changes in vagal modulation related to aging process, regardless of gender (De Meersman, Stein 2007). Concurrent training (CT) has shown the same benefits as isolated training, although to a lesser magnitude (Leveritt et al., 1999). This research has the goal of verifying the effects of CT on correlations between strength and HRV. **Methods** Ten healthy and non-physically active men were analyzed ( $48 \pm 4.1$  years). The CT proposed consists of 16-training weeks (3 d.wk-1), 3 sets of 10 maximal repetitions (RM) with 60 sec of rest between sets, 6 exercises, followed 30 min jogging at 55-85%  $VO_{2peak}$ . Maximal upper-body (UBS) and lower-body strengths (LBS) were measured by 1-RM test, involving two exercises that were part of the training routine (bench press and leg press). The RR intervals were recorded for 20 min at rest in supine position using the Polar® S810, the data was analyzed using FFT algorithm by Polar Precision Performance and were calculated the variables pNN50, RMSSD, High Frequency (HF) Hz, Low Frequency (LF) Hz were calculated. Results Maximal UBS ( $69.5 \pm 8.4$  to  $85.9 \pm 9.6$  kg) and LBS ( $196.2 \pm 29.5$  to  $315.2 \pm 62.6$  kg) improved ( $p < 0.05$ ) after the training program. There were no changes at the HRV markers analyzed. The significant correlation coefficients between UBS, LBS and HRV were:  $r = 0.58$  ( $p = 0.04$ ) UBS vs. LF (Hz), and  $r = 0.70$  ( $p = 0.01$ ) LBS vs. LF (Hz), both after training. **Discussion** Before training no correlations were found between UBS, LBS and HRV variables suggesting a preserved heart rate autonomic control in this population. After 16wk of CT, strength levels increased without any modification in the autonomic markers. Moreover, the correlation after training between UBS and LBS with LF could indicate negative influence of the strength improvement above the autonomic control. Perhaps some peripheral changes can have changed some central control structure that is reflected in the heart. **References** Leveritt, M; et al. (1999) Sports med, 28, (6), 413-427. Heffernan, KS; et al. (2007) Am J Physiol Heart Circ Physiol, 293, 3180-3186. De Meersman, RE; Stein, PK. (2007) Biol Psych, 74, 165-173.

## EFFECTS OF CARDIORESPIRATORY FITNESS OVER CARDIOVASCULAR RISK FACTORS CONTROLLING FOR OBJECTIVELY MEASURED PHYSICAL ACTIVITY IN YOUTHS

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**INTRODUCTION:** This study aimed to verify the effects of cardiorespiratory fitness levels over a set of cardiovascular risk factors, controlling for sex and physical activity (PA) of moderate (MPA), vigorous (VPA) and very vigorous (VVPA) intensities in children and adolescents. **METHODS:** Students aged 10-19 years (51 boys and 90 girls) completed measurements to participate in the study. Measured cardiovascu-



lar risk factors were: waist circumference (WC), body mass index (BMI), total cholesterol (TC), high-density cholesterol (HDL), low-density cholesterol (LDL), triglycerides (TRI), fasting glucose (GLU), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP). A metabolic syndrome risk score (MRS) was computed from the standardized z-score of WC, HDL, TRI, GLU and MAP. The 20-meter shuttle run test (SR) was used to assess CRF. FITNESSGRAM reference standards for SR laps were considered to classify participants in low-fit and fit. PA was measured by accelerometers (7164 MTI, Actigraph) during 7 consecutive days. PA was expressed as the time (min/day) expended in MPA (2000-2999 counts/min), VPA (3000-4499 counts/min) and VVPA (>4500 counts/min). A Multivariate Analysis of Covariance (MANCOVA) was used assuming CRF levels as the independent factor. Cardiovascular risk factors and MRS were assumed as dependent variables. Sex, MPA, VPA and VVPA were included in the model as covariates. Analyses were carried out in SPSS 19.0 with a significance level set at 0.05. RESULTS: A preliminary analysis indicated that there were no significant interactions between factors and covariates. For the definitive model, the strength of the relationship between CRF levels and the set of cardiovascular risk factors was strong (multivariate  $\eta^2 > 0.25$ ). Forty four percent of the variance in cardiovascular risk factors is accounted for differences in CRF levels, holding constant sex and PA. Sex differences explained 18,6% of the variance in dependent variables, controlling for the differences in CRF and PA. Only VPA showed a significant effect ( $p < 0.05$ ) over the set of cardiovascular risk factors, explaining 17,9% of their variance, when CRF, sex and PA were controlled. CONCLUSIONS: Results indicate that CRF levels have a significant effect over a set of cardiovascular risk factors, independent of sex and PA. Furthermore, VPA also has a significant effect over cardiovascular risk factors, independent of sex and CRF levels. This study was supported by FCT (Projects: PTDC-DES-7242-2006 and PTDC/DES/099018/2008; PhD grant: SFRH/BD/45090/2008).

## AEROBIC AND RESISTANCE TRAINING IN CHRONIC HEART FAILURE AND TYPE 2 DIABETES

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Introduction Aerobic and strength training specifically improve, respectively, central and peripheral limiting factors of skeletal muscle performance, also in the elderly healthy population. Type 2 Diabetes patients (DM2) suffer peripheral and metabolic limitations to skeletal muscle performance, while Chronic Heart Failure (CHF) patients are mainly limited by cardiovascular factors. Therefore, the aim of the present research was to compare and characterize the effects of the two types of exercise on DM2 and CHF. Methods 26 DM2 male patients ( $57 \pm 7.2$  yrs,  $HbA1c$   $7.3 \pm 0.7\%$ ) and 20 CHF male patients (NYHA Class II-III, ICD implanted: age  $67 \pm 5.0$  yrs, EF 28.9%) were randomized to aerobic or resistance training. Supervised exercise sessions were performed 3 times weekly following the Recommendations for exercise prescriptions in DM2 (ACSM and ADA, 2010) and in CHF (ACSM and NYHA). The following variables were assessed before and after 4 month treatments: BMI, body composition (by Total Body DEXA); peak oxygen uptake ( $VO_{2peak}$ ); muscle 1RM indirect tests (Brzycki method, chest press and leg press). Results At baseline, DM2 and CHF respectively showed the following values: BMI  $29 \pm 4.4$  and  $26 \pm 3.6$   $kg \cdot m^{-2}$  ( $p = 0.008$ ), FAT  $24 \pm 7.7$  and  $20 \pm 5.4$   $kg$  ( $p = 0.05$ ),  $VO_{2peak} \cdot kg^{-1}$   $27 \pm 4.0$  and  $18 \pm 2.6$   $ml \cdot kg^{-1} \cdot min^{-1}$  ( $p < 0.05$ ), 1RM at chest press  $48 \pm 9.8$  and  $34 \pm 6.6$   $kg$  ( $p < 0.0001$ ), at leg press  $257 \pm 55$  and  $203 \pm 32$   $kg$  ( $p < 0.001$ ). The anthropometric values did not change after any training in both groups. After aerobic training,  $VO_{2peak} \cdot kg^{-1}$  equally increased by 19% both in DM2 and CHF ( $P < 0.001$ ), while after resistance training it increased by 17% in CHF only ( $P = 0.001$ ). After resistance training, 1RM increased by 23% in DM2 and by 52% in CHF with chest press; by 17% in DM2 and by 44% in CHF with leg press. In addition, after aerobic training, a statistically significant increase by 12% and 22% at chest press and at leg press, respectively, was found in CHF. Discussion Both treatments achieved health related benefits in CHF and DM2 populations. Despite the different effects of the underlying pathology, the percent increase in  $VO_{2peak}$  elicited by aerobic training was identical in the two groups, suggesting the ability of the human body to specifically enhance damaged mechanisms as a result of a systematic physiological stimulation. The efficacy of resistance training in enhancing  $VO_{2peak}$  in CHF must be related to the impaired state of skeletal muscles caused by a long lasting condition of circulatory insufficiency. Also the larger effects of resistance training on muscle performance (1RM) in CHF points to more serious muscle deterioration in CHF, as it is known that the gain in muscle force is indirectly related to the starting condition.

## CARDIOVASCULAR RISK REDUCTION IN OLDER ADULTS BY PHYSICAL EXERCISE

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Introduction Deterioration of the cardiovascular system and the metabolic profile tends to accompany aging. Although the effects of aerobic versus resistance training on cardiovascular risk factors have been compared, there is a need to further investigate the effects of the aerobic-based exercise versus strength-based exercise on body weight (BW), body mass index (BMI), waist circumference (WC), lipids, blood pressure, and walking distance in older women and men. In the current study we hypothesized that moderate intensity, progressive aerobic-based and strength-based training would improve metabolic health of older women and men. Methods Sixty three sedentary women and men (65-95 years old) volunteered to the study. Participants were randomized into two training groups and one control group. Venous blood samples were collected into EDTA containing tubes, after 12 hours fasting. Differences between evaluations were analyzed with an ANOVA for repeated measures. Bonferroni's tests were used for multiple comparisons. Statistical significance was accepted at the  $p < 0.05$  level. Results The exercising group attained after treatment significant differences on BW, WC, BMI, DBP, TG, TC, HDL-C, LDL-C, TC/HDL-C relationship, and 6-minute walk distance. The control group only had significant differences on WC. At baseline, BMI correlated with TC ( $r = 0.35$ ), and TG ( $r = 0.38$ ); WC correlated with TC ( $r = 0.30$ ), TG ( $r = 0.35$ ), and TC/HDL-C ( $r = 0.38$ ); BW also correlated with TC ( $r = 0.33$ ), TG ( $r = 0.27$ ), and TC/HDL-C ( $r = 0.33$ ). Discussion Our finding that TC, LDL-C, TG, and TC/HDL-C diminish with exercise is consistent with previous research [1] even some have failed to attain gains after strength training in women [2] and in men [3]. A dose-response relationship between serum lipid levels (TC, TG, HDL-C, and TC/HDL-C) and levels of physical activity have been pointed to explain this absence of gains [4]. Independent of the mechanism underlying lipid changes, a reduction of 1% on TC has been shown to reduce the risk for coronary artery disease by 2% [5], which implies that our exercising participants have reduced about 12% their risk. A 1% reduction in LDL-C reduces the risk of major coronary events by approximately 2% [6], which means that we have about a 26% gain. Moreover, a decrease of 1% on HDL-C has been associated with a 2-3% increase in the risk for CHD [7], and assuming that the reverse is true, the 5% increase observed in our both programs should decrease CHD by 10-15%. References 2. Elliott KJ et al. Br J Sports Med 2002;36:340-345. 1. Kelley GA, Kelley KS. J Mens Health Gend 2006;3:61-70. 3. Sillanpaa E et al. Scand J Med Sci Sports 2009; 19: 885-895 4. Thune I et al. Arch Intern Med 1998;158:1633-40. 5. Consensus Development Panel. J Am Med Assoc 1985;253(14):2080-6 6. Pedersen TR et al. Circulation 1998;97(15): 1453-60. 7. Gordon DJ et al. Circulation 1989;79:8-15

## COMPARISON OF SYSTEMIC ARTERIAL STIFFNESS OF MEN AND WOMEN IN A JUNIOR HIGH SCHOOL STUDENT

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1) KUMW, 2) SHUJITSU UNIV., 3) KAGAWA UNIV., 4) GRADUATE SCHOOL, KUMW, 5) KIBI INTERNATIONAL UNIV., 6) RITSUMEIKAN UNIV., 7) TAU, 8) NATIONAL INSTITUTE OF HEALTH AND NUTRITION

**INTRODUCTION;** The purpose of the present study was to investigate the changes in the systemic arterial stiffness of men and women while junior high school student. **METHODS;** Four hundred eighty-seven subjects voluntarily participated in this study (age: 13.4±1.0 years, height: 159.0±8.8 cm, weight: 51.9±7.1 kg, % body fat: 20.5±7.7%). They were divided into the light body weight, standard body weight and over body weight of groups using the Ministry of Education, Culture, Sports, Science and Technology-Japan method. In addition, according to the guideline for children of the Japanese Society of Hypertension, all subjects were assigned into the normal group and high level of normal group of blood pressure. We have informed consent for subjects according to the Declaration of Helsinki. The systemic arterial stiffness was measured by the pulse wave velocity between brachial and ankle arteries (baPWV). **RESULTS;** The baPWV was 955±135 cm/s in the light body weight of group, 965±133 cm/s in the standard weight of group and 989±136 cm/s in the over body weight of group. The differences between over body weight of group and others were statistically significant ( $p<0.05$ ). The baPWV was 943±127 cm/s in the normal group of blood pressure and 1059±137 cm/s in the high level of normal group of blood pressure. The difference between normal group and high level of normal group was statistically significant ( $p<0.05$ ). The baPWV was 956±133 cm/s in the normal group of blood pressure and body weight, 981±122 cm/s in the one risk factor group (over body weight of group or high level of normal group of blood pressure) and 1083±141 cm/s in the both risk factors group (over body weight of group and high level of normal group of blood pressure). The baPWV of the both risk factors group was significantly higher rather than the other two groups ( $p<0.05$ ). **DISCUSSION;** We suspect that the systemic arterial stiffness of obese children is higher than the non-obese children. This is because the baPWV is increased by adiposity. Therefore, the findings of the study indicate that risk factor such as over body weight increases baPWV while the growth period; those would imply an important suggestion that the baPWV is affected by the growth period's lifestyle. (The Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Scientific Research (C) 21500548) **REFERENCE;** Matsmoto, N. et al (2010). J Train Sci Exer Sport, 247-256

## Poster presentations

### PP-BN12 Biomechanics: Kinematics

#### KINEMATICS OF THE SWING PHASE DURING RACE WALKING

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**Introduction** Race walking is an abnormal gait with rules which state that no visible loss of contact should occur and that the knee should be straightened from initial contact until the vertical upright position. While these rules may predominantly affect the leg's motion during the stance phase, it is possible that they also have an effect during swing. The swing phase is governed by a number of variables, including joint angles and inertial properties of the segments (Mena et al., 1981). The aim of this study was to measure swing characteristics of the leg during race walking. **Methods** Ten international male race walkers (stature: 1.83 m ( $\pm$  0.07); mass: 69.0 kg ( $\pm$  9.3)) walked on a treadmill (Gaitway, Traunstein) at 12.72 km/hr ( $\pm$  .69). The treadmill incorporated two in-dwelling force plates (Kistler, Winterthur) providing values for step length and cadence. The sampling rate was 1000 Hz and data were recorded for 30 s after 2,500 m of walking. Simultaneous video data were recorded using a high-speed camera (RedLake, Tucson). The video data were digitised at 125 Hz (SIMI, Munich) and filtered using a Butterworth 2nd order low-pass filter of 10 Hz. De Leva's (1996) body segment parameter model was applied. Moment of inertia (MOI) was calculated using the parallel axis theorem. Pearson's  $r$  was used to find associations with a confidence level of 5%. **Results** The mean step length for the walkers was 1.14 m ( $\pm$  .05) and cadence 3.06 Hz ( $\pm$  .12). The swing time of 0.36 s ( $\pm$  .01) represented 56% ( $\pm$  1.3) of total step time. At toe-off, the mean knee angle was 152° ( $\pm$  8); the knee then flexed to a minimum of 100° ( $\pm$  6) with extension to 181° ( $\pm$  3) at heel-strike. The minimum MOI for the whole leg was 0.067 kg•m ( $\pm$  .007), which combined the values for the thigh (0.014 kg•m  $\pm$  .001), shank (0.023 kg•m  $\pm$  .003) and foot (0.030 kg•m  $\pm$  .004). Minimum knee angle was correlated positively with minimum whole leg MOI ( $p = .010$ ), minimum shank MOI ( $p = .028$ ) and minimum foot MOI ( $p = .008$ ). No correlations between either minimum knee angle or MOI values with speed or swing time were found. **Discussion** The athletes in this study had a mean minimum knee angle of 100°; this is much greater than for distance running (Williams et al, 1991) and resulted from the need to straighten the knee to 181° by heel-strike. The correlations between minimum knee angle and the moments of inertia show that the negative effect of this technique is a greater inertial resistance to swing. However, the lack of association with speed suggests this may not be a critical factor in success and maintaining a technique that eases knee extension at heel-strike is more important. **References** De Leva P. (1996). J Biomech, 29(9), 1223-1230. Mena D, Masour JM, Simon SR. (1981). J Biomech, 14(12), 823-832. Williams KR, Snow R, Agruss C. (1991). Int J Sp Biomech, 7(2), 138-162.

#### KINEMATICS OF RUNNING AT DIFFERENT SLOPES AND SPEEDS

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**Introduction** The biomechanical characteristics of human locomotion, i.e. walking and running at different speeds and slopes, were plenty documented in the literature in conjunction with the mechanical efficiency of the gait (Minetti et al. 2002). No study have been carried out, at least in our knowledge, in which basic kinematical variables were measured when the running speeds vary, as it may happens during a marathon race at increasing slopes. Therefore the aim of this study was to investigate how step length, step frequency, contact and fly time are influenced when running with different constant speeds, performed at 2% and 7% slope inclination. **Methods** Eight elite marathon runners RE and eight amateur marathon runners RA, performed various tests on treadmill at 0%, 2%, 7% slope inclination, at constant speed: 14,15,16,17 and 18 km•h<sup>-1</sup>. High-speed digital cameras 210 Hz were used to record; Dartfish 5.5Pro was used to perform a 2D video analysis. **Result** Step length SL, step frequency SF, fly time FT and contact time CT were measured and ana-

lyzed for comparison. ST, SF and FT increased, CT decreased as a function of the increased speed at any grades with the exception of FT that decreased at 2 and 7% grades. At the same speed ST, CT and FT decreased and SF increased as a function of the increasing grade. Data fitted to the linear regression line ( $R^2 > 0.95$ ). The two groups were significantly different ( $p < 0.05$ ) in FT at every speed; in SL, SF at 15, 16, 17, 18 km•h<sup>-1</sup> in level running only. Significant differences between the two groups were found in FT at 2% and 7% grades in all speeds ( $p < 0.05$ ). Discussion Alterations in percentage for all variables were greater in group RA. It can be concluded that not only the running speed but also the gradient influence the selection of optimum step length and frequency with which efficient running can be maintained. The elite runners can acutely adapt to the altered circumstances more efficiently than amateur runners who have less experience. References Minetti AE, Moia C, Roi GS, Susta D, Ferretti G. Energy cost of walking and running at extreme uphill and downhill slopes. (2002). *J Appl Physiol*, 93(3), 1039-1046.

## SLOPES AND SPEED RELATED EFFECTS ON KINEMATIC AND EMG PATTERNS IN ELITE RACE WALKING

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Introduction In human locomotion every external condition generates a strategy. The aim of this study is to analyze the kinematics parameters and to identify the changes in movement pattern and muscle activity of race-walkers (RW). Methods Twelve elite RW have race walking on a treadmill for 5 minutes each slope (0, 2 and 7%) in iso-efficiency speed (IES1) with heart rate and sEMG on leg muscles constantly monitored. Digital cameras (210 Hz) were used to record; Dartfish 5.5Pro was used to perform a 2D video analysis, while for statistical analysis was used Anova. (I) The IES (km/h) for each subject at 0% grade was the average speed during the best performance in the 10000 m race, minus 1 km/h, which corresponds to the ~50% Vo2MAX and requires an energy cost (Cw0) of 5.0 J/m/kg according to previous studies (Di Prampero 1986). Moreover, according to previous data (Minetti et al. 2002) the increase of Cw as a function of ground slope is:  $0.15 \cdot \text{slope} (\%) + Cw0$ . We calculated for each ground slope the IES at which the Vo2 was equal to the oxygen consumption during level race walking using the following equation:  $Vo2 = (Cw0/21(J/m)) \cdot (IES0/0.06 (m/min))$   $IES = (Vo2 \cdot 21 \cdot 0.06)/(0.15(Cw) \cdot \text{slope} (\%) + (Cw0))$  Results IES, step length (SL) and frequency (SF) decrease as a function of the increasing slope: IES0 12.5 – IES2 11.8 – IES7 10.3; SL= (0-2%= -3.71%, n.s.; 0-7%= -12.23%,  $p < 0.001$ ); SF= (0-2%= -2.38%, n.s.; 0-7%= -6.07%,  $p < 0.01$ ). The contact time (CT) and heart rate (HR) increase at the increasing slope: CT= (0-2%= 2.46%, n.s.; 0-7%= 6.56%,  $p < 0.01$ ); HR= (0-2%= 0.62%, n.s.; 0-7%= 3.25%,  $p < 0.05$ ). The sEMG activity was reduced at the increasing slope in: tibialis anterior (0-2%= 22.49%,  $p < 0.0001$ ; 0-7%= 41.18%,  $p < 0.0001$ ); rectus femoris (0-2%= 15.35%,  $p < 0.0001$ ; 0-7%= 29.13%,  $p < 0.0001$ ). While the sEMG activity was increased in this muscles: vastus lateralis (0-2%= 22.95%,  $p < 0.0001$ ; 0-7%= 31.15%,  $p < 0.0001$ ); gastrocnemius medialis (0-2%= 21.40%,  $p < 0.001$ ; 0-7%= 48.37%,  $p < 0.0001$ ); biceps femoris (0-2%= 190.78%,  $p < 0.0001$ ; 0-7%= 201.37%,  $p < 0.0001$ ). Discussion These results provide the resultant of the real mechanical work in different slopes without increasing energetic cost, validating the equation to calculate the speed in RW only at IES between zero and 2% gradient. While for higher gradient levels the procedure used in this study seems to overestimate the speed, probably due to the different biomechanics between walking (Minetti et al., 2002) and race walking. References Di Prampero PE. The energy cost of human locomotion on land and in water. (1986). *Int J Sports Med*, 7 (2), 55-72. Minetti AE, Moia C, Roi GS, Susta D, Ferretti G. Energy cost of walking and running at extreme uphill and downhill slopes. (2002). *J Appl Physiol*, 93(3), 1039-1046.

## KINEMATICS OF THE SWING PHASE IN DISTANCE RUNNING

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Introduction The motion of the swing leg is a key component in distance running. More acute knee angles are associated with more economical runners (e.g. Williams and Cavanagh, 1987). This may be due to a decrease in the moment of inertia (MOI) of the leg, although it is unclear if other variables are affected by this decrease in MOI. The aim of this study was to measure swing characteristics of the leg during distance running. Methods Ten competitive male distance runners (stature: 1.80 m ( $\pm 0.07$ ); mass: 66.6 kg ( $\pm 5.4$ )) ran on a treadmill (Gaitway, Traunstein) at 17.56 km/hr ( $\pm .57$ ). Running pace was calculated by 10 km race time  $\times 1.03$ . The treadmill incorporated two in-dwelling force plates (Kistler, Winterthur) providing values for step length and cadence. The sampling rate was 1000 Hz and data were recorded for 30 s after 1,500 m of running. Simultaneous video data were recorded using a high-speed camera (RedLake, Tucson). The video data were digitised at 125 Hz (SIMI, Munich) and filtered using a Butterworth 2nd order low-pass filter of 10 Hz. De Leva's (1996) body segment parameter model was applied. Moment of inertia was calculated using the parallel axis theorem. Pearson's r was used to find associations with a confidence level of 5%. Results The mean step length for the runners was 1.62 m ( $\pm .12$ ) and cadence 3.04 Hz ( $\pm .18$ ). The swing time of 0.45 s ( $\pm .03$ ) represented 69% ( $\pm 1.2$ ) of total step time and was correlated positively with step length ( $p = .026$ ) and negatively with cadence ( $p = .001$ ). At toe-off, the mean knee angle was  $161^\circ$  ( $\pm 5$ ), which flexed to a minimum of  $56^\circ$  ( $\pm 6$ ) with extension to  $158^\circ$  ( $\pm 5$ ) at heel-strike. The minimum MOI for the whole leg was  $0.048 \text{ kg}\cdot\text{m}^2$  ( $\pm .008$ ), which combined the values for the thigh ( $0.016 \text{ kg}\cdot\text{m}^2 \pm .002$ ), shank ( $0.015 \text{ kg}\cdot\text{m}^2 \pm .003$ ) and foot ( $0.017 \text{ kg}\cdot\text{m}^2 \pm .003$ ). Minimum knee angle was correlated positively with minimum whole leg MOI ( $p = .011$ ), minimum shank MOI ( $p = .024$ ) and minimum foot MOI ( $p = .001$ ). Running speed was correlated with the minimum whole leg MOI ( $p = .040$ ), but no other correlations were found. Discussion A more acute knee angle led to a decrease in the MOI of the leg during distance running. The reduction in whole leg MOI was in turn correlated with speed and is thus an indicator of faster runners. The acute knee angles were achieved by knee flexion of  $105^\circ$  from toe-off and then extension by  $100^\circ$  to heel-strike. Maintaining this range of motion during a distance race requires both strength endurance and flexibility. Therefore, distance runners are advised to improve the strength of the hamstring muscles as well as increasing the mobility of the knee joint in order to make knee flexion easier during swing and increase running speed. References De Leva P. (1996). *J Biomech*, 29(9), 1223-1230. Williams KR, Cavanagh PR. (1987). *J Appl Physiol*, 63(3), 1236-1245.

## METHODS OF QUANTIFYING LOWER EXTREMITY KINEMATICS DURING RUNNING

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Introduction Both cardan and helical angles are popular methods of calculating angular kinematics. Cardan angles are sequence dependent and can influence the angular calculations. The International Society of Biomechanics recommends an XYZ sequence of rotations. However, the dominance of sagittal plane motion during gait can result in planar cross talk, causing greater than expected coronal/transverse plane profiles (Thewlis et al 2008). As such the XYZ sequence may not be the most suitable method. Helical angles

define a position and orientation vector, and motion from a reference position is expressed in terms of rotation along a single projected axis (Woltring et al 1985). This study investigates the influence of the helical method and 6 cardan sequences on lower extremity joint kinematics in the sagittal, coronal and transverse planes. Methods Eleven participants took part in this investigation. Kinematic data was obtained at 350Hz via an eight camera motion analysis system as participants ran at 4.0ms; angles were created using the helical method and the XYZ, ZXY, XZY, YXZ, YZX and YXZ sequences. Differences in peak angles and range's of motion were examined using repeated measures ANOVA's. Results Hip Main effects were found. Post-hoc analyses found that peak angles using the ZXY sequence in the coronal (ZXY=15.67 XYZ=9.08) and transverse planes (ZXY=13.60 XYZ=-21.38) were significantly greater than the others. Knee Main effects were found. Post-hoc analyses revealed that peak values using the YXZ sequence were significantly greater for the coronal (YXZ=-33.10 XYZ=-3.09) and transverse planes (YXZ=31.14 XYZ=10.79) than the others. Ankle Main effects were found. Post-hoc analyses revealed that ROM in the coronal (YXZ=26.41 XYZ=5.72) and transverse planes (YXZ=28.48 XYZ=4.42) and peak values using the YXZ sequence in the coronal (YXZ=67.65 XYZ=-9.46) and transverse (YXZ=-71.06 XYZ=-2.66) planes were significantly greater than the others. Discussion The results show that when investigating running in the sagittal plane the method used has no significant affect on angular kinematics. However, this was not the case when examining angular kinematics in the coronal and transverse planes. The results of this study with respect to lower extremity joint kinematics found that the ZXY and YXZ sequences produced anatomically unrealistic angular values and as such their use is discouraged. It appears that the ISB recommended XYZ sequence is sufficiently robust for the 3-D representation of lower extremity joint kinematics during running thus its use is encouraged. References Thewlis D, Richards J, Hobbs SJ (2008). Appropriateness of methods to calculate joint kinematics. *J Biomech.* 41 S320. Woltring H (1991). Representation and calculation of 3-D joint movement *Human Mov Sci*, 10, 603-16.

### 3-D KINEMATIC COMPARISON OF OVERGROUND AND TREADMILL RUNNING

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Introduction A number of studies investigating the mechanics of human movement have been conducted using the treadmill. The treadmill is an attractive device for the analysis of human gait, whereby velocity and gradient can be maintained and repeated (Schache et al 2001). However, to what extent the treadmill is able to mimic the kinematics of overground motion remains a controversial topic within the literature (Alton et al 1998). The aim of this study was to compare the 3-D angular kinematics of the lower extremities during overground and treadmill locomotion in order to determine the extent to which the two modalities are similar. Methods Twelve participants (Age 22.5 + 5.2 years, Height 171.2 + 5.5 cm and mass 75.4 + 8.4 kg) ran at 4.0ms in both treadmill and overground conditions. Lower extremity 3-D angular kinematic parameters during the stance phase were obtained at 500Hz using an eight camera motion analysis system. Kinematics from the hip, knee and ankle joints in the sagittal, coronal and transverse planes were collected and compared using paired samples t-tests with significance set at  $p < 0.05$ . Results Hip Significant differences in range of motion (Overground=47.61+10.42, Treadmill=31.63+10.46) and angle at heel strike (Overground=47.10+13.45 Treadmill= 35.11+12.65) were observed in the sagittal plane. Furthermore significant differences in range of motion (Overground=8.40+5.38 Treadmill= 0.41+13.51) were observed between the two conditions in the transverse plane. Knee Significant differences between the two conditions were observed in the sagittal plane for the magnitude of peak flexion (Overground=39.48+5.20 Treadmill=34.46+5.69). Ankle Significant differences between the two conditions were observed in the sagittal plane for the magnitude of motion from heelstrike to peak dorsi-flexion (Overground=18.32+7.40 Treadmill=13.94+7.24). Furthermore significant differences were also found in the coronal plane at heelstrike, toe-off and for the magnitude of peak eversion (Overground=18.32+7.40 Treadmill=13.94+7.24). Discussion Differences between the two conditions, suggest that the mechanics of treadmill locomotion cannot be generalized to overground locomotion. Thus leading to the conclusion that the treadmill should be utilized with caution within clinical and research settings in terms of its ability to mimic the kinematics of overground running. References Alton F, Baldey L, Caplan S, and Morrissey MC (1998) A kinematic comparison of overground and treadmill walking. *Clinical Biomechanics*, 13, 434-440. Schache AG, Blanch PD, Rath DA, Wrigley TV, Starr R and Bennell KL (2001). A comparison of overground and treadmill running for measuring the three-dimensional kinematics of the lumbo-pelvic-hip complex. *Clinical Biomechanics* 16, 667-680.

### YOUNG AND ELDERLY JOINT STIFFNESS IN DIFFERENT GAIT CONDITIONS

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Introduction Falls are a very common event in elderly population, principally during the gait. Findings in the literature shows that gait is an activity which requires high levels of attention to estimate, plan and execute its regulation. Thus, cognitive tasks performed with motor tasks could modify the elderly postural control and improve the risk of falls in this population. The present study had the goal to evaluate the influence of a cognitive daily task on muscular stiffness of elderly and young women during the gait. Methods Participated of this study 17 young and 18 elderly, physically fit women. The volunteers walked on a treadmill in two different conditions: normal gait and dual task gait. Electromyography signal were recorded on the muscles rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF), tibialis anterior (TA), gastrocnemius lateralis (GL) and soleo (SO). For the EMG signal analysis it was used 10 initial gait cycles for each conditions. Then the co-contraction between RF and BF, VM and BF, VL and BF, TA and GL and TA and SO were calculated by common area method (Winter, 2005). For the statistic data analysis it was used the one sample test t for the comparison between different gait condition in a same group and test t for independent samples to compare both gait conditions between the groups. Results For the cocontraction percent between RF and BF, VM and BF, VL and BF were not found significant difference in all comparisons. The cocontraction percent between TA and GL and between TA and SO were significant higher for elderly people than young volunteers in normal and dual task conditions. Discussion/ Conclusion The improve of stiffness is cited in the literature as an inefficient muscular pattern during the movement, due the high activation of agonist and antagonist muscles (Candotti et al., 2009). In line of this, high cocontraction percent also should be a mechanical disadvantage in elderly people, because it contributes for fatigue instalation consequently improve the risk of falls (Hortobágyi e De Vita, 2000). Thus, we conclude that challenge cognitive situations during gait could alterate the neuromuscular behaviour and improve the risk of falls. References Winter DA. New Jersey: John Wiley & Sons, Inc., Hoboken; 2005. Candotti CT, Loss JF, Bagatini D, Soares DP, Rocha EK, Oliveira AR, Guimarães ACS. *Journal of Electromyography and Kinesiology*. 2009; 19: 915-921. Hortobágyi T, De Vita P. *Journal of Electromyography and Kinesiology*. 2000; 10: 117-126.

## SOLEUS ACTIVITY IN POST-STROKE SUBJECTS MOVEMENT SEQUENCE FROM STANDING TO SITTING

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The beginning of the sequence of movement, from standing to sitting, requires the modulation of the plantar flexors activity, including soleus muscle, to allow the tibia's movement on the foot, preserving its antigravity function (Silva et al., 2011). Analyze whether in the 4 sample subjects of the study by Silva et al. (2011), the soleus muscle in the contra-lateral limb to the committed hemisphere maintains the trend towards higher in the electromyographic (EMG) activity when compared to the ipsilateral limb. It is also intended to verify the behavior of these muscles in terms of electromyographic activation time (in percentage) in the analyzed movement. The same sample of individuals, mean age 54.2 ( $\pm 7.9$ ) years, with hemiparesis following stroke was recruited. The EMG data was recorded using the Biopac MP 150 and the correspondent analysis was performed off-line with the Acqknowledge 3.9.0. To identify movement sequence phases a force platform connected to a Bertec AM6300 amplifier was used. The electrodes placement followed the recommendations of SENIAM. The study phase was recognized using the force platform at which anterior displacement of the center of pressure was distinguished, corresponding to the beginning of the sitting. On the other hand the beginning of the posterior shift of the center of pressure matched the final phase of the studied sequence. The soleus temporal activity as well as its magnitude was recorded during the time set. The duration of the activity was subsequently normalized to the duration of the analyzed phase and converted into a percentage. The muscle's aEMG was quantified using the indicator root mean square (RMS) after curve's rectification and signal smoothing. Comparing the EMG activity of the two soleus muscle, there was a trend in three subjects to a higher register in the more affected limb when compared to the less affected, although the lowest proportion activation time of the movement sequence studied was found in this leg. Silva A, Santos R, Sousa F. (2011). Livro de actas do 4º Congresso Nacional de Biomecânica. Coimbra, Portugal. SENIAM (1999) European recommendations for surface electromyography. In H. Hermens, R. Merletti, D. Stegeman, J. Blok, G. Rau, C. Disselhorst-Klug & D. Hägg (Eds.).

## COMPARATIVE ANALYSIS OF SHOT PUT BETWEEN SPIN AND GLIDE TECHNIQUE IN THE RELEASE ACTION

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**Introduction** In recent years it has been increase in number of athletes who use the spin technique in shot put. The shot put technique involves extremely complex movements performed at high speed in the limited space. However, no study has focused on for same subject of using spin technique and glide technique related performance. Therefore the purpose of this study was established the modality of the shot put of two different technique especially release action. **Methods** The subjects were seven male Japanese right-handed elite shot put throwers who can use spin technique and glide technique (age: 22.7 $\pm$ 2.3yrs, height: 176.6 $\pm$ 6.8cm, body weight: 107.6 $\pm$ 15.1kg, spin throw: 14.1 $\pm$ 1.3m, glide throw: 13.4 $\pm$ 1.5m). All the subjects performed total six throws that three spin throws and three glide throws same as a competition rule with recorded best throw from both techniques. Throwing movements were measured by 3-D analysis (APAS) that was calculated release speed and body movement velocities (angular velocity in the right elbow: EV, right greater trochanter velocity: TV, right knee velocity: KV). Throwing movement was defined by the divided turn-phase and release-phase with two positions. **Results** The results of this study were as follows: EV of spin technique was significantly higher than glide technique ( $p < 0.05$ ). Shot put performance was significantly related in release speed (spin technique:  $r = 0.501$ , glide technique:  $r = 0.579$ ) and EV (spin technique:  $r = 0.845$ , glide technique:  $r = 0.709$ ). However, shot put performance was not significantly correlations between TV and KV. Also, release speed was closely related to EV (spin technique:  $r = 0.928$ , glide technique:  $r = 0.808$ ). On the other hand, TV and KV were unrelated to release speed of both techniques. **Discussion** In this study, centrifugal force of the spin technique is produced more extension and smoothly in right elbow than the glide technique. In addition, only EV is correlative between shot put performance and release speed. This means that the one of the big factors in relationship to release speed was elbow extension movement of the release arm. From these results, it was suggested that it is important factor to consideration for training method to improve more release speed and explosive power of elbow extension can be expectation of better shot put performance. **References** Luhtanen P, Blomqvist M, Vanttinen T. (1997) New studies in athletics 12 (4), 25-33 G. Trezis, G Georgiadis, E Vassiliadou, P Manta. (2003) Eur J Appl Physiol 90, 10-15

## ELECTROMYOGRAPHIC ANALYSIS OF TRUNK MUSCLES DURING THE DIFFERENT PHASES OF THE GOLF SWING

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**Objective:** The aim of this study is to describe and compare the activity of different trunk muscles during swing phases. **Methods:** Ten male golfers (handicap: 5-20) performed 5 swing shots with the pitching wedge and 5 swings with the 4-iron, in a random sequence. Surface EMG was recorded from trunk muscles of both sides: rectus abdominis (RA), external oblique (EO), internal oblique (IO), erector spinae (ES) and gluteus maximus (GM). EMG signals were normalized using the maximal voluntary contraction (MVC). The average EMG signal during each phase of the golf swing was determined. Four high speed video cameras (100 Hz) were used for delimitation of swing phases. Descriptive statistics were reported as mean  $\pm$  SD. Data were tested for normality with Shapiro-Wilk test. Repeated measures one-way ANOVA were used with swing phases as fixed factor, followed by Bonferroni post-hoc analysis if necessary. The significance level was set at 5%. **Results:** The comparison between different phases through ANOVA showed a significant effect of swing phases in muscle activation level. Bonferroni pairwise comparisons showed similar pattern for both clubs, in what refers to significant differences between swing phases. The RA muscle showed, in both sides and with both clubs, its maximum activation during the Forward Swing phase (24-39% MVC). The EO muscle showed peak activity during the Forward Swing (39-63% MVC) in both sides and with both clubs. The difference between Forward Swing and the other phases were higher in the right EO (55-63% MVC). The left IO showed higher activity in the Forward Swing phase (80-84% MVC). In the right IO the peak EMG activity was observed during the Acceleration phase (48-54% MVC). The right ES showed maximum level of EMG activity in the Forward Swing phase (38-40% MVC). The left ES presented the highest EMG activity during the Acceleration phase (35-39% MVC). The right GM muscle presented greater level of EMG activity in the Forward Swing phase (62-72% MVC). The higher EMG activity of left GM was observed during the Acceleration phase (52-67% MVC) with significant differences when compared with all the other phases in both clubs (range  $p = .001-.047$ ). **Conclusion:** All muscles reached their maximum level of activity during Forward Swing and Acceleration phases. The higher activation was found in the trunk rotators to the left. Strong activations were also found in the right gluteus maximum during the Forward Swing phase and in the left gluteus maximum during the Acceleration phase. This pattern is probably related with the hip extension and to the weight transfer from the trailing to the lead leg. During the Backswing and Follow-Through phases, all muscles were recruited with low to moderate activity.

## EMG RESPONSE DURING THE SLOW COMPONENT PHASE DEPENDS ON LOCAL MUSCLE ENVIRONMENT

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EMG RESPONSE DURING THE SLOW COMPONENT PHASE DEPENDS ON LOCAL MUSCLE ENVIRONMENT Kostas Patras<sup>1</sup>, Giorgos Ziogas<sup>1</sup>, Stavros Ristanis<sup>1</sup>, Elias Tsepis<sup>1,2</sup>, Anastasios D. Georgoulis<sup>1</sup> 1Orthopaedic Sports Medicine Center, School of Medicine, University of Ioannina, Greece 2Physical Therapy School, Technological Educational Institution of Patra at Aigion, Greece INTRODUCTION: The development of an "additional" slow component on the oxygen cost of heavy "submaximal" exercise may be attributable to enhanced motor unit recruitment resulting in increased EMG amplitude [1]. However, it has recently been demonstrated that task specificity may alter the EMG response during the slow component phase [2]. We hypothesized that chronic muscle perturbations that alter the expected response to fatiguing exercise [3] may also influence the EMG response. METHODS: Fourteen healthy male amateur soccer players and fourteen amateur soccer players having undergone unilateral anterior cruciate ligament reconstruction (18.5 months post-operatively) participated in the study. Athletes underwent a GXT test to volitional exhaustion and two 10-min bouts, one at a moderate (80%LT) and one at a heavy intensity (40%D). During the 10-min bouts, blood lactate was measured at baseline and at end-exercise. EMG data were recorded at the 3rd, 5th, 7th, and 10th minute from vastus lateralis bilaterally using a telemetric EMG system. Repeated measures ANOVA's were used to compare the time course of the EMG amplitude between legs and exercise intensities. RESULTS: VO<sub>2</sub> values increased until the 9th minute of the heavy bout for both groups (F=54.4, p<0.001). End-exercise blood lactate values for the heavy bout averaged 7.9 (1.6) and 7.6 (1.7) mM for the healthy and the reconstructed group respectively. EMG amplitude increased during the heavy bout for the intact but not the operated leg of the reconstructed group (F=4.82, p<0.01). Furthermore, EMG amplitude increased during the heavy bout for both the control leg of the healthy group and the intact leg of the reconstructed group (F=5.78, p<0.01). Finally, EMG amplitude increased during the heavy bout (F=5.76, p<0.01) for the control leg of the healthy group but not for the operated leg of the reconstructed group (F=3.34, p<0.05). DISCUSSION: The VO<sub>2</sub> slow component during heavy intensity exercise is associated with increased EMG amplitude of vastus lateralis. However, our results indicate that although the development of the slow component may at least be partly attributed to additional recruitment of motor units, the EMG response is susceptible to alterations due to chronic local muscle adaptations [4, 5]. REFERENCES 1. Jones AM and Poole DC (Eds). Oxygen uptake kinetics in sport, exercise and medicine 2. Jones et. al. Am J Physiol Regul Integr Comp Physiol, 2010 3. Enoka RM and Stuart DG. J Appl Physiol 72:1631-48, 1992 4. Patras et. al. J Sci Med Sport 13:573-7, 2010 5. Patras et al. Knee Surg Sports Traumatol Arthrosc 17:977-84, 2009

## ELECTROMYOGRAPHIC STUDY OF THE GLUTEUS MAXIMUS MUSCLE BY USING AN ERGOMETRIC TREADMILL BASED ON BRUCE AND NAUGHTON PROTOCOLS: A COMPARATIVE STUDY AMONG THE PROTOCOL STAGES

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Introduction Electromyography (EMG) is a technique to monitor the electrical activity of excitable membranes, and they are applied in striated skeletal muscles. It represents the extent of action potentials for sarcolemmal membrane of striated skeletal muscle cell. By using such technique, one can record an action potential, e.g. voltage event in the time. The basis of knowledge and of understanding for EMG is the drive motor (BANKOFF, 2007). Methods For this study, we used an Lynix® electromyograph (PS6040), containing six channels, acquired from the FAPESP support 1996/5708-4. To acquire the EMG recordings, we established the frequency of 1199.760 Hz. The instrument was calibrated with 2000 HZ gain, low-pass filter of 600 Hz and high-pass filter of 10Hz. Setting input signal limits was established in 3000 uV (upper limit), -3000 uV (upper limit), and input range from -5 V to +5 V. The test parameter was simple type, and the graphics mode was calibrated in x+y+z+w.t, allowing to demonstrate records simultaneously for each experiment. The recordings were made in the last 10 seconds for each protocol stage, noting that the Naughton protocol model II has eight stages. Results Table 01. Distribution of overall means in Root Means Square (RMS) and Standard Deviation (SD) for the GMM of 15 male subjects on an ergometric treadmill by using the Bruce's and Naughton's protocol. STAGES BRUCE PROTOCOL NAUGHTON PROTOCOL RMS SD RMS SD 1 72.95 62.24 58.32 47.96 2 102.35 75.77 62.51 47.71 3 135.68 121.92 109.47 81.12 4 203.86 189.47 124.0 100.0 5 240.20 226.06 135.74 115.06 6 272.0 261.0 169.46 165.75 7 335.0 332.0 195.02 185.61 8 - 232.24 201.25 Discussion Was evident that the action potentials were higher for the ergometric treadmill by using the Bruce protocol. We found that action potentials have already started when they were higher, from the first stage, when compared with the Naughton protocol. It is interesting to observe that the action potentials organised in ascending way, according to the stages. The biggest growing difference, however, is between stage 6 and stage 7, i.e. when the speed is roughly from 5.5 mph to 6.0 mph and the inclination from 20 % to 22 %. According to Bankoff and Boer (2007); Bertazzoli and Bankoff (2009). References Bankoff ADP. Morfologia e cinesiologia aplicada ao movimento humano. RJ: Guanabara Koogan, 2007. Bankoff ADP; Boer NP. Electromyographical study of the iliocostalis lumborum and gluteus maximus muscles during locomotion on a treadmill and in a ground. Electromyogr Clin Neurophysiol, 2007, 47, 285-291. Bertazzoli BF; Bankoff ADP. Electromyography study of skeletal muscle during locomotion in a treadmill test: a case study. Electromyogr Clin Neurophysiol, 2009, 49, 125-128. Financial Support - Fapesp n° 2010/08923-2

## HOW DO HUMANS ACCELERATE WHILE RUNNING?

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Introduction Steady-state running and maximal sprint accelerations (ACC) have been widely studied, yet unsteady running has only gained limited interest. We study ground reaction forces (GRF, as a first outcome of motor behavior) during submaximal running ACC. In contrast to steady-state running, when accelerating an imbalance in braking and propulsive impulses must be generated. Theoretically, three strategies can be followed to create this positive impulse: decreasing peak braking GRF, enlarging peak propulsive GRF, and a larger relative duration of the propulsive phase. High sprint ACC are obtained by adapting the running movement to all three strategies, avoiding braking impulses (Hunter et al., 2005). It is hypothesized that in a submaximal ACC range, running kinetics gradually change to this type as ACC rises (Kugler et al., 2010). Methods 740 stances of 6 subjects (3M, 3F, 70±11kg) running at varying ACC over a series of force platforms are studied using intrasubject linear regressions. The independent variable is the ACC during stance. Dependents are the negative braking and positive propulsive impulses normalized to body mass, the according negative and positive GRF amplitudes (% of body weight) and proportional duration of propulsion. Slopes (mean±sd) of linear regression, positive values confirming the hypotheses, average explained variance and significance of regression were calculated. Wilcoxon tests indicate significances between variables (<0.05=\*). Results Non-linearity between acc and subimpulses was observed, resulting in a zone of submaximal (0-1.3m/s<sup>2</sup>) and higher

ACC (1.3-3.9m/s<sup>2</sup>). For submaximal ACC mainly (\*) a less negative braking impulse (slope:0.13±0.02) than a more positive accelerating (0.09±0.01) impulse is found. Relative propulsion duration increases (0.13±0.04). Peak braking GRF become less negative (0.12±0.04) and peak propulsive GRF more positive (0.12±0.01). Higher ACC are mainly (\*) realized by an increased propulsive impulse (0.19±0.04), whereas the braking impulse approaches zero (0.03±0.02). Proportional propulsion duration increases (0.13±0.03), peak braking GRF become less negative (0.14±0.05) and peak propulsive GRF more positive (0.10±0.03). 44 of 60 regressions were significant (p<0.05) with a mean R<sup>2</sup> of 0.42±0.20. Over subjects and variables R<sup>2</sup> are low as no correction was yet made for the large speed range and also during submaximal ACC some clearly differing more sprint-like purely propulsive contacts are observed. Discussion For submaximal ACC all substrategies are used, mainly resulting in a decrease in braking and a lesser increase in propulsive impulse. They are also used during higher ACC, mainly resulting in an increased propulsive impulse and a sprint-like almost purely propulsive type of running. Funded by Research Foundation Flanders FWO08/ASP/152. References Hunter JP, Marshall RN, McNair DJ (2005). J Appl Biomech, 21, 31-43 Kugler F, Janshen L (2010). J Biomech, 43, 343-348

## Poster presentations

### PP-BN13 Biomechanics: Electrical Stimulation/EMG

#### THE COMPARISON SOME PARAMETERS ON ELECTROMYOGRAPHY DURING TREADMILL RUNNING IN RUNNERS AND NON-ATHLETICS

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The aim of this study was comparison some parameters on electromyography during treadmill running in runners and non-athletic subjects. This research contain of 17 healthy male runners, (age 23 / 44 ± 4/30 years, weight 70 / 33 ± 9/30 kg, height 172 / 77 ± 6/35 cm, body mass index(BMI) 23 / 50 ± 2/46 kg/ m<sup>2</sup>) and 8 non-athletes (age 23 / 5 ± 4 /10 years, weight 70 / 18 ± 6/95 kg, height 173 / 75 ± 4/68 cm, body mass index 23 / 22 ± 1/85 kg/ m<sup>2</sup>) completed running on a treadmill with speed 6 kilometers per hour for data entry electromyography from vastus medialis and Gastrocnemius (GCS) muscles. calculated electromyography index was including the percentage of muscle activity in a step cycle, ratio time to reach the peak the total time activity, speed increased activity from the beginning to reach peak and Speed reduce activity from peak until the end of the muscle activity. Data analysis using multivariate analysis of variance and t- test for independent groups level 0/05 ≥ p were performed. The preliminary assessment don't show any significant difference in morphology athlete and non-athlete groups (p>0/05). survey results don't show any significant difference between amount of activity, ratio time to reach the peak, the rate of increase and decrease the speed of muscle activity vastus medialis in athlete and non-athletel(p>0/05). Similarly, there is no difference between activity rate and increase muscle activity of Gastrocnemius in athlete and non-athletes. But the average time to reach peak muscle activity GCS in athlete group was significantly 0/081 higher than non-athlete group (p<0/05). Also reduce the speed of neural activity in the GCS muscle in athletes groups was significantly 2/65ml watt per second higher than non-athlete groups (p<0/05). Generally, this study showed that when there are no differences in morphology between athletes and non-athlete group, electromyography variables are not different in running with speed 6 km between athletes and non-athletes. But in athletes the ratio time to reach the peak the total time activity and reduced speed of neural activity in GCS muscle is more. Results of the research support to hypothesis of the effect of sports participation on neuromuscular function, but to be seems that in low work load Compatibility of electromyography be less observed.

#### EFFECTS OF DYNAMIC ELECTROMYOSTIMULATION OF THE UPPER BODY ON ISOMETRIC AND ISOINERTIAL STRENGTH PARAMETERS AND THROWING PERFORMANCE

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Introduction: Elite throwing performance of baseball or handball players should be characterized by both high velocity and accuracy. One possible approach for this is electromyostimulation (EMS). Training effects of EMS are mainly explained by a synchronous activation and a higher frequentation of motor units as well as a greater recruitment of fast muscle fibres. Although one study (Pichon et al. 1995) reveals an improvement of swimming sprint performance by static EMS, there are no data for effects of dynamic EMS training on the upper body. The aim of this study was to investigate the effects of EMS supported dynamic training forms on strength, power and throwing performance. Methods: 20 strength trained subjects (22.5 ± 2.0 yrs; 177.0 ± 6.2 cm; 71.3 ± 9.5 kg) were randomized in an EMS (EMS-G) and a bodyweight group (BW-G). The training period lasted 4 weeks (2x/week). Push ups, dips, crunches and one-handed throwing movements with a rubber band (Thera-Band) were the exercises for both groups (3 sets, 10 rep., 1 min rest). The temporal distribution of contraction modes for a single repetition was 2s con, 0.5s iso and 2s ecc. The difference between the 2 groups was given in the additional application of EMS by a surface electrode vest (miha bodytec) during the exercises (individually 70% intensity; impulse: frequency 85Hz, width 350µs, type bipolar/rectangle; duty cycle 6/4). The pre- and post-test were conducted before and after the training period. The strength diagnostics were carried out with a Lat- (LM) and a Twister-Machine (TM) as well as with a Bench- (BP) and an Abdominal-Press (AP) (gym80; 3 isometric and 3 isoinertial tests with 40% additional load). Throwing performance was tested by a medicine ball toss (MBT) (one-/two-handed, 500g/2kg) and by a throwing speed test (TST) (handball, 7m) measured by a radar device (Outerlimits Sports). Results: Sign. increases of maximal isometric force (Fmax) and isoinertial power (Pmax) were shown for the BW-G: Fmax improved at BP (6%), LM (8%) and TM (6-7%). Pmax increased at TM (11-12%), AP (8%) and BP (7%). No sign. results were given for the EMS-G and between the groups (p ≤ 0.05). The EMS-G showed a significantly higher throwing performance for the TST (4%) and the one-handed MBT (3-5%). There were no sign. results for the BW-G and between the groups (p ≤ 0.05). Conclusion: There are specific effects within groups indicating that bodyweight training improves strength and power of muscle groups. Dynamic EMS training supported the coordination of these by improving throwing performance. Most advantageous combinations of both training methods (bodyweight exercises with additional application of EMS) have to be tested in further investigations by using different training stimuli (e.g. additional load, individually current intensity, time under tension etc.). Pichon, F., Chatard, J. C., Martin, A., & Cometti, G. (1995). Electrical stimulation and swimming performance. Med Sci Sports Exerc, 27, 1671-1676.

## THE EFFECT OF SUSPENSION FORKS ON UPPER BODY MUSCLE ACTIVATION DURING A SIMULATED MOUNTAIN BIKE DROP-OFF.

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**Introduction** Mountain biking (MTB) requires racers to compete over varied terrain, including rocky paths, technical single-track and open forestry roads. Courses also include frequent obstacles such as jumps and vertical drops. Previous studies (Seifert et al., 1997; MacRae et al., 2000) have investigated the use of suspension systems on performance and energy expenditure during MTB. However, no studies have examined the influence of these systems on muscle activation. The purpose of this study was therefore to investigate the influence of suspension forks on muscle electromyographical (EMG) activity. **Methods** Ten male participants (age:  $26.6 \pm 6.74$ , mass:  $76.07 \pm 6.92$ , height:  $183.73 \pm 4.55$ ) took part in this investigation. Participants rode a mountain bike (Scott Scale 40), fitted with front suspension forks (Rock Shox Tora XC SL with 100mm travel), at  $2.5\text{ms}^{-1} \pm 10\%$  off a ramp with a 30cm vertical drop off. Three trials were performed by each participant with the fork in lock out mode and three in open mode. Surface EMG information was obtained at 1000Hz from the Anterior Deltoid, Pectoralis major, Triceps Branchii and Brachioradialis muscles. Following full wave rectification and filtering at 20Hz using a low pass filter, peak and mean amplitudes from 1000ms pre and post impact were obtained and compared using paired t-tests with significance at  $p < 0.05$ . **Results** Significantly lower  $p < 0.05$  peak activation magnitudes were observed for the Anterior Deltoid (open= $0.318\text{mV}$  and lock out= $0.403\text{mV}$ ) and the Pectoralis Major (open= $0.094\text{mV}$  and closed= $0.109\text{mV}$ ). Furthermore, significantly lower  $p < 0.05$  magnitudes for the mean activation were observed for the Tricep Branchii (open= $0.114\text{mV}$  and closed= $0.134\text{mV}$ ) and Brachioradialis (open= $0.089\text{mV}$  and closed= $0.111\text{mV}$ ). **Discussion** The findings indicate that suspension forks results in significantly lower upper body muscle activation. This suggests that suspension forks are effective in reducing the landing forces encountered when riding off drop offs. When repeated drops are performed, as is typical of MTB racing, the reduced muscle activation may lead to reductions in muscular stress and ultimately result in improved performance over a longer period of the race. **References** MacRae, H. S-H., Hise, K.J. and Allen, P.J. (2000) Effects of Front and Dual Suspension Mountain Bike Systems on Uphill Cycling Performance. *Med Sci Sports Exerc.* 32(7), 1276-1280. Seifert, J.G., Luetkemeier, M.J., Spencer, M.K., Miller, D. and Burke, E.R. (1997) The effects of mountain bike suspension systems on energy expenditure, physical exertion, and time trial performance during mountain bicycling. *Int J Sports Med*, 18(3), 197-200.

## TWO DIFFERENT METHODS FOR IDENTIFICATION OF THE ELECTROMYOGRAPHIC FATIGUE THRESHOLD IN FUTSAL PLAYERS

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**Introduction** Performance limitations, particularly those related to neuromuscular fatigue may be reflected by electromyographic fatigue threshold (EMGFT). However, different methods, exercises and procedures used in researches commits data applicability. In this context, the aim of this study was determine the EMGFT of rectus femoris (RF), vastus lateralis (VL), biceps femoris (BF) and gastrocnemius lateralis (GL) muscles obtained by two different methods. **Methods** Ten amateur futsal players performed 5 minutes warm up at  $5\text{ km.h}^{-1}$ , followed by an incremental protocol at  $8\text{ km.h}^{-1}$ , with increments of  $1\text{ km.h}^{-1}$  every 3 minute, until voluntary exhaustion. Surface electrodes were placed on the bellies of the RF, VL, BF and GL muscles from the right lower limb. For the determination of EMGFT it was considered the methodologies proposed by Devries et al., (1982) (EMGFT 1) and Candotti et al., (2008) (EMGFT 2). Two-way analysis of variance (ANOVA) was used ( $p < 0.05$ ). **Results** The mean values of the EMGFT from the RF, VL, BF and GL muscles were, respectively,  $11.17 \pm 1.03$ ,  $11.21 \pm 1.31$ ,  $10.85 \pm 0.85$ ,  $11.51 \pm 0.98$  for EMGFT 1 and  $11.13 \pm 2.10$ ,  $11.35 \pm 2.33$ ,  $12.87 \pm 1.83$ ,  $11.25 \pm 1.99$  for EMGFT 2. No differences between the EMGFT 1 and EMGFT 2 and between the muscles were found. The relative speeds of the EMGFT 1 from the RF, VL, BF, and GL muscles were respectively, 77.12%, 78.78%, 73.36% and 81.06% of the maximal speed achieved, while the relative speeds from the EMGFT 2 were 73.48%, 79.91%, 91.30% and 74.97%, also showing similar values. **Discussion** The results confirm the proposal that the neuromuscular fatigue threshold can be identified by the analysis of the EMG signal. The mean values of the EMGFT 1 and EMGFT 2 (RF, VL, BF and GL) relatives to the maximal intensity achieved on the test (77.12%-81.06%) were similar to the ones from preview studies (HUG et al., 2006; HANON et al., 1998), except for the BF in the EMGFT 2 (91.30%). The occurrence of EMGFT 1 and 2 were also similar with the lactate threshold (74.6%) and lower than anaerobic threshold (87.3%), except for the BF in the EMGFT 2 (91.30%) (FRAGA, SILVA, GONÇALVES, 2009). **References** Devries, H.A.; Moritani, T.; Nagata, A.; Magnussen, K. *Ergonomics*, London, (1982), 25(9), 783-791. HANON C, Thépaud-Mathieu C, Hausswirth C, Le Chevalier JM. *Eur J Appl Physiol Occup Physiol.* (1998), 78(4), 315-23. Candotti CT, Loss JF, Melo Mde O, La Torre M, Pasini M, Dutra LA, De Oliveira JL, De Oliveira LP. *Can J Physiol Pharmacol.* (2008), 86(5), 272-8. Hug F, Laplaud D, Lucia A, Grelot L. *Int J Sports Med.* (2006), 27(6), 456-62. Fraga, C.H.W.; Silva, S.R.D.; Gonçalves, M. Motriz, Rio Claro. (2009), 15, 911-918.

## THE EFFECTS OF INCREASED MUSCLE ACTIVATIONS ON SPRINT START KINEMATICS, A THEORETICAL APPROACH

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**The Effects of Increased Muscle Activations on Sprint Start Kinematics, a Theoretical Approach** Jessop, D. M.1 and Pain, M.T.G.2 1: Southampton Solent University (Southampton, UK), 2: Loughborough University (Loughborough, UK) **Introduction** The aim of this study was to analyse the influence of increased muscle activations on sprint start performance using a four segment torque driven computer simulation model. Increased muscle activation in the sprint start has been previously examined experimentally but the findings were relatively inconclusive (Gutiérrez-Dávila et al., 2006). It was considered that a theoretical approach would enable greater control over variables such as the initial position of the athlete. **Methods** One elite male subject performed a series of maximal effort sprint starts. Data were collected for three dimensional joint kinematics and muscle activations. The two dimensional computer model was created using Matlab 7 and Simulink and comprised of a head and trunk, thigh, shank and foot. Torque generators were inserted at the hip, knee and ankle, and horizontal and vertical non-linear spring dampers were used to represent ground contact. The kinematic data provided initial joint orientations, after which, the model was driven using the EMG data combined with joint torque/ angle/ angular velocity data. The model started on movement onset and stopped on take-off from the starting block. Model inputs were optimised, using DIRECT optimisation (Finkel, 2003), to give the maximum horizontal velocity of the centre of mass on takeoff (OPTVEL). Following this, the start was re-optimised but the initial joint activations were forced to be >14% above the previous initial levels (OPTACT). **Results** Data for OPTVEL were: contact time = 0.27 s, horizontal velocity =  $2.61\text{ ms}^{-1}$ , vertical velocity =  $0.64\text{ ms}^{-1}$ , horizontal acceleration =  $9.54\text{ ms}^{-2}$ . Data for OPTACT were: contact time = 0.18 s horizontal velocity =  $1.84\text{ ms}^{-1}$ , vertical velocity =  $1.29\text{ ms}^{-1}$ , horizontal acceleration =  $10.20\text{ ms}^{-2}$ . **Discussion** Despite



its simplicity, the torque driven model was successfully used to represent and investigate the sprint start. Increasing activations did not increase horizontal velocity but did reduce contact time and increase horizontal acceleration. It should be considered that the criterion used to define sprint start performance can influence the results found (Bezodis et al., 2010). To investigate further, more sophisticated computer simulation models are needed. These should include a greater number of body segments, and simulate the start further into the race. REFERENCES Bezodis, N., Salo, A. I. T. and Trewartha, G. (2010). Sports Biom. 9 (4), pp. 258 – 269. Finkel, D. E. (2003). DIRECT Optimisation Algorithm User Guide. Centre for Research in Scientific Computation: North Carolina State University. Gutiérrez-Davilla, M., Dapena, J. and Campos, J. (2006). J Appl Biom. 22, 195-201.

## MECHANICS OF DOUBLET FIRINGS IN SIMULATED MOTOR UNIT POOLS

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Motor unit double discharges, or doublet firings, have been described as two consecutive motor unit discharges that occur with short interspike intervals. By the use of electrical stimulation protocols, short interspike intervals inserted at the beginning of a stimulation train have been shown to increase both the peak force and the rate of rise of force production (Garland and Griffin, 1999). The aim of this article is to estimate possible mechanical effects of simulated motor unit doublets in selected motor unit pools (MUPs) during the initial isometric contractions. Five different MUPs with varying ranges were simulated considering important nonlinearities in the force response to pairs of stimuli according to Thomas et al. (1999). The results support the hypothesis that double discharges represent a functional entity: expected increases depend on the properties of the MUP as a whole. Relative timing of the doublet discharges occurs, but has only little effect.

## VARIABILITY IN VASTUS LATERALIS, RECTUS FEMORIS AND BICEPS FEMORIS MUSCLES ACTIVITY DURING ELECTRICAL AND MAGNETIC FEMORAL NERVE STIMULATION

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**Introduction** Magnetic nerve stimulation (MS) has a lower focality than electrical stimulation so coactivation of nearby nerves and muscles can result in a lesser ability to stimulate specific muscles. The aim of this pilot study was to determine the specificity with which MS activates quadriceps and hamstring muscles and whether this activation pattern affects torque magnitude. Since electromyography cannot be used to assess muscle activity during tetanic MS, near-infrared spectroscopy (NIRS) was used to estimate it. The change in total haemoglobin (tHb) during knee extension was examined in vastus lateralis (VL), biceps femoris (BF), and rectus femoris (RF) during (1) maximal voluntary contraction (MVC), (2) electrical supramaximal doublet twitch stimulation (TW) and (3) tetanic MS, at 40° and 80° knee angles. **Methods** Three men (27-31 y) participated. MS (2-s, 90% of max power at 25Hz) was applied through a 50-mm double coil. Electrical stimulation and MS were delivered to the femoral nerve. Changes in VL, BF and RF tHb were continuously monitored using NIRS and change in tHb was calculated as a difference from baseline to contraction. **Results** The relative MS torques were similar in subjects 1 and 2 (78% and 75% of MVC, respectively); TW was 32% and 20%, respectively. Subjects 1 and 2 showed identical changes in VL, BF and RF tHb during TW, MS and MVC, where the absolute decrease in VL tHb mirrored the increase in the torque magnitude. However, MS torque in subject 3 was low (25% of MVC); TW was 30.2% of MVC, VL tHb decreased less than RF at 40°, and BF and RF tHb decreased with the same pattern, but with lesser magnitude. At 80°, the change in tHb of VL, BF and RF was the same as at 40° during TW and MVC but there was an increase in VL tHb, no change in BF, and a substantial decrease in RF tHb during the MS. After normalizing tHb to torque, the pattern of change in tHb was consistent across all contractions, except that the decrease in VL tHb during TW was the largest in all subjects despite eliciting the smallest torque value; that decrease was larger at 40° ( $P = 0.04$ ). **Discussion** High torque generation during MS was associated with substantial decreases in VL (and to a lesser degree RF) tHb (i.e. blood flow), whereas the lower torque in subject 3 was associated with minimal decreases in VL but greater decreases in RF. Thus, low torques might result from preferential activation of RF, indicating that the placement precision of the coil on the nerve significantly impacts muscle activation and torque magnitude. The higher relative decrease in tHb during TW suggests a lesser efficiency of contractile force transmission when compared to MS or MVC. Examination of more subjects is clearly warranted.

## PERIPHERAL MUSCLE STIMULATION WITH PULSED MAGNETIC FIELDS: RELIABILITY OF ED NEUROMUSCULAR PARAMETERS

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[1] Institute of Sport Science [2] Institute of Physiology [3] Department Aging Science and Humanities **Introduction** Compared to electrical muscle stimulation (EMS), human skeletal muscles can be stimulated relatively painlessly by pulsed magnetic fields (magnetic nerve stimulation, MNS) even at high intensities and frequencies. The aim of the study was to examine the reliability of magnetically evoked twitch and tetanic muscle contractions. **Methods** 18 healthy men ( $26 \pm 4$  years) took part in the test-retest study. In a first experiment single twitch contractions (magnetic gradient: 159 A/μs; impulse width: 280 μs) were applied to the quadriceps femoris muscle (QF). After a short resting the QF was stimulated at 50 Hz for one second (magnetic gradient: 90 A/μs). To minimise the movement of the racetrack coil an extra load was applied to the QF, which could be kept constant at 13.9 kPa. The "peak torque" (PT), "rate of torque development" (RTD), "half relaxation time" (HRT) and "rate of torque relaxation" (RTR) were tested for reliability using the intraclass correlation coefficient (ICC) and the coefficient of variation (CV). **Results** All parameters of evoked single twitch contractions (PT: ICC = 0.97 (0.91 - 0.99), CV =  $2.5 \pm 2.4$  %; RTD: ICC = 0.88 (0.70 - 0.95), CV =  $7.2 \pm 4.3$  %; HRT: ICC = 0.89 (0.74 - 0.96), CV =  $4.1 \pm 3.4$  %; RTR: ICC = 0.81 (0.55 - 0.92), CV =  $6.7 \pm 5.8$  %) and tetanic contractions of 50 Hz (PT: ICC = 0.96 (0.90 - 0.99), CV =  $4.4 \pm 3.0$  %; RTD: ICC = 0.86 (0.68 - 0.95), CV =  $9.7 \pm 5.2$  %; HRT: ICC = 0.81 (0.57 - 0.93), CV =  $7.6 \pm 9.3$  %; RTR: ICC = 0.95 (0.86 - 0.98), CV =  $5.8 \pm 4.7$  %) showed high correlations (ICC) and less day-to-day variabilities (CV). **Discussion** Both the relative (ICC) and absolute reliability indices (CV) suggest a highly reliable method of twitch and tetanic muscle stimulation (50 Hz) with pulsed magnetic fields. Gerrits et al. (2001) reported a larger CV for PT (9 %) of a tetanic 50 Hz EMS. Additionally, they found CVs for HRT (7 %) and RTD (13 %), but only at a frequency of 100 Hz. Polkey et al. (1996) observed a CV for PT of 8.5 % for single twitch contractions while stimulating the femoral nerve magnetically. In a recent study Cannon et al. (2008) observed lower ICC values for PT (0.81), RTD (0.81), HRT (0.81) and RTR (0.82) for electrically evoked single twitch contractions via the femoral nerve. **References** Cannon J, Kay D, Tarpenning KM, Marino FE (2008). Scand J Med Sci Sports, 18, 5, 627-635. Gerrits HL, Hopman MT,

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## ANALYSIS OF ELECTROMYOGRAPHIC SIGNAL AND KINEMATIC PARAMETERS DURING INCREMENTAL RUNNING PROTOCOL

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**Introduction** Incremental Running protocols are often used to determine specific exercise intensities, which are widely used for the application of training protocols. In this context, the biomechanical evaluation is an important tool for understanding the factors related to performance in running. Therefore, the aim of this study was to analyze the effect of running with increasing speed on the electromyographic signal (EMG) amplitude of the iliocostalis lumborum (IC), rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), tibialis anterior (TA), biceps femoris (BF) and gastrocnemius lateralis (GL) muscles, stride length (SL) and stride frequency (SF), and the inter-stride variation coefficient (VC) of these parameters during treadmill running protocol. **Methods** Nine runners performed five minutes at run speed of 9 km.h<sup>-1</sup>, followed by incremental protocol with initial velocity of 10 km.h<sup>-1</sup> and an increment of 1 km.h<sup>-1</sup> every 3 minutes until exhaustion. The EMG signal (Root Mean Square - RMS) of each muscles, SL and SF was calculated from the average of the last ten stride cycles, at 60%, 80% and 100% maximum velocity (Vmax) reached during the incremental protocol. The VC inter-stride was used to analyze the variability these variables. After that, the one-way repeated measures ANOVA was used for comparison of values of SL, SF, RMS and VC between speeds examined. The significant level was set at  $p < 0.05$ . **Results** The SL, SF and RMS values of the RF and GL increased with the running speed increment, while for the muscles VL and VM was verified and increase only at the 60% in relation to 100% from the Vmax. The higher VC variability was occurred in SL and the EMG signal of the BF and TA during the sub-maximal intensities (80% e 60% Vmax) and higher variability was from SF and the EMG signals from the IC, BF, GL and TA during the maximal intensity (100% Vmax). **Discussion** The EMG signal, the SF and the SL increased concomitantly to the speed increment, indicating the exigency of the recruitment of new motor units which intensify their firing rate provide greater joint stability (CARDOZO and GONÇALVES). Besides, the SL presented contribution to the four times increase of speed in relation to the SF. These results suggests that the muscular activity increases in function of the running intensity in a distinct way to the lower limb muscles and could be associated to the greater variability of the neuromuscular responses and the adjusts promoted in the stride cycles as the speed increases (FRAGA, Da SILVA and GONÇALVES, 2009). **REFERENCES** Cardozo AC, Gonçalves M. (2003). Electromyography and Clinical Neurophysiology, 43(6), 377-380. Fraga CHW, Silva SRD, Gonçalves M. (2009). Motriz, 15(4), 911-918.

## DOES FATIGUE CHANGE MUSCULAR ACTIVATION STRATEGIES IN RECURVE ARCHERY?

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**DOES FATIGUE CHANGE MUSCULAR ACTIVATION STRATEGIES IN RECURVE ARCHERY?** Eroğlu K. 1.1, Ertan, H.2, Knicker, A.J.3, Soyulu, R. 4 1: Sakarya University, Sakarya/Turkey, 2: Anadolu University, Eskisehir/Turkey, 3: German Sports University, Cologne, 4: Hacettepe University, Ankara/Turkey. **Introduction** In an archery competition, the archer is sustained to shoot in difficult conditions as stress, wind, etc. The pulling weight is approximately 20 kg. of a bow, and the archer 144 times pull his bow in a competition. If stress or weather conditions block shooting, the archer can hold down the bow but must pull again in order to shoot his arrow in a given period. When considering of the pulling weight of the bow, to shoot arrow will be difficult for the archer. According to some studies elite archers develop a specific forearm and pull finger muscle activation strategy by active contraction of the forearm extensors with the fall of the clicker. Because of these conditions, the aim of this study was to analyse the effects of fatigue on drawing hand forearm muscular activity. **Methods** 6 Female (Age: 16,66±3,44; Training age: 5,88±2,92) and 10 male (Age: 22,33±12,95; Training age: 4,11±2,80) subject were involved in the study. Each subject participated in double test session and each archer shoot 12 arrows before and later fatigue protocol and drawing hand forearm flexors and forearm extensors EMG activities has been measured in each tests. In fatigue protocol, the subject has repeated sets of drawings (each set included 6 drawings without arrow and shooting). The subject was asked to rate her fatigue level by looking at the Borg Scale. The subject has repeated the drawing set 11 times. EMG recordings 1 s prior and 1 s after the fall of clicker has been analysed and their mf values has been calculated in Matlab. Differences between two test session was analysed in Wilcoxon statistical tests. **Results** According to the results of the study, there were not significant differences in forearm flexors and extensors in drawing arm between two test session ( $p > 0.05$ ). However, median frequencies of EMG values has shown significant differences of some of the drawing arm muscles before and after fatigue protocol according to 3 arrows ( $p < 0.05$ ). **Discussion** As a result, any differences was observed with the effect of fatigue in the archers forearm extensors and forearm flexors in drawing arm. P-value was 0,0676 in forearm flexor. It can be thought that with more subjects the results may be show significant differences especially in forearm extensors and also effects of the fatigue can be searched any other muscles in bow arm or drawing arm. **References** Ertan, H., Kentel, B., Tumer, S. T., & Korkusuz, F. (2003). Activation patterns in forearm muscles during archery shooting. Human Movement Science, 22, 37-45. Ertan, H., Soyulu, A. R., & Korkusuz, F. (2005). Quantification the relationship between FITA scores and EMG skill indexes in archery. J. of Electromyography and Kinesiology, 15, 222-227.

## RELATIONSHIP BETWEEN EMG ACTIVITY OF QUADRICEPS MUSCLE AND SKIN COLD STIMULATION OF THE DERMATOME AREA

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**Introduction** It is well known that facilitation and inhibition of spinal motoneurons takes place markedly with electrical stimulation of cutaneous nerves, with skin brushing, and with skin anesthesia. In a previous study, we found that skin cold stimulation (SCS) recruits fast motor units at low tension (Yona, 1997). This result was obtained with SCS applied directly above the working muscles. However, it is unclear whether EMG activity of quadriceps muscle results in the same changes in facilitation induced by SCS of the dermatome area at rest in lower limb muscles. The purpose of this study was to examine the change of EMG activity, during dynamic contraction, of the three superficial quadriceps muscles with SCS on vastus lateralis (VL) and L4 dermatome area on the medial side in lower limb. **Methods** Seventeen healthy male subjects (age 21-42) voluntarily participated in the present study. Unilateral dynamic knee extension was performed for

one sec at 15% MVC. Force was measured using a torque transducer. Subjects randomly performed 5 repetitions of the task under 4 conditions: (1) direct SCS of VL (SCS), (2) non-SCS of VL(non-SCS), (3) SCS of L4 dermatome(SCS-L4) in lower limb(Keegan and Garrett.,1948), (4) non-SCS of L4 dermatome. SCS condition was achieved by cooling the skin to 25°C using a gel cooling pad (Alcare Co. Ltd). Surface EMG from the muscle belly of the RF, VL and VM were recorded using miniature electrodes. The root mean square of the EMG (rmsEMG) and mean power frequency (MPF), using the wavelet method, were analyzed on computer. Results The rmsEMG in VL with SCS was significantly greater than activation without SCS but the rmsEMG decreased in SCS-L4. However, RF and VM did not change in all conditions. VL also changed significantly in comparison with SCS / non-SCS ratio of rmsEMG. On the other hand, MPF did not change in all conditions. Discussion SCS increased rmsEMG in VL, but in contrast SCS-L4 rmsEMG decreased. This signifies the linkage of the L4 dermatome to VL motoneurons because SCS-L4 projects motoneuron inhibition to VL. Therefore, we suggest that SCS-L4 during dynamic contraction inhibits VL motoneurons in the presence of sensory-motor linkage. These results suggest that the influence of cutaneous input can demonstrably modulate muscle activation with transmission across interneurons. References Yona M. (1997). *Jpn J Physiol*, 47(4):341-348. Keegan, Garrett. (1948). *Anat Rec* 102:409-437.

## Poster presentations

### PP-BN14 Motor Learning 3

#### **DYNAMICAL SYSTEM APPROACH IN ANALYSIS OF DISCRETE MOVEMENTS IN SOCCER. WHAT HAPPENS WHEN THERE ARE FOUR CHOICES IN ORDER PARAMETER WITH SUBJECTS REPRESENTING BOTH ENDS OF THE SKILL CONTINUUM?**

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Dynamical System Approach as methodology in analysis of discrete movements in soccer. What happens when there are four choices in order parameter with subjects representing both ends of the skill continuum? Nilsen AK<sup>1</sup>, Ingvaldsen RP<sup>2</sup> <sup>1</sup>Department of Sport and Physical Education, Bergen University College, Bergen Norway <sup>2</sup>Departement of Sport and Physical Education, Nord-Trøndelag University College, Levanger Norway Introduction Two studies explore the application of a dynamical system approach in the analysis of discrete hand movements (Sørensen et al., 2001, Rostoft et al., 2002). Both studies demonstrate that the spatial position of an approaching ball function as a control parameter in the shift between two different techniques, i.e. order parameters. The aim of the present study was to use the same procedures, but now with subjects shifting between four different techniques in receiving and passing a ball in soccer. The spatial position of an approaching ball was used as a control parameter, the combination of inner or outer left or right foot represented the four choices in order parameter. Methods Sixteen female subjects participated in this study in a specialist group with highly skilled soccer players, and in a normal group of subjects with no experience from soccer. Under three different experimental conditions the subjects were required to receive balls from nine different spatial locations, and rapidly pass the balls towards a target. 1) The control parameter was scaled systematic with balls from the right side of the subject to the left side, and vice versa. 2) The spatial location of the ball direction varied randomly. 3) The control parameter was scaled systematic while simultaneously inducing stress by giving the subjects simple mathematical tasks. Results In Condition 1 and 2, the specialist group showed greater variation in use of receiving and passing techniques compared to the normal group. For the latter group the right foot dominated. Overall, the specialists used the same techniques in the same position whether the scaling went from the right to the left or the opposite scaling direction. The normal group used one solution for one way and another for the opposite direction. In Condition 3, the group differences in technical choices were even more significant. Discussion The present study has demonstrated the possibility of using four choices in order parameter with spatial localisation as a control parameter in a study of a discrete movement. The results also favour a view that motor preferences interact with task demand, as emphasized in the study by Rostoft et al. (2002). Rostoft, M.S., Sigmundsson, H., Whiting, H.T.A. Ingvaldsen R.P. (2002) Dynamics of hand preferences in 4 year-old children, *Behavioural Brain Research*, 132, 59-68. Sørensen, V., Ingvaldsen R.P., Whiting H.T.A. (2001). The application of co-ordination dynamics to the analysis of discrete movements using table-tennis as a paradigm skill. *Biological Cybernetics*. 85, 27-38.

#### **VISUAL SEARCH STRATEGIES AND VISUAL CUES OF BASEBALL BATTERS BEFORE THE PITCHER'S WIND-UP AND RELEASE**

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Introduction Hitting a baseball requires a batter to process information accurately because a pitcher throws the ball very fast. Researchers have tried to identify the important sources of visual information used by baseball batters during the preparatory phase of a pitch. The main purposes of the present study were to examine the differences in visual search strategies and visual cues between expert and non-expert hitters before the pitcher's wind-up and release. Methods Seven of these subjects were members of the Chukyo University baseball team (Expert group), and the other seven subjects were ordinary university students (Non-expert group). The subjects were asked to observe pitches thrown by a pitcher on a screen and to push a switch button when they made a decision to swing the bat. The pitches were edited to occlude and present selectively specific pitcher's body parts. Subject's eye movements, reaction times and accuracies in judging were measured and analyzed. Results Expert hitters shifted their fixation point from the proximal part of the pitcher's body, such as the head, chest and trunk, to the pitching arm and the release point before pitcher release, while the gaze point of the non-expert group visually focused on the head and the face. Moreover, when the pitcher's wrist or elbow was selectively presented, the response time was significantly delayed compared with when the pitcher's upper body was shown. Moreover when the pitcher's release point, wrist and elbow were selectively presented, the response time of an expert hitter was significantly delayed compared with when the pitcher's arm, upper body, and under body was shown for expert group. No such differences the response time of a non-expert hitter were observed for any or all conditions. Discussion These results of eye movements were consistent with the previous results of Shank and Haywood (1987), Kato and Fukuda (2002), and Takeuchi and Inomata (2009). Moreover, these results of visual cues were consistent with the previous results of Muller, Abernethy, and Farrow (2006). These results suggested that Expert baseball hitters used visual search strategies to gaze at specific cues (the pitcher's arm including the whole body) during the pitcher's motion. References Kato, T., & Fukuda, T. (2002) Visual search strategies of baseball batters: eye movements during the preparatory phase of batting. *Perceptual and Motor Skills*, 94, 380-386. Muller, S., Abernethy, B., and Farrow, D. (2006) How do world-class cricket batsmen anticipate a bowler's

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### APPLICATION OF THE REVERSING FUNCTION ON SENSUOUS CONSCIOUSNESS TO MOTOR LEARNING

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**Introduction** In motor learning, learners accomplish the acquisition of a technique in sports by awakening and selecting their sensuous consciousness and making an appropriate sensory schema by means of their selected sensuous consciousness. In brief, it is important to awaken to one's own sensuous consciousness for the acquisition of a technique in sports. However, this task is difficult for beginners and learners who have only a limited ability of self observation. During a movement, we can direct our consciousness to two different directions. The first is to our own movement (own sensuous consciousness), the other direction is to the external environment. These two directions of the consciousness possess a reversing function. As an example, we consider walking in a crowd. In this case, we can direct our consciousness to our own walking form and also to other people's action in order to evade other people. Therefore, the aim of this study is to clear the effectiveness of directing one's own consciousness to an external environment in an acquisition of techniques in sports. **Method** In order to achieve this aim, the movement form of two assignments were compared (learner's consciousness is directed to one's own sensuous consciousness in the first assignment and it is directed to the external environment in the second assignment). As the research object, the movement in artistic gymnastics is selected because an acquisition of a motor technique is the main aim in artistic gymnastic. Beginners of artistic gymnastics are selected as the research subjects. **Result** The following became apparent by comparing these two assignments. The assignment that is directed to an external environment, worked more effectively for the acquisition of a motor technique than the other one. **Conclusion** Through this study clear evidence was discovered that an application of the reversing function on sensuous consciousness works very effectively for beginners. Henceforth, training methods like this should take into consideration the study of various other movements. However, the setting of a training situation influences training results in case of using this reversing function. The ability of trainers to provide such a setting should also be disclosed in the future.

### VISUAL REACTION TIME IN THE TWO SPECIALITIES OF KARATE: KUMITE COMBAT AND KATA FORM.

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**INTRODUCTION** Reaction time seems to be an important feature of the practitioners in some combat sports. In karate, choice reaction time (CRT) seems to differentiate between athletes and sedentary people (Mori et al., 2002). Karate has two sports modalities. Kumite is the combat competition where an athlete must interact with the adversary and reacts to his/her actions. In the kata competition, the karateka does his/her actions without the adversary opposition. In kumite, athletes have to react to frequent visual stimulus; for example, punches or kicks must be defended to avoid being scored. The hypothesis of this study is that kumite athletes have a shorter visual CRT than kata athletes. **METHODS** After signing an informed consent, 169 karate athletes (70 women) participated in the study. They were divided into 2 groups according to their competition specialities. CRT was measured using the software SuperLab Pro 2.0. It was designed and validated a non-specific protocol with visual stimulus and manual responses. Each participant performed 4 blocks of 25 trials. The whole first block and the first trial of each block were excluded from the statistical analysis. Two variables were calculated: CRT in milisec (mean of 72 the trials) and efficiency in the test (number of correct responses divided by reaction time and multiplied by a constant to avoid decimals). Statistical package SPSS 15.0 was used. Analysis was performed separately by gender (male and female). After confirming the equality of variances with the Levene's test, a Student T-test was used to compare kata and kumite groups. **RESULTS** In the male groups, CRT and efficiency in the test were  $381,74\text{ms} \pm 51,54$  and  $246,85 \pm 30,58$  in kumite, and  $392,07\text{ms} \pm 72,86$  and  $238,92 \pm 39,82$  in kata. In the female groups, the results were  $409,64\text{ms} \pm 66,10$  and  $228,21 \pm 32,66$  in kumite and  $396,38\text{ms} \pm 70,14$  and  $231,78 \pm 28,23$  in kata. No differences between kata and kumite groups were found in CRT in male ( $t=,743$ ,  $p>,05$ ) nor in female ( $t=-,778$ ,  $p<,05$ ). The variable efficiency in the test shows also no differences between groups (male  $t=-,986$ ,  $p<,05$ ; female  $t=-,458$ ,  $p<,05$ ). **DISCUSSION** Some personal features can differentiate athletes of a specific speciality. These qualities could be used to predict if someone can reach a good performance in that sport. CRT is not a quality that can differentiate kata and kumite athletes. So, this variable can not be used in a talent selection process where an athlete goes to be recommended to training in a specific modality. In other combat sports, research showed that athletes are different than sedentary people in some RT tasks but not in others. For example, in fencing, athletes and sedentary people have the same simple RT and CRT in rest state but not during exercise (Mouelhi Guisan et al., 2006). In conclusion, there are no differences in CRT between kata and kumite athletes. **REFERENCES** Mori S, Ohtani Y, Imanaka K. (2002). Hum Mov Sc, 21, 213-230. Mouelhi Guisan S, Bouzaouach I, Tenenbaum G, Ben Kheder A, Feki Y, Bouaziz M. (2006). J Sports Med Phys Fitness, 46, 344-351.

### WHAT KINESTHETIC DO THE COLLEGE SWIMMER BE AWARE OF DURING SWIM SKILL ENHANCEMENT?

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**Introduction** In water exercise, human perceive buoyancy, hydraulic pressure and drag from water. Swimmer is aware of those water features and must swim fast. The skillful swimmer's motion has been conducted based on voluntary movement with the swimmer perceived and treated many kinesthetic feedbacks affected by water. If this kinesthetic that swimmer have been aware of during swim skill enhancement is revealed, we would suggest swimmers what kinesthetic should be concentrated during swim. The purpose of this study was investigated what kinesthetic feedbacks the college swimmer have been aware of during swim skill enhancement using psychological scale test. **Method** Questionnaire form gathered from the swimmers belonging college swim team in Japan. We choose 300 subjects data after exception error data. We asked the subjects twelve questions using a seven point Likert scale (1: Extremely disagree ~ 7: Extremely agree) what kinesthetic be aware of during swim skill enhancement. This scale meaning that if the point was raised, the swimmer has been very aware of the kinesthetic. The data were analyzed using factor analysis with promax rotation. **Result** We found three main factor named "somatic sense", "time perception" and "special sense". Mean of the score of somatic sense ( $5.57 \pm 0.85$ ) and time perception ( $5.84 \pm 0.87$ ) were high than special sense ( $3.87 \pm 1.16$ ). **Discussion** Our main findings were that the swimmer has been aware of somatic sense and time perception during swim skill enhancement. This result was confirmed that swimming skill was called "closed skill" requiring the swimmer concentrate somatic sense than special sense (Schmidt and Lee, 1999). Experienced swim skill has been

represented arm coordination or inter-limb coordination that requiring swimmer to control timing of movement (Seifert et al., 2010). Our result indicating that swimmer should concentrate time perception for keep controlling their coordination using somatic sense as time event during swim skill enhancement. References Schmidt R. A. and Lee T. D. (1999) Motor control and learning: A behavioral emphasis. 3rd ed. Champaign, Ill.; United States: Human Kinetics. Seifert L., Toussaint H. M., Albery M., Schnitzler C., and Chollet D. (2010) Arm coordination, power, and swim efficiency in national and regional front crawl swimmers. *Human Movement Science*, 29(3), 426-439.

### FACTOR PATTERNS OF MOTOR PERFORMANCE OF PRIMARY SCHOOL GIRLS ACCORDING TO BIRTH SEASON

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**Introduction** The effect of season of birth on different health related traits is a current subject in medical research. However, there are details about the physiological process in literature of human biology, little information can be found for the effect of birth season on the motor performances of children. Only some publications show the relationship between birth season and performances of players (Dudink, 1994; Edwards, 1994; Rollin, 1992). Therefore, the aim of our research was to study the effect of birth season on development and sport accomplishment of young girls. **Methods** During the research 426 junior level primary school girls were studied for physical development and motor performances. The body height and body weight of them was taken, moreover 20 m dash, standing board jump, 6 minutes continuous running, throwing a stuffed ball and obstacle race-test were evaluated throughout the school Physical Education lessons. Univariate analysis of variance, correlation and factor analysis applying statistical programme package, SPSS, were used for data processing. **Results** Data of the variance analysis study results show that the children group included in the tests were quite homogenous in body height, but heterogeneous in body weight and motor performances. Physical development and four of the five evaluated sport skills were affected by the birth season. Development and motor performances of the summer and autumn born school girls was generally better than of those born in winter or spring. Differences are significant except the obstacle race-test. The results of factor analysis show similar factor patterns for different birth seasons. From data of winter-, summer- and autumn born girls two factors, while of spring born girls three factors could be separated. These factors explain 57-69 % of total variance. It was found for all birth season that age, body measurements and throwing a stuffed ball belonged to the first factor (anthropometric factor) with the highest factor weight. The second factor and in case of spring born girls the third factor contain the 20 m dash, 6 minutes continuous running, and obstacle race-test (running ability factors). **Discussion** The results call attention to the fact that the variation of motor performance of girls in the studied age period mostly depends on their development, body height and body weight. **References** Dudink, A. (1994) Birth date and sporting success. *Nature*, Vol. 368. April 14, 592. Edwards, S. (1994): Born too late to win? *Nature*, Vol. 370. July 21, 168. Rollin, J. (1992) Rothmans Football Yearbook 1992-1993 Headline, London, 1992

### HOW PLASTIC SURGERY MODIFIES THE BODY SCHEMA: EVIDENCE FROM A LONGITUDINAL STUDY OF POSTURE

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Plastic surgery offers a quite unique window on abrupt and permanent modifications of a human's body schema. Its impact is comparable to amputations or other severe injuries, with the evident advantage from the experimenter's (and patient's) point of view that it is planned, allowing longitudinal studies and quantification of the weight and distribution of modified bodily masses (e.g., weight of the prosthesis). One potential drawback is that modifications due to (aesthetic) plastic surgery are often too little to be revealed by motor control tasks, making it difficult to measure the time course of body schema readaptation. The aim of our study is measuring the capability of the body schema to readapt to significant and abrupt changes, such as the distribution of mass centers, and in particular to assess what is the time course of such re-adaptation. For this reason, we have carried out a longitudinal study on postural modifications on a population of female patients (N = 30) who were subjected to additive or reductive plastic surgery. Posture and stabilometry evaluations were performed before surgery (T0), and after 1 month (T1), 4 months (T2), and 1 year (T3). Posture was reconstructed from spatial tracking system (Fastrack™ Polhemus) recordings. Stabilometry analysis was performed by force platform (Globus Italia). The results document a modification in posture and a significant increase in the sway area after body mass alterations. Posture and stabilometry data return to equilibrium after 1 year. Our data suggest that posture control relies on, at least in part, feedforward than only on feedback strategies.

### FUNDAMENTAL MOTOR SKILLS AND BODY COORDINATION OF PRESCHOOL GIRLS AND BOYS

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**INTRODUCTION** Researchers emphasize that children should be encouraged to participate in diverse body coordination and Fundamental Motor Skills (FMS) activities, which children need in order to adapt their movements to different environments and be physically active in their daily lives (Stodden et al. 2008). This study aims to find out and compare differences in body coordination and FMS between preschool girls and boys. **METHODS** We measured preschool girls' and boys' body coordination using the KTK (Schilling 2000) and FMS using the APM-Inventory (Numminen 1995). We looked at three mean age groups: three years, 10 months (n = 9); five years, four months (n = 9); and six years, three months (n = 15). The Mann-Whitney test analyzed the differences between the two genders in body coordination activities – walking backwards on three balance beams 6.0, 4.5, 3.0 cm width, hopping over progressively higher foam hurdles (0–60 cm), jumping rapidly from side to side, stepping from platform to platform and moving the first platform to new position before stepping onto it again as fast as possible – and FMS – right foot static balance, left foot static balance, dynamic balance, walking speed (10 m), running speed (10 m), standing broad jump, sliding, galloping, somersault, throwing and catching combination, throwing at a target, kicking a ball at a target. **RESULTS** Significant differences were found between the genders when comparing the performances of the five-year-olds (U = 0; p = 0.044) and the six-year-olds (U = 8; p = 0.028) in walking backwards on three balance beams; the six-year-olds in hopping over progressively higher foam hurdles (U = 4; p = 0.005) and throwing at a target (U = 7; p = 0.019). The girls and boys performed equally on all the other test items. **DISCUSSION** An expected finding was that the differences in body coordination and FMS between the girls and boys were more common in the older rather than younger age groups of the children. Surprisingly, in the five-year-old age group, the boys showed better balance skills than the girls. This might be due to test-specific effects. On the other hand, this also might reflect changes in the preschool educational atmosphere: girls and boys are encouraged to be physically active in their play.

Based on the earlier research, logical findings were that in the oldest age group, the girls were more developed than the boys in their dynamic balance, and the boys showed better mastery than the girls in their manipulative skills, which might be due to typical free-time physical activities for boys, such as ball games. REFERENCES Numminen, P. 1995. APM-Inventory. Jyväskylä: LIKES. Schilling, F. 2000. Koordinationstest für kinder KTK manual. Göttingen: Beltz test. Stodden, D.F. et al. 2008. Quest 60, 290–306.

## **MOTOR SKILLS DURING LANDING AND ITS RELATIONS TO PHYSICAL FITNESS AND PHYSICAL ACTIVITY OF ELEMENTARY SCHOOL CHILDREN**

KUNO-MIZUMURA, M.

OCHANOMIZU UNIVERSITY

**Introduction** Physical activity is critical to children's health and development. Recent studies have suggested that children with good object control skills are more likely to become fit adolescents. Fundamental motor skill development in childhood may also be an important component to promote long-term fitness (Bannett et al, 2008). On the other hand, some authors have speculated that altered neuromuscular control and strength of the lower extremity are responsible for the injury rates in children. Ground reaction force (GRF) may provide a surrogate measure for the strain experienced by musculo-skeletal system on landing. Better neuromuscular function may help to attenuate GRF on landing to reduce the injury risks during exercise, however, no studies have examined that motor skills during landing of children in relation to physical fitness development or physical activity (PA) level. The purpose of this study was to investigate motor skills during drop landing and its relation to physical fitness and pedometer-determined PA at school in Japanese elementary school children. **Methods** Subjects were children in grades 5 to 6 attending elementary school in Tokyo, Japan. Ninety-eight healthy children (48 for 5th grade and 50 for 6th grade) completed physical fitness battery tests such as broad jump, shuttle run, sit-and-reach, grip strength, side steps, sit-up, throwing a ball, and 50m run. The children also performed drop landing from 30 cm height block to investigate motor skills during landing. To determine shock attenuating ability, peak GRF on landing was measured by force platform (Kistler Inc., Switzerland) and normalized by subject's body weight (BW) for further analysis. The children wore pedometers (Life Coder EX, Suzuken, Japan) for two school days. **Results** Height and BW were significantly greater in 6th grade students compared with the 5th grade students. For physical fitness, grip strength, shuttle run, broad jump and 50 m run performance were also greater in 6th grade students. Peak GRF during landing produced  $5.2 \pm 1.1$  times BW for 5th grade students, while peak GRF during landing for 6th grade students produced significant smaller GRF ( $4.7 \pm 1.1$  times BW). There were significant positive correlations between PA at school and the results of shuttle run and that of sit-up. However, there was no significant correlation between peak GRF on drop landing and any of physical fitness measures or PA. **Discussion** These data indicate that motor skill during landing evaluated by peak GRF improved with age in elementary school children even. However, this difference in motor skill does not appear to be related to measures of physical fitness. Further studies are needed to elucidate neuromuscular development in children with respect to safety during exercise.

## **OBESE CHILDREN HAVE LOWER FINE MOTOR COMPETENCE THAN THEIR NORMAL-WEIGHT COUNTERPARTS**

GENTIER, I.1.2, D'HONDT, E.1.2, DEFORCHE, B.1.3, DE BOURDEAUDHUIJ, I.1, LENOIR, M.1

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**Introduction** It is widely accepted that childhood obesity negative effects on medical, psychosocial, and fitness condition as well as on gross motor skill level. However, studies investigating fine motor skills in obese children are currently lacking, although they could provide insight in their perceptual-motor functioning. Therefore, this study aimed to investigate fine motor skills in obese compared to normal-weight children. **Methods** Thirty-six obese children were recruited, and 36 age- and gender-matched normal-weight children served as controls. Gross and fine motor skill competence was assessed by means of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (Bruininks & Bruininks, 2005). **Results** Scores on manual control ( $p=0.05$ ), body coordination ( $p<0.001$ ), and strength and agility ( $p<0.001$ ) were significantly better in the normal-weight children compared to their obese counterparts, while a strong tendency was found for fine manual control ( $p=0.059$ ). A main effect of age ( $p<0.001$ ) revealed that the older age group obtained significant higher scores on all subtests. Furthermore, BMI related differences in manual control and body coordination varied according to age group indicating that the obese and normal-weight children belonging to the younger age group displayed more pronounced differences in their fine motor skill performance compared to the older age group. **Discussion** These findings confirm the detrimental effect of excess weight on gross motor skill performance. However, obese children's fine motor skills were also affected even though in these tasks the non-contributory mass that participates in the movement is restricted. This is in line with other studies which postulate that obese children have difficulties when sensory information is needed to plan and control movements (D'Hondt et al., 2008; Petrolini et al., 1995). A possible deficit in perceptual motor skills is therefore suggested. This study also indicates that differences between normal-weight and obese children in fine motor skill performance seem to become smaller with increasing age. This contradicts the findings of D'Hondt et al. (2010) which state that the negative impact of childhood obesity seem to deteriorate across developmental time. **References** Bruininks RH, Bruininks BD (2005). Bruininks-Oseretsky Test of Motor Proficiency (2nd ed.). Pearson Assessment, Minneapolis D'Hondt E, Deforche B, De Bourdeaudhuij I, Lenoir M. (2008). Neurosci Lett, 440, 72–75 D'Hondt E, et al. (2010). Int J Pediatr Obes, doi:10.3109/17477166.2010.500388 Petrolini N, Iughetti L, Bernasconi S. (1995). Int J Obes, 19, 928

## **COMPARISON OF RESPONSES MPF, IEMG, AND RMS BETWEEN KOREAN FOLK AND INTERNATIONAL TUG OF WAR OF KOREAN COLLEGE STUDENTS**

LEE, B.K.1, SHIN, J.M.1, LIM, W.K.2

1: SMU (CHEOAN, S. KOREA), 2: HUIJASAN, S. KOREA

**Introduction** International Tug of War was Olympic regular game from 1900, Paris to 1920, Antwerp. Tug of war International federation (TWIF) was established 1960, and hold International competition. Korea have a folk Tug of War, but the methods was different. The purpose of this study was to compare the EMG responses of MPF, IEMG, and RMS during international and Korean folk Tug of War, and to analyse the physiological characteristics of Tug of War. **Methods** The EMG signal were collected during Tug of War competition on 6 muscles for 1 minute, divided every 10 second, screened high quality signal, and accepted 5 second signals. This study used the data of Lee et al.(2009), and modified. The EMG variables including MPF, IEMG, and RMS were analyzed for muscle activities and fatigue. **Results**, **Discussion** MPF responses showed significant difference among times on 5 of 6 muscles, but there were no significant MPF shift. MPF responses of anterior tibialis only showed significant difference between 2 methods of Tug of War. IEMG of the Korean folk group on

triceps and rectus femoris were significant difference with those of international group. There were no significant difference on EMG responses among time and groups on 4 muscles during Korean folk and International of Tug of War. There were no significant difference among 1 minutes(time) and methods on most of the muscles during Tug of War on RMS. RMS of anterior tibialis showed significant difference among 60 seconds contraction only, and RMS of rectus femoris of Korean folk group were significant difference with those of international group. Korean Tug of War player might used more isotonic than isometric contraction. International Tug of War player might used mainly isometric contraction. The difference of methods, human race, intensity and duration of contraction(Dimitrova et al., 2009), and the direction of contraction(Kay et al., 2000) may different muscle and fatigue responses. Conclusion Muscle activity level of anterior tibialis, rectus femoris and triceps of folk groups significant difference with those of international groups on MPF, IEMG or RMS. Muscle activity level and fatigue were significantly different on some muscles between Korean folk and international methods. References Dimitrova NA, Arabadzhiev TI, Hogrel JY, & Dimitrov GV (2009). Fatigue analysis of interference EMG signals obtained from biceps brachii during isometric voluntary contraction at various force levels. *J. Electro. Kinesiol.*, 19(2): 252-258. Kay D, St. Clair Gibson A, Mitchel MJ, Lambert MI, & Noakes TD (2000). Different neuromuscular recruitment patterns during eccentric, concentric and isometric contractions. *J. Electro. Kinesiol.*, 10(6): 425-431. Lee BK & Lim WK (2009). Comparison of responses in electromyography between international and Korean folk tug of war performance, *Exercise Science*. 18(4): 505-516.

## Poster presentations

### PP-SH16 Skill and Cognition

#### DOES CEREBRAL OXYGENATION AFFECT COGNITIVE FUNCTION DURING EXERCISE?

ANDO, S.

FUKUOKA UNIVERSITY

DOES CEREBRAL OXYGENATION AFFECT COGNITIVE FUNCTION DURING EXERCISE? Ando, S.1, Kokubu, M.2, Yamada, Y.1, Kimura, M.3 1: Fukuoka University, (Fukuoka, Japan), 2: Osaka University of Health Sport Sciences (Osaka, Japan), 3: Kyoto Prefectural University of Medicine (Kyoto, Japan) Introduction Cognitive function is fundamentally important to most human activities. The importance of cognitive function in sports has been emphasized (Williams and Ericsson 2005). Many sports require high-level cognitive functioning under conditions of physiological stress. Since cognitive function is likely to be associated with athletes' performance, it is crucial for cognitive function to be maintained during strenuous exercise for maximal sports performance. Multiple factors may affect cognitive function during exercise. However, to understand the way in which strenuous exercise affects cognitive function it is necessary to investigate the range of potential mechanisms individually, and to accumulate empirical evidence bearing on each. This study tested whether cerebral oxygenation affects cognitive function during exercise. Methods We measured reaction times (RT) of 12 participants while they performed a modified version of the Eriksen flanker task, at rest and while cycling. In the exercise condition, participants performed the cognitive task at rest and while cycling at three workloads [40, 60, and 80% of peak oxygen uptake (VO<sub>2</sub>)]. In the control condition, the workload was fixed at 20 W. RT was divided into premotor and motor components based on surface electromyographic recordings. The premotor component of RT (premotor time) was used to evaluate the effects of acute exercise on cognitive function. Cerebral oxygenation was monitored during the cognitive task over the right frontal cortex using near-infrared spectroscopy. Results In the exercise condition, we found that premotor time significantly decreased during exercise at 60% peak VO<sub>2</sub> relative to rest. However, this improvement was not observed during exercise at 80% peak VO<sub>2</sub>. In the control condition, premotor time did not change during exercise. Cerebral oxygenation during exercise at 60% peak VO<sub>2</sub> was not significantly different from that at rest, while cerebral oxygenation substantially decreased during exercise at 80% peak VO<sub>2</sub>. Discussion In the present study, premotor time significantly decreased during exercise at 60% peak VO<sub>2</sub>, in accord with previous reports (Brisswalter et al. 2002). However, despite an improvement in cognitive function during exercise at 60% peak VO<sub>2</sub>, cerebral oxygenation during exercise at 60% peak VO<sub>2</sub> was no different from that at rest. Error rate was not affected by exercise at 60% peak VO<sub>2</sub>. These results suggest that an improvement in cognitive function occurs during moderate exercise, independent of cerebral oxygenation. References Brisswalter J, Collardeau M, Arcelin R (2002) *Sports Med*, 32, 555-566 Williams AM, Ericsson KA (2005) *Hum Mov Sci*, 24, 283-307

#### PERCEPTUAL CUES VARIABILITY ON ANTICIPATING TENNIS SERVES. LEFT HANDED ARE MORE READABLE THAN RIGHT HANDED EX PROFESSIONALS PLAYERS

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The aim of this study was compare perceptual cues variability of tennis serves, on right and left-handed players, to assist anticipation on devolution stroke. Eight ex professionals' players where analyzed in official matches at Barcelona Stage of Black Rock Circuit 2008, on clay court, in the course of the first round to semifinals of main draw. Two groups were formed by arm-racket laterality. Three left-handed players with top ATP career ranking 1st, 5th, and 14th position, and five right-handed players with 2nd, 3rd, 5th, 6th, and 10th best position. Bi-dimensional kinematics analysis where performed using a camera DCR-HC23E (Sony, Japan) to image capture, and software Utilius® EasyInspect to obtain spatial and temporal data of 187 serves. Forty-two variables were created from serve technique. Canonical correlation analysis was performed to verify relationships among serve technique variables, and serve result described thru bounce time-location. The main result shows three canonical correlation coefficients for each group:  $r = 0.976, 0.896$ , and  $0.848$  for left-handed group, and  $r = 0.921, 0.592$ , and  $0.529$  for right-handed group. All pairs of canonical coefficients are compound with the same variable of dependent set of variables, 'ball time between impact and bounce'. The first pair of canonical variate of left-handed group, means correlation with 'horizontal position of knee at body arc', what can be interpreted like when knee are more to the right side of body server, faster the ball came. In right-handed group corresponds to 'time of ball toss', interpreted like when ball toss get more time, slower ball serve came. Second and third coefficients correspond to the same pair of canonical variate for both groups, which is the 'horizontal position of knee and foot at racket-ball impact moment'. The main conclusion appoints to an important difference between groups, regarding second and third canonical correlation coefficients, can be observe that left-handed players are more regular in their actions during competition, through this information a returner can easier develop a response. The thematic relevance of Opponent Study in Sport is evident when the possibility of inform players when and how fit their responses allows coaches to enhance an intervention or plan a match.

## A DESCRIPTION ABOUT PERCEPTUAL CUES FOR ANTICIPATION OF TENNIS SERVES AT THE PROFESSIONAL LEVEL

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BARCELONA UNIVERSITY

Four hypotheses of what a tennis serve returner must perceive to anticipate direction and velocity were appointed from literature: initial position of server, ball toss, body arc on knee bend, and angle between elbow-ball-shoulder before racquet ball contact. The aim of this study was to verify if these hypotheses could be related to stroke direction and velocity while competition. Eighteen right handed professionals' players were analyzed in official matches of Godò County Championship's 2008 - Barcelona, on clay court, in the course of the first round to quarter finals of main draw. Kinematics analysis were performed using a camera DCR-HC23E (Sony, Japan) to image capture of 306 serves, and software Utilius® EasyInspect (CCC, 2007) to extract spatial and temporal data. Forty-two variables were created from hypotheses, and canonical correlation analysis was performed to verify relationships among those variables and serve action result, described by bounce time-location. The most significant result shows to second serves  $R_c = 0.9725$ ,  $\lambda = 0.0056$ ,  $F = 4.6793$  ( $p < 0.001$ ), and  $x^2 = 303.4540$  ( $p < 0.001$ ), presenting horizontal oscillation of elbow when appears behind body movement as the most powerful predictor (canonical variate = -3.0795), associated with time from ball flight until bounce location (canonical variate = 14.436). That can be interpreted like when elbow appears close to the body ball comes slower. It is concluded that this information can be useful on training perception during practice and also on planning and preparing for a match. Provide players with information which allow fitted responses on fast technique actions reveal the thematic importance of perceptual cues in the field of Opponent Study in Sport.

## THE PATH OF ADOLESCENT ATHLETES TOWARD EXPERTISE

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Introduction Genetic factors in close interaction with the environment (practise/training), combined with the psychological characteristics of athletes, are all variables that will shape and influence the extent to which athletes reach expertise (Baker & Horton, 2004). The aim of the study is to analyze the development of excellence in youth sport, particularly the relationships between personal characteristics and contextual factors. Methods Forty-eight athletes sub-17 years of age ( $15.7 \pm 0.99$ ), from a soccer academy (20), a volleyball club (14) and an elite volleyball centre (14) participated in the study. A retrospective interview (Côté, Ericsson & Law, 2005) portuguese version from Barreiros & Fonseca (2007) was held to 48 athletes of soccer and volleyball. The interviews were applied individually, at the beginning of the season, by the principal researcher. Demographic and training loads information were also collected. Results Soccer players have a longer period of participation in sport than their volleyball peers, but elite volleyball players practice 2,5 more hours per week than the other athletes. The soccer players demonstrate higher values than volleyball players in the desire to become professionals in their sport. All the players prefer to train hard at the club or training center than playing with friends, just for fun. Discussion The high demands of expertise in professional soccer players leads young athletes to begin training at a very early age. The fact that the profession of footballer implies a high social recognition and provide significant financial income, compared to a professional volleyball career, probably have conditioned the opinions expressed by these young football players wanting to become professionals in this sport. Sport specialization seems also to eliminate fun from practice at adolescence years. References Baker, J., & Horton, S. (2004). A review of primary and secondary influences on sport expertise. *High Ability Studies*, 15, 2, 211-228. Côté, J., Ericsson, K.A., & Law, M. (2005). Tracing the development of athletes using retrospective interview methods: A proposed interview and validation procedure for reported information. *J of Applied Sport Psychology*, 17, 1-9. Barreiros, A., & Fonseca, A. M. (2007). Versão portuguesa da Entrevista Retrospectiva Quantitativa de Côté, Ericsson e Law. Unpublished paper. Faculty of Sport. University of Porto.

## RELATIONSHIPS BETWEEN PHYSICAL ACTIVITY IN DIFFERENT CONTEXTS AND COGNITIVE IMPAIRMENT AMONG OLDER ADULTS

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Objective: The study aims to explore a) whether leisure-time physical activity (LTPA) and Non-LTPA (NLTPA) are independently associated with cognitive impairment; and b) the relation of specific components of physical activity (frequency, duration and intensity) and cognitive impairment in later life. Methods: A total of 2,727 persons (65+) participating in 2005 Taiwan National Health Survey was studied. It's a multi-stage stratified systematic sampling design with a nationally representative sample. Cognitive impairment was assessed by the Chinese version of Mini-Mental State Examination ranged 0-30. Cut-off points for illiterate and literate were 13/14 and 23/24 respectively. Information on names, frequency and durations for each type of LTPA and NLTPA during the past 2-week period was self-reported. Energy expenditure of each activity per week was calculated by: activity intensity code (kcal/min)  $\times$  frequency  $\times$  duration for each time (min)/2. The energy expenditure values were then added up into total weekly amount of energy expenditure for both LTPA and NLTPA. After adjusting for socio-demographic variables (gender, age, educational attainment, marital status, employment, income, living status), lifestyle behaviors (smoking and drinking) and health status (BMI, stroke, fall, activities of daily living and depression). Multivariate logistic regression models for predicting cognitive impairment were undertaken to compute adjusted odds ratios (AOR) for LTPA and NLTPA. Given that LTPA rather than NLTPA was associated with cognitive impairment, AORs for the three components of LTPA were calculated. Results: NLTPA was not associated with cognitive impairment ( $p = 0.26$ ). Participants expending less energy in LTPA had higher risk of cognitive impairment (0 kcal/week: AOR = 1.75, 95%CI: 1.16-2.62; 1-999 kcal/week: AOR = 1.35, 95%CI: 0.89-2.06; 1,000-1,999 kcal/week: AOR = 1.15, 95%CI: 0.71-1.87, reference 2,000+ kcal/week) ( $p = 0.02$ ). Risk reduction among the three components of LTPA energy amount was only associated with duration, which was marginally significant ( $p = 0.06$ ) (0-14 minutes: AOR = 1.76, 95%CI: 1.00-3.10; 15-29 minutes: AOR = 1.65, 95%CI: 1.03-2.65; 30-59 minutes: AOR = 1.05, 95%CI: 0.73-1.51, reference 60+ minutes). Conclusions: LTPA rather than NLTPA is associated with reduced risk of cognitive impairment in older adults. Among the three components of LTPA, only duration, especially engagement for at least 30 minutes, is significantly associated with reduced risk of cognitive impairment.



## FROM VISUAL PERCEPTION TO VISUAL-MANUAL COORDINATION.

SGAMBELLURI, R., GOMEZ PALOMA, F.

UNIVERSITY OF SALERNO

**Introduction** The Developmental Test of Visual Motor Integration (VMI) is a "paper and pencil" test, in which the child is required to copy a developmental sequence of geometric figures. The test, starting from the assumption of a significant correlation between the ability of children to reproduce geometric shapes and their scholastic performance (Hammill, et al., 1993), is based on the theory that the development of intelligence and learning have a sensory-motor basis. It consists of two main tests and two additional tests, one on visual perception a visual perception, and the other on motor coordination. **Aim** The research, based on a sample of 117 children in primary schools of Salerno area, is to implement a cognitive survey in order to identify any children at risk as well as analyze if two main tests are organic and consistent with the other additional tests. **Method** The research, after a first theoretical-argumentative phase, has provided a second experimental phase for the administration of the tests of 10-15 minutes; the test was carried out individually. **Results** The research results showing in graphical form, clearly affirm that: • the average percentile test of visual perception is much more than 50%; • the average percentile test of motor coordination is just under 50%; • the average percentile of the VMI test is very low, less than 20%. **Discussion** The results showed that the VMI test, which measures the accuracy of transcription (Motor Coordination) of geometric figures seen in developmental sequence (Visual Perception), shows great difficulties, although the two skills, motor coordination and visual perception measured individually with specific tests, clearly show a great capacity in the children of the sample. **References** HAMMILL, D.D., BARTELL, B.D.(1995). Teaching students with learning and behavior problems. Pro-Ed, Austin, TX. LUCISANO, P., SALERNI, A. (2002). Metodologia della ricerca in educazione e formazione. Roma: Carocci Editore. WILLIAMS, H.G. (1983). Perceptual and motor development. Englewood Cliffs NJ: Prentice-Hall.

## EYE-HAND COORDINATION ASSESSMENT IN SECOND-GRADE CHILDREN : PILOT STUDY OF CITY OF SALERNO'S PRIMARY SCHOOLS.

AMBRETTI, A., D'ELIA, F., SIBILIO, M.

UNIVERSITY OF SALERNO

**Introduction** The Italian National Guidelines for the curriculum of primary school of 2007 require the achievement of motor skills related to visual motor coordination as one of the goals for skill development at the end of primary school, measurable through a different use of evaluation tools. Among the several motor assessment tests recognised by the international scientific community, the VMI Developmental Test of Visual-Motor Integration (Beery & Buktenica, 2000) represents a valid instrument of assessing the visual-motor coordination skills and their constitutive elements. **Aim** of the present research has been to provide, through the use of the VMI battery of tests, to analyze an integrated model of eye-hand coordination assessment, in a sample of primary school. **Methodology** The methodology combined experimental research and action-research, involving University of Salerno (Italy), and 5 primary schools in Salerno. The research protocol has therefore involved definite procedures, jointly followed by schools and University which shared goals and methods. The team of school-university researchers has complied with the following criteria: • sample's auxological and psychomotor characteristics • involvement of handicapped subjects and handicap typology • integrated and rigorous use of the VMI battery of tests in scholastic according to the research project in order to be harmonically suitable for educational activities. • VMI administration training for the teachers involved. **administration of the VMI test:** The team of researchers, in cooperation with each class' regular teachers, has provided for the group administration of the VMI test. **Results** The results of the research among the 5 schools of the city of Salerno has shown a slight significant difference only between two of the schools using the same use of motor evaluation assessment. **Discussion** The study opens up to further researches on the use of motor evaluation assessment in the primary school to improve teaching strategies thanks to the introduction in the classroom context of motor assessment tests that would be consistent with the aims and the didactic organization of Italian primary school. **Reference** Meinel K. The Attempt to Form Theories of Sport Movements in Pedagogical Aspects Società Stampa Sportiva :Roma, 2009 Ministry of Education Guidelines for the nursery and primary school. Roma, 2007. Keith E.Beery Developmental Test of Visual-Motor Integration Firenze: Giunti Editore, 2007.

## ELEMENTS OF COMPLEXITY IN ORIENTEERING FOR BEGINNERS

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With few exceptions (e.g., Ottosson, 1987; Sigurjónsson, 2007), how beginners in orienteering manage the tasks they are presented is far from well researched. In Swedish orienteering clubs, beginner instruction is normally administered according to a well established pedagogy, most often talked about as a ladder of difficulty. This system builds on many years of collected experiences of instruction, and appears to be generally effective. However, if this pedagogy could be validated by empirical data, its application would be even further motivated. On the other hand, data could, alternatively, point to a more or less different ranking of orienteering difficulties, and thus provide indications of need of revisions of the pedagogy. In this research project, split times between control points on courses for children (aged 11 and younger) on regular orienteering events provide data for analysis. It is assumed that more difficult legs would result in greater spread in running times. In other words, a correlation between complexity of orienteering tasks and spread in running times is hypothesised. In a first analysis (Ottosson & Erfors, 2009), split times for 851 young competitors on the third stage of the International O-Ringen five days orienteering event in 2008 were analysed. A clear tendency that more complex legs of the course resulted in greater spread was found; both when a measure of Length Standardized Spread and when the simple measure Average Speed was used. It was further found that shorter legs resulted in greater spread than expected. A possible explanation might be that there is a certain amount of "tuning time" before a runner sets off towards the next control point. An observation study of young orienteers' behaviour at the outset of a new leg, performed at the O-Ringen event 2009 (Ottosson & Erfors, 2010), revealed that there seems to be such an effect, but relatively marginal. In this presentation, further data analyses are reported, together with a tentative classification of elements contributing to the complexity of orienteering tasks. Cases where information overload could be assumed are specifically discussed. Ottosson, T. (1987). Map-reading and wayfinding (Göteborg Studies in Educational Sciences, 65). Göteborg, Sweden: Acta Universitatis Gothoburgensis. Ottosson, T., & Erfors, A. (2009, June). Spread in running times as a measure of orienteering complexity for beginners. Presentation at the 15th Congress of the European College of Sport Science, Oslo, Norway. Ottosson, T., & Erfors, A. (2010, June). Measuring orienteering complexity for beginners. Presentation at the 16th Congress of the European College of Sport Science, Antalya, Turkey. Sigurjónsson, T. (2007). Barns kartlesing: Et samspill mellom kartleser, kart og terreng. Oslo, Norway: Norges Idrettshøgskole.

**VISUAL SEARCH STRATEGIES IN VOLLEYBALL: A COMPARISON BETWEEN LABORATORY AND LIVE-ACTION SETTINGS**

AFONSO, J.1, MESQUITA, I.1, GARGANTA, J.1, MCROBERT, A.2, WILLIAMS, A.M.2,3

*1-UNIVERSITY OF PORTO – FACULTY OF SPORT 2-LIVERPOOL JOHN MOORES UNIVERSITY – SCHOOL OF SPORT AND EXERCISE SCIENCES 3- THE UNIVERSITY OF SYDNEY – DISCIPLINE OF EXERCISE AND SPORTS SCIENCE*

The majority of researchers examining visual search behaviours in sport have employed film-based tasks. A potentially difficulty with using film-based tests is the absence of depth information and lack of opportunity to interact in a dynamic environment, which may alter some of the underlying search behaviours employed. We compare data gathered in laboratory and live-action settings in an attempt to examine whether any significant differences exist across the two situations. Volleyball players were confronted with six offensive scenarios in random order, while positioning themselves as backcourt defenders. Twenty-seven participants were assigned to the live-action setting and sixteen were assigned to the film-based condition. In both conditions, scenarios lasted around 5 seconds. One-way ANOVA showed differences between film and live-action settings in number of fixations, total fixation duration, and number of fixation locations ( $p \leq 0.05$ ). In the live-action setting, participants employed more fixations and fixated more locations when compared with the film-based setting. Chi-square showed differences in the areas fixated across the two settings ( $p \leq 0.001$ ). While watching the test film, participants tended to frequently fixate the middle-attacker and the visual pivot between setter, ball, and middle-attacker. In the live-action setting, they more often observed reception and setting trajectories. Our findings suggest that care should be taken when attempting to generalise the findings from film-based test protocols to live-action settings in sport and highlight the benefits of collecting visual search data in-situ whenever possible. Acknowledgements: Financed by the Foundation for Science and Technology – Ministry of Science, Technology and Superior Teaching of Portugal (SFRH/BD/45428/2008).

**16:15 - 17:45****Invited symposia****IS-PM10 Cellular and Molecular Responses to High Intensity Training****CELLULAR AND MOLECULAR RESPONSES TO HIGH INTENSITY TRAINING**

GIBALA, M.1, WISLOFF, U.2, HAWLEY, J.3

*1MCMMASTER UNIVERSITY, CANADA; 2NORWEGIAN UNIVERSITY OF SCIENCE & TECHNOLOGY, NORWAY; 3RMIT UNIVERSITY, AUSTRALIA*

High-intensity interval training (HIT) induces numerous physiological adaptations that resemble traditional endurance training despite a low total exercise volume. As little as six sessions of HIT over two weeks, totaling ~15 min of "all out" cycle exercise within a total training time commitment of ~2 h, increases the maximal activity of mitochondrial enzymes and improves performance during tasks that rely heavily on aerobic energy provision. These data suggest that HIT may be a potent and time-efficient strategy to induce skeletal muscle metabolic adaptations that improve functional exercise capacity and are linked to improved health. Accumulating evidence suggests that HIT activates many of the same signaling cascades that are believed to regulate mitochondrial biogenesis in response to endurance exercise. Recent work has shown that short-term training using a more "practical" model of HIT (e.g., 10 x 1 min repeats at ~90% maximal aerobic work capacity, interspersed by 1 min of recovery) increased muscle oxidative capacity and improved endurance performance. Other work has revealed this protocol also increased mitochondrial content and improved blood glucose control in previously sedentary individuals who might be at higher risk for inactivity-related disorders as well as type 2 diabetics. Regular exercise training also confers beneficial effects to the heart and vasculature, and accumulating evidence suggests that the magnitude of these benefits increases proportionally with the intensity of exercise training. It has emerged that regular exercise training also confers beneficial effects to patients at risk for, or who have, established heart dysfunction and disease. Moreover, exercise training may reduce the dysfunction of the heart itself and, at least, partly restore its ability to effectively function as a pump. Recent studies in patients with established heart disease suggest that a high relative, yet aerobic, intensity of the exercise training improves the intrinsic pump capacity of the myocardium, an effect not previously believed to occur with endurance training. However, more and larger studies are needed to establish the safety and efficacy of such exercise training in patients with heart disease. Finally, an emerging body of research has considered whether manipulating carbohydrate availability augments the adaptation to endurance training and HIT. Current evidence supports the hypothesis that commencing a portion of short-term training programs in the face of low muscle glycogen content and/or low exogenous carbohydrate availability promotes training adaptation (i.e., mitochondrial biogenesis) to a greater extent than when subjects undertake a similar training regimen with normal or elevated glycogen levels. Although several putative cell signaling pathways have been implicated in this nutrient-exercise adaptation process, further work is required to determine the precise mechanisms promoting the amplified endurance training adaptation when individuals commence selected training sessions with low carbohydrate availability.

**CARDIOVASCULAR EFFECTS OF HIT: FROM MICE TO MAN**

WISLØFF, U.

*NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY*

Prospective, observational studies suggest that low aerobic fitness, measured as maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ), is a strong and independent predictor for total and cardiovascular mortality in healthy individuals and in patients with cardiovascular disease. The relationship between  $\text{VO}_{2\text{max}}$  and health has been studied using either a top-down or bottom-up strategy. The top-down approach starts by epidemiological studies, and then works its way towards identifying possible general physiological mechanisms. The bottom-up strategy begins by studying the basic molecular mechanisms induced by exercise training, and thence upwards to a coherent view of improved public health. Neither approach has alone been successful in establishing firm links between molecules and public health. The main focus of our research activity is to combine the two strategies into a more integrative approach bringing epidemiological, experimental and clinical expertise together. The presentation will review research from own laboratory using epidemiological, clinical and experimental studies to explore adaptation to high intensity interval training. To exemplify, in a rat model we demonstrated that aerobic interval training may be a potent modifier of post-infarction heart failure (HF). Based upon this animal model, we demonstrated the efficacy of aerobic interval training in enhancing cardiovascular fitness and reversing myocardial remodelling in patients with HF after a

myocardial infarction. At present, the group runs a clinical multicenter phase-II trial across Europe. Also novel data on contractile function, calcium (Ca<sup>2+</sup>) cycling and mechanisms of impaired contractile function in isolated cardiomyocytes from patients with coronary heart disease will be presented. Another example of translational research from the presenters group is the use of animal models with inborn low or high aerobic capacity. To determine whether there are more than a statistical link between VO<sub>2</sub>max and CVD, we hypothesized that artificial selection of rats based on Low and High intrinsic Running Capacity (LCR/HCR rats, respectively) would yield models that contrast for risk factors related to CVD. In summary, LCR rats had all symptoms of the metabolic syndrome as observed in man along with a 28-45% shorter lifespan than HCR rats which developed a healthy profile. These contrasting models provide the first demonstration that an intrinsic component of oxidative energy metabolism is inherently connected with longevity. Based upon these data we conducted two clinical studies in patients with metabolic syndrome, in obese adolescents and adults, followed by prospective epidemiological studies of more than 23 800 men and 25 991 women related to physical activity and prognoses for developing metabolic syndrome.

## NUTRITIONAL MANIPULATION OF HIT-INDUCED ADAPTATION IN TRAINED INDIVIDUALS

HAWLEY, J.

*RMIT UNIVERSITY*

Acute alterations in substrate availability modify many of the immediate exercise response and, when repeated over days and weeks, modulate several adaptive processes in skeletal muscle that ultimately underpin the phenotype-specific characteristics observed in trained individuals. Skeletal muscle glycogen concentration exerts a regulatory effect on many cellular processes. For example, commencing endurance exercise with low muscle glycogen stores results in a greater transcriptional activation of enzymes involved in carbohydrate metabolism including the adenosine monophosphate-activated protein kinase (AMPK), glucose transporter-4 (GLUT-4), hexokinase and the pyruvate dehydrogenase (PDH) complex, compared to when glycogen content is normal or high. Recent investigations have systematically manipulated carbohydrate availability before endurance-based high-intensity interval training (HIT). The results from these studies demonstrate that independent of prior training status, short-term HIT programs in which some workouts are commenced with either low muscle glycogen levels, and/or low exogenous carbohydrate availability augment training adaptation to the same or to a greater extent than when similar workouts are undertaken with normal glycogen stores. This talk will explore some of the potential mechanism(s) underlying the benefit to training adaptation with reduced carbohydrate availability and offer practical recommendations for the periodised training of endurance-based athletes.

## Invited symposia

### IS-SH08 Identity, Culture, Performance and Professional Sport

#### IDENTITY, PERFORMANCE, CULTURE AND PROFESSIONAL SPORT

RAVIZZA, K.

*CALIFORNIA STATE UNIVERSITY*

Ravizza (1990) has argued that there are a unique set of challenges around ethics and the identity of the sport psychologist in such intensely performance focused cultures. Discussions will consider how the sport psychologist can operate in an ethically sound and effective way within a culture where gaining trust and respect are key to any success. We will also examine how sport psychologists can maintain their independence to enable them to adopt a longer term view of performance enhancement and player focus despite being inside a culture where results must be immediate and contract termination is inevitable. Lindsay, P., Breckon, J.D., Thomas, D. and Maynard, I. (2007) In pursuit of congruence: a personal reflection on methods and philosophy in applied practice, *The Sport Psychologist*, 21: 335-52. Nesti, M. (2010) *Psychology in football*, London: Routledge. Ravizza, K. (1990) Sportpsych consultation issues in professional baseball, *The Sport Psychologist*, 4, 330-340. Ravizza, K. (2002) A philosophical construct: a framework for performance enhancement, *International Journal of Sport Psychology*, 33:4-18.

#### FAIRNESS, CHEATING, AND PROFESSIONALISM IN SPORT

LOLAND, S.

*THE NORWEGIAN SCHOOL OF SPORT SCIENCES*

FAIRNESS, CHEATING, AND PROFESSIONALISM IN SPORT Sigmund Loland, The Norwegian University of Sport Sciences (Oslo, Norway) Introduction When voluntarily engaged in a rule-governed practice, a moral obligation arises to keep the rules. This is an obligation of fairness (Rawls 1971). Its rationale is that it is unfair to benefit from the cooperation of others without doing one's share. Cheating is the intentional violation of rules to gain an (unfair) advantage. The paper presents an overview and a discussion of the variety of cheating in the context of professional sports (Loland 2002). Method The approach is one of practical ethics in which general principles are weighed against considered judgments in actual practice. The aim is to reach a 'reflective equilibrium' in which principles and concrete judgments are consistent and mutually supportive (Rawls 1971). Results and discussion One common version of cheating is hidden violations of rules to escape penalty and thus gain an exclusive advantage. This is a classic form of deceit. A second version is the so-called 'professional foul'. Rules are violated openly and the penalty is accepted. The consideration is that the advantage gained outweighs the penalty given. A third version is what in ball games is called 'play acting' or 'diving'. A rule violation is simulated to gain an advantage and usually with the additional intention of imposing penalty on a competitor. The moral status of the various ways of cheating is critically discussed in the context of ideals of professionalism, and it is speculated about the future of fair play in professional sports. References Loland, S. (2002). Fair play in sport: a moral norm system. London: Routledge Rawls, J. (1971). A theory of justice. Cambridge, Mass.: Harvard UP

**IDENTITY, CULTURE, PERFORMANCE AND PROFESSIONAL SPORT**

NESTI, M.

LIVERPOOL JOHN MOORES UNIVERSITY

Presenters will discuss the demands placed on the sport psychologist working in professional team sport environments. Drawing on over 9 seasons work inside the English Premier League as a sport psychologist, Nesti (2010) has argued that issues around confidentiality, values and authenticity impact on what can be achieved and overall effectiveness. Lindsay et al. (2007) have discussed this in terms of the importance of philosophy of practice, and Ravizza (2002) has suggested that developing self awareness and self knowledge is essential for those hoping to work in the brutal and exciting culture of professional sport.

**Oral presentations****OP-BN08 Biomechanics in Children and Women****THE INFLUENCE OF ANTHROPOMETRIC MEASURES ON THREE-DIMENSIONAL BREAST KINEMATICS**

BROWN, N.1, WHITE, J.2, MILLIGAN, A.2, RISIUS, D.2, SCURR, J.2

1: ST MARY'S UNIVERSITY COLLEGE, UNITED KINGDOM, 2: UNIVERSITY OF PORTSMOUTH, UNITED KINGDOM

**INTRODUCTION** Investigation of breast kinematics in three-dimensions (3D) during physical activity has informed breast support requirements. However, despite substantial individual differences observed in the dimension and weight of the female breast (Gefen & Dilmoney, 2007), empirical research has not firmly established if breast size is related to body size and composition and the influence of anthropometric measures on 3D breast kinematics is under-reported. The purpose of this study was to investigate the ability of anthropometric measures to explain variation in 3D breast displacement, velocity and acceleration. **METHODS** Following institutional ethical approval, 3D displacement of the trunk and right nipple were recorded using eight calibrated infrared motion capture cameras (200 Hz; Oqus, Qualisys) for 48 A to DD cup size women (mean  $\pm$  SD; age  $25 \pm 7$  yrs, height  $167.0 \pm 6.4$  cms, weight  $63.0 \pm 8.2$  kg) during bare-breasted treadmill running ( $2.8$  m.s<sup>-1</sup>). Movement of the trunk in six-degrees of freedom was eliminated from movement of the breast and resultant kinematics calculated during 5 gait cycles. Chest and cup size were determined by a trained bra fitter and estimations of breast mass (g) made (Turner & Dujon, 2005). Following ISAK procedures restricted anthropometric profiles were recorded for each participant. Body mass, stature, body mass index, WHR, individual skinfolds (SF), somatotype, percent body fat, breast mass and suprasternal notch to nipple distance were included in analyses. **RESULTS** Breast mass and suprasternal notch to nipple distance were related to mediolateral (M-L) breast displacement, velocity and acceleration ( $R^2_{adj} = 0.569$ ,  $R^2_{adj} = 0.415$  and  $R^2_{adj} = 0.331$ ,  $P < 0.05$ ). Breast mass, suprasternal notch to nipple distance and iliac crest SF accounted for 37% and 45% of the variance observed in anteroposterior (A-P) breast acceleration and velocity, respectively ( $P < 0.05$ ). Vertical breast displacement and velocity were related to breast mass and iliac crest, triceps and subscapular SFs ( $R^2_{adj} = 0.561$ , and  $R^2_{adj} = 0.640$ ,  $P < 0.05$ ). **DISCUSSION** Findings suggest that breast mass and suprasternal notch to nipple distance significantly contribute to the explanation of M-L breast kinematics. Therefore bra design for larger-breasted women may need increased focus on reducing M-L breast motion. Furthermore, breast mass and upper body fat distribution influences vertical breast displacement and velocity. This may have implications for females in terms of performance and comfort during exercise and lead to altered breast support requirements following changes in breast mass and body composition. **REFERENCES** Gefen A, Dilmoney B. (2007). Rehab Asst Tech, 15, 259-271. Turner AJ, Dujon DG. (2005). Br J Plast Surg, 58, 290-298.

**DIFFERENCES IN TRUNK KINEMATICS BETWEEN MALES AND FEMALES DURING CUTTING MOVEMENT**

MORNIEUX, G., GEHRING, D., GLUNZ, B., GOLLHOFFER, A.

UNIVERSITY OF FREIBURG

**Introduction** Knee valgus moment during side-step cutting has frequently been investigated to understand knee injury rate differences between males and females (McLean et al., 2005; Pollard et al., 2004; Sigward et al., 2006). It has for instance been demonstrated that hip and knee kinematics at initial contact were related to higher knee valgus moments observed in females (McLean et al., 2005). However, the role of the trunk remains unclear, even if trunk and knee valgus motions were reported to be combined during knee injury situations for female athletes (Hewett et al., 2009). Therefore the aim of the study was to investigate the influence of gender on trunk kinematics and its possible link to knee valgus moment during a side-step cutting task. **Methods** 12 males ( $180 \pm 6$  cm;  $74 \pm 8$  kg) and 12 females ( $167 \pm 5$  cm;  $59 \pm 7$  kg) performed side-step cutting maneuvers with different cutting angles at a 4m/s approach velocity. All trials were randomized and subjects get the information in which direction they had to cut by means of a light system, about 450ms before the foot came into contact with a forceplate. 3D kinematics (Vicon) of the trunk and knee joint as well as knee valgus moment were measured at initial contact (IC) and at the time when peak knee valgus moment occurred (peak knee moment). A paired t-test was used to determine the influence of gender on the different dependent variables during the 60° cutting maneuver. **Results** Knee valgus was significantly higher for females ( $1.5 \pm 3.9^\circ$ ) than males ( $-2.0 \pm 3.6^\circ$ ) at IC ( $p=0.031$ ) and at peak knee moment ( $p=0.02$ ). Moreover, females exhibited larger trunk external rotation ( $30.1 \pm 7.7^\circ$ ) than males ( $24.1 \pm 6.2^\circ$ ) at IC ( $p=0.045$ ) but not at peak knee moment ( $p=0.08$ ) anymore. Knee valgus moment was not significantly influenced by gender. **Discussion** The higher knee valgus at IC and at peak knee moment for females than males was consistent with previous studies (McLean et al., 2005; Sigward et al., 2006). This could be related to differences in anatomy or in neuromuscular control and would possibly increase the risk of knee injuries in females. The 3D kinematical analysis of the trunk revealed that the trunk rotation was influenced by gender. The increased trunk external rotation at IC for females could reflect less effective coupling between the trunk and the lower limb. However, there was no difference between males and females in the knee valgus moment. Therefore the possible influence of the trunk on the knee valgus moment needs further research. **References** Hewett T., Torg J., Boden B. (2009). Br J Sports Med, 43(6), 417-422. McLean S., Huang X., van den Bogert A. (2005). Clin Biomech, 20(8), 863-870. Pollard C., Davis I., Hamill J. (2004). Clin Biomech, 19(10), 1022-1031. Sigward S., Powers C. (2006). Clin Biomech, 21(1), 41-48.

**WHAT ARE THE EFFECTS OF EXCESSIVE BODY MASS ON FOOT LOADING IN CHILDREN?**

COUSINS, S.1, MORRISON, S.2, DRECHSLER, W.2

1: CDU (DARWIN, AUSTRALIA), 2: UEL (LONDON, ENGLAND)

**Introduction** The feet, as the bodies' base of support, are continually subjected to changing patterns of foot stress; continually resisting ground reaction forces during common activities of daily living. The presence of obesity may lead to foot alterations, especially in children due to their immature foot structure and late ossification. These factors can contribute to undermining the foot as a weight bearing structure resulting in pain and structural alterations; however few studies have examined the association between foot loading and body mass in children. The aim of this study was to determine the impact of excessive body mass on the foot loading characteristics in children during level walking. **Methods** 100 participants (22 obese, 22 overweight, 56 normal weight) were recruited from local schools in East London. Participants were asked to walk at a self-selected speed on a pre-defined walkway with the MatScan® (TekScan, USA) placed in the centre. The following variables were extracted for further analysis: peak pressure, peak force, pressure-time and force-time integrals. Data for 3 trials were used to determine the foot loading characteristics at the lateral and medial heel, midfoot, 1st metatarsal, 2nd-5th metatarsals and Hallux. **Results** During walking obese and overweight children experienced increased loading at all 6 regions of the foot in comparison to normal weight children. A one-way ANOVA and Tukey post-hoc test revealed obese and overweight children experienced significantly greater loading at the midfoot and 2nd-5th metatarsals in comparison to the normal weight group ( $p < 0.05$ ). **Discussion** These results revealed that obese and overweight children demonstrated increased loading at all regions of the foot in comparison to normal weight children. The increased loading was particularly prevalent at the midfoot and 2nd-5th metatarsals. These results are similar to previous findings where obese children experienced significant greater loading at the midfoot and metatarsals compared to non-obese children (Dowling et al. 2001). The increase in foot loading at the midfoot may be related to structural deformities at the feet indicative of a collapsed medial-longitudinal arch, with several studies reporting flatter feet in obese children as a result of structural maladaptations at the midfoot (Dowling et al. 2004; Mickle et al. 2006). The foot loading characteristics displayed by these participants were useful to distinguish between normal and abnormal loading patterns on the plantar aspect of the foot however the effects of excessive body mass on the structural and functional characteristics of the feet in children requires further investigation. **References** Dowling A, Steele J. (2001). *Int J Obes*, 25, 845-852. Dowling A, Baur L. (2004). *Int J Obes*, 28, 1514-1519. Mickle K, Steele J, Munro B. (2006). *Int J Pediatr Obes*, 1, 183-188.

**DETERMINANTS OF MUSCULAR FORCE PRODUCTION IN PRE-PUBERTAL CHILDREN: THE ROLES OF TENDON STIFFNESS AND MUSCLE ACTIVATION**

KORFF, T., WAUGH, C., FATH, F., BLAZEVOICH, A.

BRUNEL UNIVERSITY

**Introduction** The overall purpose of this study was to gain a better understanding of the mechanisms underlying age-related differences in muscular force production during childhood. Differences in the capacity for muscular force production between children and adults have been shown to be influenced by increases in muscle size and improvements in motor unit recruitment. Here, we asked if age-related changes in tendon stiffness would influence the capacity of muscular force production in pre-pubertal children. In adults, tendon stiffness has been shown to influence both electro-mechanical delay (EMD) and the contractile rate of force development (RFD). The first specific aim of this study was therefore to determine the relationships between tendon stiffness and EMD as well as tendon stiffness and RFD in pre-pubertal children. The second purpose of this study was to determine the relative neural and mechanical contributions to age-related changes in muscular force production by examining the effects of both tendon stiffness and rate of muscle activation on EMD and RFD. **Methods** Achilles tendon stiffness, EMD (time between the onsets of muscle activity and force), RFD (slope of the force-time curve) and rate of EMG rise (RER; slope of the EMG-time curve) were determined during plantarflexion contractions performed with a maximum RFD in forty-seven prepubertal children (age =  $8.3 \pm 1.6$  yrs). **Results** Tendon stiffness was negatively correlated with EMD ( $r = -0.66$ ) and positively correlated with RFD ( $r = 0.58$ ). A regression analysis indicated that both the RER and tendon stiffness were significant predictors of RFD and cumulatively accounted for 61% of the variance in RFD in children. **Discussion** These results demonstrate the importance of both neural and mechanical factors for muscular force production during childhood. They thereby significantly add to our understanding of the mechanisms underlying age-related improvements in muscular force production and may have further implications with respect to the interpretation of age-related differences in the performance of more complex motor tasks. Supported by the Engineering and Physical Sciences Research Council

**BREAST EXTENSION DURING TREADMILL RUNNING: A CASE STUDY**

SCURR, J., WHITE, J., MILLIGAN, A., RISIUS, D., HEDGER, W.

UNIVERSITY OF PORTSMOUTH

**Introduction** Movement-related breast pain is reported in up to 72% of exercising females (Gehlsen & Albohm, 1980) and may arise from tension on breast skin and fascia (Mason et al., 1999). Additionally, the supporting structures of the breast may be stretched with repeated loading during exercise (Page & Steele, 1999). Previous breast biomechanics research has predominantly considered vertical breast displacement during exercise, but whether this causes tension or stretching on breast structures beyond their static position is unknown. Therefore, the aim was to present a protocol to measure multi-planar breast movement beyond the static positions during running. **Methods** One female (32D breast size) had markers attached to the thorax and right nipple. To determine static breast positions (gravity loaded), markers were tracked with the participant standing (inferior), upside-down (superior), lying on the right and left (lateral and medial), on all fours and prone (anterior and posterior). Markers were then tracked during treadmill running ( $10 \text{ km} \cdot \text{h}^{-1}$ ) in three conditions; no bra, everyday bra and sports bra. Peak breast movement beyond the static positions in each direction determined breast extension. Additionally, vertical, anteroposterior and mediolateral breast displacement relative to the thorax was calculated. **Results** With no breast support, running caused movement beyond all static positions (inferior 19 mm, medial 8 mm, lateral 4 mm, anterior 3 mm, posterior 22 mm) except the superior position. Both bras reduced movement to within all static boundaries except the posterior. The greatest breast extension occurred posteriorly and neither bra eliminated this. During running breast displacement was greatest vertically (no bra 69 mm, everyday bra 34 mm, sports bra 25 mm). Despite the sports bra being most effective at reducing vertical displacement, it allowed movement beyond the inferior static position during running. **Discussion** Running in no bra resulted in multi-planar breast extension; bras effectively eliminated this, except posteriorly. Considerable posterior extension occurred which may relate to breast tissue compression. Previous research reports breasts slapping against the chest during running (McGhee et al., 2007), which may characterise this com-

pression. Minimum breast lift in the sports bra meant that despite displacement reductions, the breast still extended beyond the inferior static position during running. Future research should utilise this protocol to compare multi-planar breast extension and breast pain during running. References Gehlsen G, Albohm M. (1980). *Physician Sports Med*, 8, 89-96. Mason B, Page K, Fallon K. (1999). *Australian J Sci Med Sport*, 2, 134-44. McGhee D, Steele R, Power B. (2007). *Brit J Sports Med*, 41, 879-83. Page K, Steele J. (1999). *Sports Med*, 27, 205-11.

### POSTURAL SWAY FEATURES IN EARLY ADOLESCENT FEMALE ATHLETES

PAU, M., LOI, A., LIGGI, M., PEZZOTTA, M.C.

UNIVERSITY OF CAGLIARI

POSTURAL SWAY FEATURES IN EARLY ADOLESCENT FEMALE ATHLETES Pau, M1., Loi, A2., Liggi, M.1 and Pezzotta, M.C2. 1: Department of Mechanical Engineering, University of Cagliari (Italy) 2: Scuola Regionale dello Sport della Sardegna, Italian Regional Olympic Committee (Italy) Introduction Elite athletes of disciplines where balance is an essential component in achieving a high level performance exhibit different capabilities in terms of postural sway assessed during upright stance, depending on the specific sport practiced (Perrin et al., 2002, Herpin et al., 2010). Is this true even in the case of young subjects? We tested this hypothesis by analyzing postural sway features of early adolescent rhythmic gymnasts, basketball and volleyball players with at least three years of experience. Methods Forty-five female athletes in the early adolescence stage were recruited for the study. All subjects belonged to teams involved in competitive activities, and attended at least three 90-minute training sessions per week. Using a pressure platform, time series of center of pressure (COP) position were acquired under bipedal (eyes open, EO and closed, EC) and unipedal conditions. Data processing made it possible to calculate Sway Area (SA), COP Path Length, COP displacements in Antero-Posterior (AP) and Medio-Lateral (ML) directions, as well as COP velocity. Results In bipedal stance, EC values of SA and COP displacements in ML and AP directions were found to be significantly higher with respect to the EO condition for all the sports, while the discipline appeared to be responsible for differences in COP path length and velocity in the AP and ML directions. In the unipedal stance, gymnasts exhibited better performances as regards SA and COP displacements for the dominant limb, while the volleyball group of subjects was characterized by lower values of COP velocity and, correspondingly, by lower COP path length for the non-dominant limb. Discussion The specific content of rhythmic gymnastic training would lead one to expect a better balance performance even for basic balance tasks (Calavalle, 2008), but in our study this was not clearly observed. On the contrary, bipedal balance was somewhat better in volleyball and basketball players. Gymnasts exhibit lesser sway amplitude in the unipedal stance probably due to the specific content of training sessions. In any case, it appears that the not fully developed postural system limits the possibility of transferring abilities acquired in the specific training in basic balance tasks, and that different disciplines appear to improve balance capabilities in a similar manner. References Perrin P, Deviterne D, Hugel F, Perrot C (2002) *Gait and Posture* 15, 187-194 Herpin G, Gauchard GC, Lion A, Collet P, Keller D, Perrin P (2010), *J. of Electrom. and Kin.* 20, 162-169 Calavalle AR, Sisti D, Rocchi MBL, Panebianco R, Del Sal M, Stocchi V (2008) *Eur J. Appl. Physiol.* 104, 643-649

## Oral presentations

### OP-PM20 Cardiovascular: Blood Pressure and Flow

#### FORCE DISTRIBUTION AFFECTS BLOOD PRESSURE IN RECREATIONAL ALPINE SKIING.

SCHEIBER, P., SEIFERT, J., MUELLER, E.

UNIVERSITY OF SALZBURG, DEPARTMENT OF SPORT SCIENCE

INTRODUCTION: It has been demonstrated that the individual skiing style has an important influence on the physiological stress of older recreational skiers (Scheiber 2010). Blood pressure of older exercising people may be elevated during rest and exercise. Consequently, the knowledge on the relationship between blood pressure response and individual skiing styles is of interest. METHOD: Kinetic (ground reaction forces), kinematic (knee angle) variables, systolic and diastolic blood pressure of 9 advanced older skiers (61.1 $\pm$ 5.6 yrs.) were collected simultaneously during recreational skiing on a medium steep slope (17°). Pearson's correlations were obtained to analyze the relationships among biomechanical and mean arterial pressure (MAP) data. Intra-class correlation coefficients (Cronbach's Alpha) were calculated to test reliability of MAP measurements. Level of significance was set a priori at  $p < 0.05$ . RESULTS: MAP ranged from 90 to 136 mmHg and the test-retest reliability (three trials) of the blood pressure measurements resulted in ICC=0.953,  $p < 0.01$ . No significant correlations were found between the variables knee angle, mean and peak ground reaction force and the MAP data. However, the individual co-loading of the inner leg (ranging from 30 to 45%) correlated significantly positive with the MAP ( $R^2 = .602$ ). DISCUSSION: Heart rate and blood lactate responses in older recreational skiers were found to be mainly determined by the kinematic variables of the individual skiing style (Scheiber et al. 2010). However, in this study the co-loading of the inner leg significantly influenced the hemodynamic response of these skiers. In general, recreational skiing was characterized by an alternation of loading and unloading phases, due to a higher loaded outer and a lower loaded inner leg. However, this alternation will be reduced when skiers tend to load both legs equally and the recruitment patterns of the leg muscles may change substantially (Kröll et al. 2010). This, in turn, may hinder perfusion and blood pressure has to increase to keep total blood flow constant. CONCLUSION: Skiing with an increased co-loading of the inner leg seems to be critical, because the reduced perfusion may result in increased anaerobic metabolism during consecutive skiing. REFERENCES Scheiber et al. (2010). *Scand J Med Sci Sports*. DOI: 10.1111/j.1600-0838.2010.01146.x. Kröll et al. (2010). *Med Sci Sports Exerc.* Aug; 42(8), 1545-1556.

#### CARDIOVASCULAR RESPONSE DURING INCREMENTAL CYCLE ERGOMETER TESTS: GENDER AND AGE DIFFERENCES

BARALDO, A., TAPERI, C., CEVESE, A.

UNIVERSITY OF VERONA

Introduction The literature on cardiovascular responses to aerobic exercise does not clarify the role of stroke volume changes in the enhancement of cardiac output (Ogawa 1992). The aim of this project was to characterize the cardiovascular response, in terms of Heart Rate (HR), Stroke Volume (SV) and Cardiac Output (CO), during cycle-ergometer incremental tests, in young and aged subjects of both sexes. Methods We recruited 34 healthy volunteers (years, BMI): 8 Young Males (YM) (25  $\pm$  2, 22.3  $\pm$  3); 8 Elderly Males (EM) (66.5  $\pm$  3.5, 29.09 $\pm$ 2.9); 9 Young Females (YF) (23  $\pm$  2.4, 20.4  $\pm$  2.3); 9 Elderly Females (EF) (67 $\pm$  6.9, 23.1 $\pm$  2.7). We recorded cardiovascular data with

Portapres TNO, during cycle ergometer incremental tests, starting with a load of 40 W for 3 min followed by 10 W (YF, EF) or 20 W (YM, EM) increments each minute, up to voluntary exhaustion. Since the time course of exercises was not identical among the subjects, data are presented as mean $\pm$ SD at 3 points: rest, 40% and 80% maximum workload ( $V'O_2$  max). Three way ANOVA was used to detect significant differences ( $P < 0.05$ ). Results In all groups HR (bpm) increased linearly and progressively with the effort, although the increase was limited in the elderly group, both males and females, but the difference was significant at 80% $VO_{2max}$  only: YM  $74 \pm 13.2$ ,  $110 \pm 23.8$ ,  $165 \pm 14.3$ ; EM  $83 \pm 9.6$ ,  $108 \pm 7.3$ ,  $144 \pm 13.1$ ; YF  $88 \pm 12.9$ ,  $112 \pm 1.7$ ,  $167 \pm 1.4$ ; EF  $87 \pm 14$ ,  $101 \pm 2.1$ ,  $144 \pm 1.3$ . At rest, SV (ml) was higher in males than in females, and in young than in older subjects. Irrespective of the age, in the males it increased at 40% but declined slightly at 80%, while in the females it increased at 40% and increased further at 80%; differences between males and females were significant: YM  $95 \pm 23$ ,  $135 \pm 23$ ,  $128.7 \pm 17$ ; EM  $65 \pm 18.3$ ,  $84 \pm 20.2$ ,  $82 \pm 21.1$ ; YF  $62 \pm 7.8$ ,  $66 \pm 0.7$ ,  $77 \pm 0.6$ ; EF  $52 \pm 12.7$ ,  $60 \pm 0.8$ ,  $70 \pm 0.08$ . In all subjects, CO (l/min) significantly increased in proportion to the effort, and differences in changes were significant among the groups: YM  $7 \pm 0.8$ ,  $14 \pm 1.7$ ,  $21 \pm 2.4$ ; EM  $5 \pm 1.5$ ,  $9 \pm 2.1$ ,  $12 \pm 2.4$ ; YF  $6 \pm 1.2$ ,  $7 \pm 0.05$ ,  $12 \pm 0.2$ ; EF  $5 \pm 1.6$ ,  $6 \pm 0.1$ ,  $9 \pm 0.07$ . Discussion While the overall cardiovascular response to exercise was similar in the 4 groups, if expected age and gender related differences are accounted for, all females appeared to apply a different strategy for CO enhancement during exercise, relying on continuous deployment of the pumping reserve function of their heart, while males used only tachycardia after the initial rise in SV (Vella 2005; Proctor 1998). The mechanism underlying this remarkable gender related difference deserves further examination. References (1)Vella CA, Robergs RA (2005) Br J Sports Med. 39, 190-5 (2)Ogawa T and al (1992) Circulation 86, 494-503 (3)Proctor DN and al (1998) J Appl Physiol. 84, 599-605

## EFFECTS OF HYDRATION ON POST-EXERCISE HYPOTENSION AND HEMODYNAMIC MECHANISMS

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Introduction: Post-exercise hypotension (PEH) has been extensively reported in healthy subjects, but its hemodynamic mechanisms remains controversial when recovery is conducted in the seated position. Exercise causes a state of hypo hydration that might influence hemodynamic responses during the recovery period. Previous studies observed that intravenous hydration may prevent PEH (Charkoudian et al., 2003). However, the effect of oral hydration that is recommended before and after exercise is not clear. Thus, this study was designed to investigate the effects of oral hydration on post-exercise blood pressure (BP) and its hemodynamic mechanisms. Methods: Sixteen young men underwent four sessions executed in a random order: control without hydration (CW), exercise without hydration (EW), control with hydration (CH) and exercise with hydration (EH). In the hydration sessions, subjects drank 1l of water in the night before, 500 ml of water 60 min before the intervention (rest or exercise) and 1ml of water for 1g of body mass lost immediately after the intervention. In exercise sessions, they exercised for 45 min on a cycle ergometer at 60% of  $VO_{2peak}$ . Systolic (S), diastolic (D) and mean (M) BP, as well as cardiac output (CO) and heart rate (HR) were measured before and 60 minutes after the interventions. Data was analyzed by a 3-way ANOVA for repeated measures. Results: Contrary to the hypothesis, hydration did not change hemodynamic responses after the exercise. Exercise produced a significant reduction in SBP (EW= $105 \pm 1$  vs.  $99 \pm 1$  mmHg and EH= $105 \pm 1$  vs.  $102 \pm 1$  mmHg,  $p < 0.05$ ), and abolished the increase in DBP observed in the control sessions. CO decreased while SVR increased significantly and similarly after the control and exercise sessions. However, the decreases in CO after the control sessions were accompanied by decrease in HR (CW =  $68 \pm 2$  vs.  $63 \pm 2$  bpm and CH= $67 \pm 2$  vs.  $61 \pm 2$  bpm,  $P < 0.05$ ), while they were due to a reduction in stroke volume after the E sessions (EW= $63 \pm 3$  vs.  $58 \pm 4$  ml and EH= $64 \pm 3$  vs.  $60 \pm 5$  ml,  $p < 0.05$ ). Discussion: Results from this study indicated that in healthy young subjects hydration did not modify the hypotensive effect promoted by the aerobic exercise during the recovery period, and it also did not affect the hemodynamic determinants of PEH. References: Charkoudian, N.; Malliwill, J. R.; Morgan, B. J.; Eisenach, J. H.; Joyner, M. J. (2003). J Physiol, 552(2), 635-644. Financial support: FAPESP (2007/08355-1)

## RAPID LOSS OF ISOMETRIC TRAINING-INDUCED REDUCTIONS IN RESTING BLOOD PRESSURE

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Introduction Few studies have investigated the loss of isometric exercise training (IET) induced reductions in resting blood pressure (RBP). It seems only Howden et al (2002) have followed-up RBP assessment after a period of de-training. They showed that training-induced reductions in RBP were lost within 10 days of completion of a 5-week programme. The purpose of this study was to follow-up participants, 1 week after a 4-week bilateral-leg IET programme. Methods 13 healthy males, mean age  $21.0 \pm 2.4$  yrs, body mass  $78.1 \pm 18.2$  kg and stature  $177.1 \pm 4.6$  cm (mean  $\pm$  s), gave informed consent and completed a 4 week IET crossover study. Crossover between exercise and control conditions was separated by 6 weeks. IET intensity was set at the proportion of peak EMG (%EMG<sub>peak</sub>), which corresponded to 95% of the peak heart rate (HR<sub>peak</sub>) achieved during an incremental isometric exercise test to exhaustion. IET consisted of 4x2 min bouts, separated by 3 minutes of rest, on 3 days.wk<sup>-1</sup>. Training intensity (EMG mV) was updated if the mean training session HR deviated from the pre-set HR by  $> 5\%$ . RBP was measured at the brachial artery, seated, using an automated oscillometric device. This was done at baseline, post-training and following 7 days of detraining. Results 4 weeks of bilateral-leg IET resulted in significant reductions in resting SBP, DBP and MAP ( $-4.9 \pm 5.8$ ,  $-2.8 \pm 3.2$  and  $-2.8 \pm 2.2$  mmHg respectively;  $p < 0.05$  in all cases) compared to control. These training-induced reductions in RBP were lost following 1 week of de-training. Discussion These findings demonstrate that the training-induced reductions in resting blood pressure are rapidly lost upon cessation of 4 weeks of IET (bilateral-leg exercise performed at 95% HR<sub>peak</sub>, which equates to approx 24% MVC). These findings suggest that: (i) the adaptive mechanism responsible for the reduced RBP from this duration of IET, is unlikely to involve structural changes in the cardiovascular system, and (ii) IET must be continued weekly in order to benefit from the potential prophylactic hypotensive effect. References Howden R, Lightfoot T, Brown S, Swaine IL. (2002). Expt Physiol, 87, 507-515. Millar PJ, Bray SR, McGowan CL, MacDonald MJ, McCartney N. (2007). Blood Press Monit, 12, 307-314. Taylor AC, McCartney N, Kamath MV, Wiley RL. (2003). Med Sci Sports and Ex, 35, 251-256. Wiles JD, Coleman DA, Swaine IL. (2010). Eur J of Appl Physiol, 108 (3), 419-428.

## BLOOD PRESSURE AND PLASMA VOLUME RESPONSES DURING RECOVERY: EFFECT OF EXERCISE INTENSITY AND EXERCISE LIMB

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**Introduction** Arterial and central venous blood pressures (BP) are reduced following exercise, which contributes to exercise being a key anti-hypertensive therapy and facilitates expansion of plasma volume (PV). However, the effects of exercise intensity, duration and exercising limb on post-exercise hypotension and hypervolaemic responses are not resolved. Therefore, the purposes of this study were to identify the acute (<24 h) profiles of arterial BP and PV for (i) endurance (END) versus repeated high-intensity exercise (RHIE), and (ii) lower-body versus upper-body exercise (RHIE-L vs. RHIE-U). **Methods** Twelve untrained males (age:  $23 \pm 3$  y, body mass:  $72.4 \pm 12.8$  kg,  $\text{VO}_2$  max:  $44 \pm 8$  mL/min/kg) completed one END (50 min at 65%  $\text{VO}_2$  max), one RHIE-L and one RHIE-U exercise trial (both RHIE, five 30-s maximal sprints with 4.5-min recovery), ~2 wk apart. Measurements were taken at baseline, during exercise (cycle ergometry), continuously (beat-to-beat BP) or at 15-min intervals (blood samples) throughout the first 3-h seated recovery, then at 8 and 22 h. Change in PV was calculated from haemoglobin and haematocrit. Responses were modelled for key parameters (e.g., nadir) before inferential analysis. Results RHIE-L led to a one fold larger post-exercise hypotension compared with END (Area 'Under' Curve:  $7540 \pm 3853$  vs.  $3897 \pm 2757$  mm Hg/min,  $p=0.05$ , 95%CI:  $3392 \pm 3372$ ), whereas similar responses were evident for exercising different limbs (RHIE-U  $6420 \pm 3947$ ,  $p=0.48$ , CI:  $-1261 \pm 3896$  mm Hg/min). RHIE-L led to a two fold larger post-exercise decrease in PV compared with END ( $789 \pm 268$  vs.  $251 \pm 175$  %/min, CI:  $537 \pm 236$ ), whereas it was similar to RHIE-U ( $692 \pm 284$  %/min, CI:  $-97 \pm 237$ ). In contrast, arterial BP at 22 h was reduced after END ( $-8 \pm 8$  mm Hg) but not after RHIE-L ( $0 \pm 7$  mm Hg,  $p=0.04$ , CI:  $7.8 \pm 7.2$  mm Hg) or RHIE-U. PV expansion at 22 h was similar (CI:  $0 \pm 5\%$ ) for END ( $+5 \pm 5\%$ ) and RHIE-L ( $+5 \pm 5\%$ ), as well as for RHIE-U ( $5 \pm 7\%$ , CI:  $-1 \pm 7\%$ ). **Discussion** The different post-exercise hypotension responses between END and RHIE may implicate peripheral dilatory factors associated with exercise intensity. Whereas, the similar hypotension following exercise with the arms may implicate central factors. Only END reduced BP the next day, possibly due to extended neuroendocrine or endothelial disturbance following intense interval exercise. Similar plasma volume expansion by 22 h, irrespective of intensity and exercising limb, indicates that a variety of exercise regimes may induce hypervolaemia, not obviously related to acute arterial hypotensive responses. Thus, exercise intensity may be a more important parameter for post-exercise hypotension but not the subsequent hypervolaemia.

## THE EFFECTS OF ISOMETRIC EXERCISE TRAINING ON ARTERY DIMENSIONS AND BLOOD FLOW IN MIDDLE-AGED MEN

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**Introduction** Previous isometric training studies reporting reductions in resting blood pressure have not explored whether there are concomitant changes in resting artery dimensions and blood flow. Furthermore, the influence of isometric training intensity on these adaptations has not been investigated. Therefore, the purpose of this study was to explore whether training-induced reductions in resting blood pressure are associated with concomitant changes in the vasculature of the trained and untrained limbs and to establish if these adaptations were intensity dependent. **Methods** Subjects undertook an 8 week training programme consisting of 4x2 min bilateral-leg isometric contractions 3 x per week (Wiles et al., 2010). Two groups exercised at intensities equivalent to 70% ( $n=10$ ) or 85% ( $n=10$ ) of their peak heart rate (%HRpeak; as established in a prior incremental test), and a third group acted as controls ( $n=10$ ). Resting systolic (SBP), mean arterial (MAP) and diastolic (DBP) blood pressure was measured at baseline and post-training. Artery diameter and mean blood flow (brachial and femoral) were also measured at rest using Doppler ultrasound. Analysis of variance was used to determine whether post-training measures were significantly different to baseline. Also, baseline values were used as a covariate to account for initial resting blood pressure values. **Results** There were significant reductions in resting SBP ( $-10.8 \pm 7.9$  mmHg) and MAP ( $-4.7 \pm 6.8$  mmHg) in the 85%T group post-training and concomitant significant increases in resting femoral mean artery diameter (FMAD;  $1.0 \pm 0.4$  mm) and femoral mean blood velocity (FMBV;  $0.68 \pm 0.83$  cm/s), which resulted in increased femoral artery blood flow (FABF;  $82.06 \pm 31.92$  ml/min). There were no significant changes in brachial artery measures after training. Furthermore, there were no significant changes in any resting measure in the 70%T or control group. **Discussion** This study shows that the reductions in resting SBP and MAP observed after isometric training are associated with concomitant increases in resting artery dimensions and blood flow, but these changes were restricted to the trained limbs. This suggests that the vascular adaptations were localised. Furthermore, these adaptations seem to be training-intensity dependent, as they were not observed in the 70%T training group. These findings could be explained by reduced resting vascular tone, enhanced endothelium-dependent function or by vascular remodelling. The stimulus for such adaptations may arise from changes in availability/activity of nitric oxide as a result of sheer stresses during isometric exercise (McGowan et al. 2007). Exactly how these sheer stresses occur during isometric exercise and how they might be related to isometric training intensity would be deserving of future study. McGowan CL, Levy AS, McCartney N, MacDonald MJ. (2007). Clin. Sci. 112, 403-409. Wiles JD, Coleman DA, Swaine IL. (2010). Eur. J. Appl. Physiol. 108, 419-428.

## Invited symposia

### IS-BN01 Motor Control - From Basics to Applications

#### SHORT-TERM AND LONG-TERM EFFECTS OF VARIABILITY-INCREASING CON-STRAINTS

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The development and successful integration of approaches such as synergetics or dynamic system approaches, stochastic resonance and neurobiological insights, as well as artificial neural network simulations contributed to a reconsideration and acceptance of variability. Motor studies on practical developments (e.g. contextual interference or differential learning) have underpinned that induced variability facilitates learning (e.g. Brady, 2004; Frank et al., 2008) and that it enables flexible and, thus, stable patterns of coordination (Bernstein, 1967). However, the amount and structure of optimal movement variability in the course of successful learning is still under debate. A generally valid training concept is complicated by the fact that various moderator variable, such as age, skill level, type of skill, or individual pre-experiences, are suggested to strongly affect variable training regimes. By starting with a broad range of different movement



experiences which is steadily reduced in the process of learning, the solution space (i.e., the space that covers the different executions) may be adequately covered to encourage the task specific interpolation ability (Birklbauer, 2006; Schöllhorn et al. 2009). That is, especially on a higher skill level, movement variability should remain within the functional boundaries of the skill to be learned. Such a convergent variability structure should enable an adequate fine-tuning. This talk will highlight experiments in various sports that demonstrate benefits and limits of variable training and practical applications. Besides different forms of variable practice, the main focus lies on alternative ways to increase variability within the movement skill and in a sport specific manner, respectively. Research on the application of special variability-increasing constraints will be presented. One example demonstrates the acute effect of running with elastic cords when first exposed to the cords and their effect after an acquisition period as well as long-term effects on different observational levels. Other examples show the practical application in different ball games and on different skill levels. These results especially highlight the positive transfer performances after variable training. A third example shows the effects of different cord applications during the golf swing in comparison to a golf-specific training tool. Bernstein, N. A. (1967). *The Co-ordination and Regulation of Movements*. Oxford, Pergamon Press Birklbauer, J. (2006). *Modelle der Motorik*. [Concepts of motor science] Aachen, Meyer&Meyer Brady, F. (2004). *Perceptual & Motor Skills*, 99(1), 116-126 Frank et al. (2008). *Biological Cybernetics*, 98(1), 19-31 Schöllhorn et al. (2009). *Human Movement Science*, 28(3), 319-333

## NEUROPHYSIOLOGICAL FUNDAMENTALS OF MOTOR CONTROL

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Human motor control enables all kinds of motor actions from simple reflexes to highly complex manipulative skills. The central nervous system (CNS) is challenged to move the body in a three dimensional environment by coordinating activity of up to 600 muscles. Most actions therefore require profound MOTOR PLANNING. Thus, before motor cortical neurons are activated, input from other centres is necessary. In voluntary actions, one key input reaches the motor cortex from the presupplementary motor area, which in turn receives inputs from the basal ganglia and the prefrontal cortex (Haggard, 2008). Interestingly, the onset of activity in these areas was shown to precede the time when subjects became aware of their motor decision. After motor planning, the MOTOR COMMAND is released. Recent studies indicated that motor commands for dynamic muscle activation differ from motor commands responsible for tonic contractions. Beck et al. (2008) demonstrated that at the onset of dynamic movements, excitation of the motor cortex (M1) is spatially restricted to areas representing the involved muscles whereas adjacent areas are inhibited. Apart from the 'spatial restriction' there seems also to be a 'temporal restriction' indicated by preferential activation of cortical neurons responsible for fast corticospinal projections (Taubé et al. unpublished). The functional significance of such a cortical activation pattern may be a temporally focused motor command. Although the release of the cortical motor command will cause a movement, this movement would most often not result in the desired consequences without the help of SENSORY FEEDBACK. This can easily be seen in patients with loss of proprioceptive feedback who are not able to adequately control posture, locomotion and other motor tasks. Thus, sensory feedback is required to ensure that the motor command in fact causes the predicted consequences. However, sensory feedback is not only used to detect movement errors but also to maximise power output. For instance, in plyometric movements the integration of sensory feedback is used to provide adequate muscle stiffness and allow elastic properties. An appropriate integration of sensory feedback as well as a proper conceptualization of the motor command can only be achieved by FEEDFORWARD MOVEMENT CONTROL. Especially fast and ballistic movements rely on feedforward control. On a behavioural level, inaccuracy of feedforward control can be demonstrated by 'aftereffects', where a specific movement pattern is preserved although the environmental context has changed. On the level of the CNS, the cerebellum plays a crucial role in adapting feedforward control (Bastian, 2006). The talk will give a short overview about the stages and corresponding neural substrates, which are necessary for a successful motor control, i.e. motor planning, conceptualization of context specific motor commands, processing of sensory feedback and operation of feedforward control. Bastian (2006) Curr Opin Neurobiol Beck et al. (2008) J Neurosci Haggard (2008). Nat Rev Neurosci

## FUNCTION OF VARIABILITY IN MOTOR CONTROL

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Introduction Recently, researchers have explored the use of non-linear techniques to analyze human movement. Variability in human movement is often considered as noise or error in the data. However, in the dynamical systems approach, variability is considered a natural variation in the biological system and is inherent in the biological signal while noise is not part of the signal. The purpose of this lecture is to present methods of evaluating variability and the meaning of variability in terms of human motion. Methodological Approaches Coordination in this approach is defined as the interaction of contiguous joints or segments. Two methods that are often used to evaluate coordination are modified vector coding (VC) and continuous relative phase (CRP). The modified vector coding approach was developed using an angle-angle approach. Multiple profiles (i.e. trials) are computed the same way and then averaged to develop mean and standard deviation profiles of these trials. It must be noted that the vector coding angles are directional and thus circular statistics must be used to calculate the mean and standard deviation (Bachelet, 19xx). CRP is considered a higher order analysis. In a CRP analysis, the angle and angular velocity of a segment are plotted on the ordinate and abscissa from which a phase angle is calculated from the origin to the data point at each instant in time throughout the cycle. The same procedure is done with the other segment. The two phase angles are then subtracted to develop the CRP angle. A mean and standard deviation can be calculated over multiple trials (Hamill et al., 1999). In both cases, the standard deviation profile indicates the variability in the coordination between the segments. Discussion Bernstein (1967) suggested that coordination variability is essential to ensure flexibility in task execution. In evaluating the biological variability inherent in a movement over a number of trials it has been reported that a higher level of coordination variability is a normal or healthy or less skilled scenario while a lower level of coordination variability is the opposite (Hamill et al., 1999; Pollard et al., 2005). This interpretation has been well-established in cardiovascular heart disease. The major problem with this approach is that the windows of high and low variability have not been established. It is clear that References Batschelet, E. (1981). New York: Academic Press. Bernstein, N. (1967). Oxford: Pergamon Press. Hamill, J, Van Emmerik, R., Heiderscheit, B, Li, L. (1999). Clin Biomech, 14: 297-308. Hamill, J, Haddad, J., McDermott, W. (2000). J Appl Biomech, 16:400-420. Heiderscheit, B, Hamill, J, Van Emmerik, R. (2002). J Appl Biomech, 18:110-121. Pollard, C, Heiderscheit, B, Van Emmerik, R, Hamill, J. (2005). J Appl Biomech 21:143-152.

## COMPUTATIONAL MOTOR CONTROL OF HUMAN MOVEMENTS

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Due to the numerous degrees of freedom in the human motor system, there exist an infinite number of possible movements for any given task. A central issue in motor control research is how the brain selects particular movements given the large set of possibilities (Diedrichsen et al., 2010). The purpose of this study was the construction of a computational model to unravel the principles the brain might use to select one movement out of the plethora of possible movements in a given situation. Thereby, based on different optimization criteria human movements were generated via computer simulations and compared to measured human movements for validation purposes. Eight subjects performed five pointing movements to each of two targets. All movements were tracked using an IR-tracking system (Vicon). A computational framework was developed consisting of three optimization criteria (MHJ: minimum hand jerk, MAJ: minimum angle jerk, MTC: minimum torque change), a biomechanical full-body model and an optimization algorithm for the calculation of optimal movements based on the three criteria (Simonidis et al., 2009). Motion capture data was mapped on the biomechanical model in order to yield reference movements. Pointing movements were synthesized for each trial based on the three criteria. Orthogonal reference functions were used to quantify the similarities between human and synthesized pointing movements. The resulting coefficients can be interpreted as correlation coefficients (Schöllhorn, 1995). Averaged over 40 trials the results for the hand movements reveal only small differences in similarity coefficients in extrinsic kinematic coordinates (e.g. target 2, hand trajectories: MHJ=.996, MAJ=.998, MTC=.992; tangential hand velocities: MHJ=.959, MAJ=.973; MTC=.883). On joint level the MAJ-criterion showed a closer fit to the human data than the MTC-criterion (e.g. target 2, joint angles: MAJ=.906, MTC=.578; joint angular velocities: MAJ=.677; MTC=.324). Based on these results, the brain most likely uses a MAJ-criterion in movement production. Since the MAJ-criterion did not fully reproduce the human movements an exclusive application of this principle by the brain seems unlikely. Therefore, future research will include combinations of optimality criteria as well as different types of movement tasks. Diedrichsen, J., Shadmehr, R., Ivry, R.B. (2010). Trends in Cognitive Sciences, 14 (1), 31-39. Simonidis, C., Stein, T., Bauer, F., Fischer, A., Schwameder, H., Seemann, W. (2009). IEEE Int. Conference on Humanoid Robots, pp. 317-322. Schöllhorn, W.I. (1995). In K. Häkkinen, K.L. Keskinen, K.L. Komi & P.V. Mero (Eds.). XVth Congress of the International Society of Biomechanics (pp. 824-825). Finland: Gummerus Printing.

## Oral presentations

### OP-PM29 Stress, Damage, Inflammation 2

#### EFFECT OF DHA-RICH FISH OIL CHRONIC SUPPLEMENTATION ON NEUTROPHIL FUNCTION, INFLAMMATORY MEDIATORS AND MUSCLE DAMAGE MARKERS BEFORE AND AFTER A MARATHON RACE

CURY-BOAVENTURA, M.F.1, SANTOS, V.C.1, LEVADA-PIRES, A.C.2, ALVES, S.R.1, PITHON-CURI, T.C.1, CURI, R.2

1CRUZEIRO DO SUL UNIVERSITY, 2 INSTITUTE OF BIOMEDICAL SCIENCES, SAO PAULO UNIVERSITY, SAO PAULO, SP, BRAZIL

Introduction: Marathon race is associated with transient suppression of neutrophil function and changes in inflammatory mediators. Docosa-hexaenoic acid (DHA) has anti-inflammatory and beneficial effects on neutrophil function. Objective: The aim of this study was to investigate the effect of DHA-rich fish oil (FO) supplementation on neutrophils function and plasma concentration of inflammatory mediators and muscle damage markers in marathon runners before and after a marathon race. Methods: Twenty one athletes (age: 36± 0.2 years; body mass: 60 ± 1.1 kg, height: 164 ± 0.01 cm, body fat: 9.4 ± 0.6, BMI: 22.4 ± 0.4 kg/m<sup>2</sup>; race duration: 2h52min + 5 min; training program: 136 ± 15 km/wk) were recruited. Eight marathon runners were supplemented with 3 g of FO per day (FO group) and thirteen were not supplemented (C group). The following determinations were carried out: plasma concentration of creatine kinase (CK), lactate dehydrogenase (LDH), C reactive protein (CRP), PGE<sub>2</sub>, IL-1 beta, TNF-alpha, IL-6, IL-8, IL-1ra IL-2 and IL-10 and neutrophil function (phagocytosis capacity, viability, phosphatidylserine externalization and DNA fragmentation). Results: Plasma concentration of CK, LDH and CRP were already above the maximum reference value before race indicating muscle damage and systemic inflammation in C and FO group. We observed a significant increase in the plasma concentration of PGE<sub>2</sub>, IL-6, IL-10 and IL-1ra in C group after race. Plasma PGE<sub>2</sub>, IL-6, IL-10 and IL-1ra were maintained before and after race in FO group. The marathon race led to a decrease in phagocytosis capacity in C and FO group. We also observed an increase in loss of membrane integrity, phosphatidylserine externalization and DNA fragmentation in C group neutrophils at recovery period of training (before race). FO supplementation prevents the loss of membrane integrity but induced phosphatidylserine externalization and DNA fragmentation in neutrophils. Conclusion: FO supplementation partially reversed inflammatory response and death induced by training and /or marathon but didn't prevent the muscle damage and neutrophils function.

#### KINETICS OF DIABETES INFLAMMATORY RESPONSE TO INTENSE EXERCISE

HATANAKA, E.

CRUZEIRO DO SUL UNIVERSITY

Hatanaka E1, Bortolon JR1, Silva Junior AJA1, Murata GM1, Newsholme P2, Curi R3, Pithon-Curi TC1, 1Post-Graduate Program in Human Movement Sciences, Institute of Physical Activity Sciences and Sports, Cruzeiro do Sul University (São Paulo, Brazil), 2School of Biomolecular and Biomedical Science, Conway Institute, University College Dublin (Dublin, Ireland) 3Department of Physiology and Biophysics, Institute of Biomedical Sciences (São Paulo, Brazil). Introduction: High intensity exercise imposes major acute endocrine, metabolic and immune alterations which persist for a period of several hours after the exercise and may be detrimental to the health of diabetics [1]. In this study we evaluated installation and resolution of inflammation in control and diabetic rats subjected to a session of intense exercise. Methods. Blood samples were taken from rats before, immediately after, 2 hours and 24 hours after exercise. Pro-inflammatory cytokines (TNF-α, IL-1β, CINC-2α/β, MIP-3α, L-selectin and IL-6), anti-inflammatory cytokines (IL-1ra and IL-10), growth factor (VEGF-α), Immunoglobulins (IgA and IgM), acute phase proteins (PCR and C3), muscle lesion marker (CK), and glycemia were measured. We also analyzed the occurrence of macrophage death by necrosis and/or apoptosis. Results. In the control group, intense exercise diminished serum glucose levels time-dependently (r=0.97). The diabetic group remained hyperglycemic in all the conditions studied, showing a slight decrease in glucose levels (24%) after 2 hours of exercise. Twenty-four hours after reaching exhaustion, diabetic rats still showed a continuing increase in the concentration of IL-1β (1.6-fold) and TNF-α (2.0-fold) and proportion of necrotizing macrophages (4.5-fold), while the control group returned to basal conditions. The control group presented a peak of IL-6 after two hours of exercise. No changes were observed in

IL-6 concentrations in the diabetic group. Moreover, no differences were found in the levels of IgA, IgM, C3, CINC-2 $\alpha/\beta$ , MIP-3 $\alpha$ , L-selectin, IL-1 $\alpha$ , IL-10 and VEGF- $\alpha$  under the conditions of this study. Conclusion. We concluded that injury was induced in the non-trained diabetic group after 24 hours of exhaustive exercising, while the control group returned to basal conditions. This is the first time it has been observed that the resting time for diabetics undergoing intense training must differ from that of non-diabetic controls. Additionally, the inflammatory markers, IL-1 $\beta$ , TNF- $\alpha$  and proportion of macrophages in necrosis may be used as markers of recovery in sports practice after intense exercise. References. [1] Gleeson M. (2007) *J Appl Physiol*, 103(2):, 693-699. Supported by Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

## PHYSICAL EXERCISE AND REDOX BALANCE IN TYPE 2 DIABETICS: EFFECTS OF TRAINING ON CELLULAR DAMAGE AND BIOCHEMICAL MARKERS OF OXIDATIVE STRESS

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Physical exercise and redox balance in type 2 diabetics: effects of training on cellular damage and biochemical markers of oxidative stress M. Pittaluga<sup>1</sup>, F. Magli<sup>1</sup>, I. Dimauro<sup>1</sup>, A. Sgadari<sup>2</sup>, B. Tavazzi<sup>2</sup>, S. Fulle<sup>3</sup>, R. Mancinelli<sup>3</sup>, P. Parisi<sup>1</sup>, D. Caporossi<sup>1</sup> <sup>1</sup>Dept. of Health Sciences – University of Rome "Foro Italico", Italy; <sup>2</sup>Dept. of Gerontological, Geriatric and Physiatric Sciences, Catholic University of Sacred Heart – Rome, Italy; <sup>3</sup>Dept. Basic and Applied Medical Sciences (BAMS), Interuniversity Institute of Miology (IIM), University 'G d'Annunzio' – Chieti, Italy Altered redox balance has been suggested as a contributory factor for initiation and progression of diabetes and its complications. It is supposed that a moderate physical training can improve the oxidative-stress dependent cellular response in diabetic patients both stimulating the molecular pathway of short-term answers, and, following a long term exposition, modulating the expression of genes involved in antioxidant response and DNA damage check and repair. To evaluate both the short- and long-term effects of physical training (PT) on oxidative stress markers in type 2 diabetics we planned a two steps protocol. In the first phase we evaluate the effect of a 4-months moderate PT both on 12 diabetic sedentary males (62.1 $\pm$ 4.3 yrs), and 12 healthy sedentary males (61.7 $\pm$ 3.9 yrs). DNA damage (Comet assay) in lymphocytes in untreated as well as H<sub>2</sub>O<sub>2</sub> treated samples, and multiple biochemical markers of antioxidant status were assessed. In the long-term protocol 10 diabetic males were selected: 5 sedentary (62.0 $\pm$ 4.5 yrs); 5 (62.2 $\pm$ 9.5 yrs), practicing a moderate PT from at least 1 year. Gene expression changes was evaluated, performing a RT PCR Array on 46 genes selected among the the gene sets of antioxidant response and DNA damage check and repair. After training, in diabetic patients % DNA in Comet tails resulted significantly lower both in untreated and in treated cells. In both groups, training led to a significant increase of reduced glutathione, glutathione balance, as well as ascorbic acid levels. In diabetic patients, PT induced a significant diminution in malonylaldehyde. No differences were seen in apoptosis frequency between trained and untrained diabetics. Regarding the gene expression changes, the most interesting result is the overexpression of GADD45 (3.5 folds). Our data suggest that moderate physical training reduces the susceptibility to both spontaneous and H<sub>2</sub>O<sub>2</sub> induced DNA damage in diabetic patients. Biochemical data confirm the hypothesis that training can cause adaptive responses in terms of endogenous antioxidant, as well as an improvement in ascorbic acid recycling mechanisms. Preliminary RT PCR Array analysis show that long term moderate physical training can lead to a modulation of the expression of some DNA repair systems and cell cycle control genes. Further studies are planned to validate this findings on a larger sample.

## LEVELS OF INFLAMMATORY PROTEINS IN SUBCUTANEOUS ADIPOSE TISSUE AND THE CIRCULATION, IN RESPONSE TO 2 WEEKS OF HIGH INTENSITY INTERMITTENT TRAINING.

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Insulin resistance has been shown to be causatively linked to the modulation of the levels of cytokines and chemokines. Adipose tissue is a major source for production of many cytokines and an increase in the volume of adipocytes and infiltration of macrophages can lead to an elevation of inflammatory cytokines, which if prolonged, results in chronic low grade inflammation. Chronic low grade inflammation underpins many long term illnesses including type 2 diabetes and cardiovascular disease (Libby et al. 2002). Exercise training can reduce resting levels of certain inflammatory biomarkers (e.g. Thompson et al. 2010), but despite this, other studies have reported no change in inflammatory status after a 3 month exercise programme (Christiansen et al. 2010). This latter group suggested that modification of the cytokine profile may require higher intensity exercise. Two weeks of high intensity intermittent training (HIIT) has been shown to increase fat oxidation within skeletal muscle and aerobic capacity (Talanian et al. 2007), but the inflammatory response to HIIT is unknown. Twelve overweight/obese, but otherwise apparently healthy young males (Mean  $\pm$  SD) 23.7  $\pm$  5.2 y, body mass 91.0  $\pm$  8.0 kg, body mass index 29.1  $\pm$  3.1 kg-m<sup>-2</sup> completed 2 weeks of HIIT. Each session of HIIT consisted of 10X4 min cycling at 85.0  $\pm$  4.6 % VO<sub>2</sub>peak separated by 2 min rest. Resting blood and subcutaneous adipose tissue samples were taken before and after the 2 week training period. IL-6, IL-6 receptor (IL-6R), TNF- $\alpha$ , adiponectin and MCP-1 protein content were quantified in plasma and adipose tissue by ELISA. An oral glucose tolerance test was completed before and after training to assess changes in insulin sensitivity. Preliminary analysis of protein content has shown a reduction in IL-6 production within the adipose tissue ( $P < 0.05$ ), as well as an increase in IL-6R concentration ( $P < 0.05$ ). Analysis has also shown a significant reduction in IL-6R and MCP-1 in the circulation ( $P < 0.05$ ). No alterations in insulin sensitivity were observed after the training period. Therefore, this suggests that just 2 weeks HIIT is sufficient to induce beneficial alterations in the resting inflammatory profile of an overweight/obese population. References Christiansen T, Paulsen SK, Bruun JM, Pedersen SB & Richelsen B (2010) *Am J Physiol Endocrinol Metab* 298, E824-31. Libby P, Ridker PM & Maseri A (2002) *Circulation* 105, 1135-43. Talanian JL, Galloway SDR, Heigenhauser GJF, Bonen A & Spriet LL (2007) *J Appl Physiol* 102, 1439-47. Thompson D, Markovitch D, Betts JA, Mazzatti D, Turner J & Tyrrell RM (2010) *J Appl Physiol* 108, 769-79.

## PHYSICAL ACTIVITY, FITNESS, CHRONIC SYSTEMIC LOW-GRADE INFLAMMATION, CARDIOVASCULAR RISK FACTORS AND BODY MASS INDEX IN CHILDREN AND ADOLESCENTS AGED 10 – 19 YEARS

WESSNER, B., HACKL, M., VIDOTTO, C., TSCHAN, H., BACHL, N.

UNIVERSITY OF VIENNA

Introduction Regular physical activity exerts well documented beneficial effects on markers of the metabolic syndrome and chronic low-grade inflammation as well as on cardiovascular risk factors in children (Platat et al., 2006; Tanha et al, 2011). The aim of this cross-sectional study was to investigate whether additional physical activity through sports activities on a competition level is able to influence the above mentioned parameters. Methods Pupils (10-19y) from a particular high school in Vienna with two distinct school-types (elite

sports vs. regular) agreed to participate in the study. Anthropometric data, physical activity and fitness were assessed in 344 pupils (regular school: n=202; elite sports school: n=142). Fasting blood samples were withdrawn from 201 pupils (regular school: n=101; elite sports school: n=100). Metabolic parameters (blood glucose, insulin, cholesterol, and triglycerides), inflammatory parameters (hs-CRP, hs-IL-6, hs-TNF- $\alpha$ ), adipokines (leptin, leptin sR, adiponectin) and cardiovascular risk factors (homocysteine, NT-proBNP) were measured. Statistical comparisons were performed separately for girls and boys using a univariate factor analysis (school type & age groups). Results As expected, pupils from elite sports classes were involved in physical activity on more days per week (median: 6d; 4-7) than pupils from regular school classes (median: 4d; 1-7) ( $p<0.001$ ). Both, girls' and boys' shuttle run performance was significantly higher in elite sports scholars (up to +55%,  $p<0.001$ ) as was the width of medicine ball throw (up to +44%,  $p<0.001$ ). Anthropometric data did not differ between school types. Cardiovascular risk factors (NT-proBNP and homocysteine), leptin sR and inflammatory parameters were associated with BMI and age. However, the school type did not influence these parameters. Discussion It has been shown that illnesses such as diabetes, cardiovascular diseases, cancer and others are associated with physical inactivity – a risk factor for the accumulation of visceral fat and consequently of chronic systemic inflammation (Pederson, 2009). The results of this study contribute to the growing evidence that higher body mass index correlates with metabolic and cardiovascular risk factors even in childhood and adolescence. Our study might be biased by the unusual low participation of overweight children even in the regular school classes which could explain the lack of association of risk parameters and school type. References Platat C, Wagner A, Klumpp T, et al. (2006). *Diabetologia*, 49(9), 2078-2085. Tanha T, Wollmer P, Thorsson O, et al. (2011). *Acta Paediatr*, [Epub ahead of print]. Pederson BK. (2009), 587(Pt 23), 5559-5568.

## Oral presentations

### OP-PM34 Physical Activity and Health 3

#### THE IMPACT OF OVERWEIGHT AND OBESITY IN HEALTH AND CARDIORESPIRATORY FITNESS IN ADOLESCENTS OF A TOWN OF SAO PAULO STATE -BRASIL.

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**Introduction** Obesity is a multifactorial problem characterized by excessive accumulation of fat, which causes a lot of disturbances to health, reducing life expectancy, threatening its quality. Obesity and overweight, are significant risk factors for development of chronic cardiovascular diseases, insulin resistance, diabetes mellitus and some types of cancer, and orthopedic diseases. One way to identify how obesity is affecting an individual health is by checking the level of cardiorespiratory fitness, which is associated with low and very low levels of fitness and a sedentary lifestyle that surrounds the disease. **Methods** The study sample consisted of 91 students in 9th grade of elementary school (in Cristais Paulista City, in Sao Paulo State - Brasil), aged 14 to 17 years, which, had been invited to volunteer to participate and the study aimed to classify the level of overweight and obesity by body mass index (BMI) also classify the level of physical activity by international questionnaire of physical activity (IPAQ), evaluating the level of cardiorespiratory fitness by means of a submaximal VO<sub>2</sub> (Bench McArdle Test), and make possible associations and correlations of the variables mentioned, for the adolescents. The comparisons, associations and correlations between the results obtained for physical fitness by scoring the IPAQ and also by ratings by VO<sub>2</sub> test, and the state of obesity were performed with the Mann-Whitney, Fisher, and Person (Simple Correlation), respectively. The analysis was conducted using the statistical software GraphPad InStat® for Windows® and the significance value of 0.05 was adopted for all statistical procedures. **Results** The prevalence of overweight and obesity is well below the national average (15.38% overweight/obese against 84.62% eutrophic). However, when stratified between gender, this study found a high prevalence of overweight/obesity for males (23.7% boys against 15.38% girls). When dealing with the physical activity level, there is a much higher rate of population studied compared with the national average (22% was weak against 78% regular/good). In relation to cardiorespiratory fitness, we found a negative correlation with the fitness of overweight and obesity. **Discussion** The results tell us that, in the case of obesity and overweight, instruments that assess the status of isolated physical activity without pointing out the degree of fitness may not be able to associate or relate this indicator to the health of people, since these instruments consider low-intensity activities, which are known not to contribute to the cardiorespiratory gain and thus little or no influence on metabolic aspects such as weight control.

#### EXERCISE TRAINING REDUCES VISFATIN LEVELS IN OBESE CHILDREN

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**Introduction** Obesity is a major global epidemic problem involving both children and adults (Koutedakis et al., 2005). The traditional view of adipose tissue, as a passive reservoir for energy storage, is no longer valid and it is clear that the adipose tissue is a complex and highly active metabolic endocrine organ that secretes a large number of proteins that are collectively referred to as adipocytokines (Kershaw & Flier 2004). Adipocytokines, i.e. leptin, adiponectin, resistin, visfatin, have numerous functions, including regulation of satiety, carbohydrate and lipid metabolism and insulin sensitivity. The purpose of the present study was to investigate the effects of obesity and exercise on plasma visfatin, adiponectin and resistin levels in children. **Methods** A sample of 42 children (lean=24, obese=18), aged 10-14 years old, were divided into 4 age-matched groups: a lean inactive group (n=11), an obese inactive group (n=9), a lean active group (n=13) and an obese active group (n=9). Active participants were engaged in regular swimming ( $\geq 1$  y,  $\geq 3$  times/week,  $\geq 1$  h per session). Resting blood samples were drawn in the morning and the assessment of each adipocytokine was measured by ELISA. Results For visfatin the analysis revealed effects that approached significance for BMI group,  $F(1, 41) = 3.64$ ,  $p = .06$ ,  $\eta^2 = .09$  (Table 2), and exercise group,  $F(1, 41) = 3.66$ ,  $p = .06$ ,  $\eta^2 = .09$ . Obese individuals demonstrated greater visfatin levels ( $3.3 \pm 1.3$  ng/ml) than their lean counterparts ( $2.6 \pm 1.1$  ng/ml) whereas active children exhibited lower visfatin levels ( $2.6 \pm 1.1$  ng/ml) than their active counterparts ( $3.3 \pm 1.2$  ng/ml). Furthermore, within obese individuals, active individuals had lower visfatin concentration ( $2.8 \pm 1.2$  ng/ml) compared to their inactive counterparts ( $3.8 \pm 1.2$  ng/ml). Adiponectin demonstrated lower mean values in obese children ( $3.8 \pm 1.9$ ) than their lean counterparts ( $5.9 \pm 2.7$ ). Resistin levels were comparable between groups. **Discussion** These results indicate that childhood obesity elevates visfatin and lowers adiponectin levels whereas exercise training may be able to reduce visfatin levels in obese children. References Koutedakis Y., Bouziotas C., Flouris A. & Nelson P. (2005). *Med Science Sports Exercise*, 37, 2070-4. Kershaw EE, Flier JS. (2004). *J Clin Endocrinol Metab*, 89, 2548-56.

## SUCCESSFULLY IMPLEMENTING PHYSICAL ACTIVITY PROJECTS FOR FAMILIES: LESSONS LEARNED

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**SUCCESSFULLY IMPLEMENTING PHYSICAL ACTIVITY PROJECTS FOR FAMILIES: LESSONS LEARNED** Romeo-Velilla, M.I, Murphy, R.I, Stratton, G.I  
1: RISES, LJMU (Liverpool, UK) Introduction The necessity to influence health behaviour in family units is endorsed by recent national reports in the UK (e.g. Healthy Weight, Healthy Lives report (2008)). The National Institute for Health and Clinical Excellence (2009) outlined recommendations for families and their physical activity. The Active Families Programme 2009-2010 was delivered as part of the Liverpool Active City (LAC) strategy 2005-2010. Community based organisations were invited to tender for a grant to increase physical activity in family groups. The evaluation of the family projects aimed to explore families' needs; identify families' and practitioners' views on how a family project should be delivered; and find out key aspects of the implementation process to inform future interventions for families. Methods An in-depth qualitative evaluation was designed to explore family and practitioners experiences of engaging with and delivering the projects. Semi-structured interviews were conducted with families (n=3 families, 3 mothers + 3 teenagers) and practitioners (n= 4 instructors, n= 3 project leads, n=2 LAC coordinators). In addition, a focus group was conducted with mothers (n=4) and project leads (n=3) on separate occasions. Content analysis was applied. Results Relatively little is known about how to successfully intervene with families to promote physical activity. Marketing strategies were carried out with a different approach: comprehensive ongoing marketing strategies vs. one-off actions at the beginning of the project. Practitioners had difficulties engaging with families before and during the projects. Instructors had difficulties keeping motivated all participants due to vast age differences and showed concerns about providing the same fitness level to all ages. Some mothers expressed that their children's school was an accessible venue, as they did not feel comfortable going to leisure sport centres or gyms. They also found positive the time (6pm), price (£1 per adult, £0.50 per child) and remarked the importance of the fun component as the key aspect to keep attending. Conclusion An ongoing comprehensive marketing strategy seemed to better engage families. Project objectives need to be clearly set and well defined in terms of their priority: fun for all vs. fitness for all. It is recommended to only recruit experienced instructors and to provide training to instructors and leads on how to deliver family sessions. References Department of Health, 2008. Healthy Weight Healthy Lives: A Cross-Government Strategy for England. Crown Publishing, London, UK. National Institute for Health and Clinical Excellence (NICE), 2009. Promoting Physical Activity for Health and Young Children, London: NICE.

## DEVELOPMENT OF NORMAL WEIGHT OBESITY DURING ADOLESCENT GROWTH: A COHORT STUDY IN NORTHERN PORTUGAL

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1: Institute of Education, University of Minho (Portugal), 2: College of Education at Polytechnic Institute of Viana do Castelo (Portugal), 3: Research Center for Sports Science, Health and Human Development (Portugal) Introduction Normal weight obesity (NWO) refers to a condition that combines a normal body mass index (BMI) with an excessive body fat (De Lorenzo et al., 2006). Given the current increasing prevalence of obesity and physical inactivity among children and adolescents, we hypothesized that NWO might develop early in life. Therefore, the aim of the present study was to determine the incidence and prevalence of NWO in schoolchildren followed from age 9 to age 15 years. Methods Anthropometric assessments (baseline, age 9 and follow-up, age 15) were performed in a cohort of 288 children enrolled in the EMCV (Estudo Morfofuncional da Criança Vianense) at school setting. Stature, weight and skinfold thickness (triceps and subscapular) were measured using standard procedures (Lohman et al. 1988). BMI and percentage body fat (%BF) derived from skinfolds (Slaughter's equations) were calculated. "Normal BMI" and "excessive body fat" were defined by the International Obesity Task Force (IOTF) standards (Cole et al., 2000) and the health-related cut-offs of 25%BF in boys and 30%BF in girls, respectively (Williams et al., 1992). Results In boys, the prevalence of NWO was less than 1% at both assessments and no new cases occurred in the 6-year study period. Unlike boys, the prevalence of NWO in girls increased from 0% (baseline) to 8.3% (follow-up) ( $p < 0.05$ ), revealing that all cases emerged during adolescence (cumulative incidence of 8.3%). Conclusion In girls, but not in boys, there was a concerning development of NWO during adolescent growth. Future research is needed for a better understanding of this difference and of the role of physical activity in the prevention and treatment of NWO. References De Lorenzo A, Martinoli R, Vaia F, Di Renzo L (2006). Normal weight obese (NWO) women: an evaluation of a candidate new syndrome. *Nutr Metab Cardiovasc Dis* 16:513–523. Cole T, Bellizzi M, Flegal K, Dietz W (2000). Establishing a standard definition for overweight and obesity worldwide: international survey. *BMJ* 320:1240-1243. Lohman TG, Roche AF, Martorell R. 1988. Anthropometric Standardization Reference Manual. Champaign: Human Kinetics Books. Williams DP, Going SB, Lohman TG, Harsha DW, Srinivasan SR, Webber LS, et al. (1992). Body fatness and risk for elevated blood pressure, total cholesterol, and serum lipoprotein ratios in children and adolescents. *Am J Public Health* 82: 358-363.

## LONGITUDINAL EFFECTS OF PHYSICAL ACTIVITY PATTERNS AND BODY MASS INDEX IN CARDIORESPIRATORY FITNESS DURING ADOLESCENCE

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**Introduction** In last decades, children's CRF and PA are declining globally, probably as a consequence of youth preferences for sedentary activities. Several longitudinal studies have reported the relationships of total physical activity and intensity with fitness and fatness or with other risk factors in children, but few have addressed the influence of different context of physical activity in health related cardiorespiratory fitness in youth. Therefore, the aim of this longitudinal study was to explore the effect of BMI, overall PA and different domains of PA in CRF over four years of observation throughout adolescence. **Methods** 170 students (96 girls, 56.5%) from one high school (Valongo-Porto) were followed with starting ages of 11 to 17 yr-old. Cardiorespiratory was evaluated with the 20m-Shuttle Run (20m-SR) from Fitnessgram battery test as number of laps. Physical activity and Parents' education were obtained through a standard questionnaire. Parents' education was categorized in Low, Middle and High education, and BMI in normal weight, overweight and obesity, according to established cut points (1). CRF was used as dependent variable in a multilevel analysis using LMwIN. Two levels' structures were used: first level for individuals and second level for time observations. **Discussion** CRF was negatively associated with BMI and positively with PAI. Each question from physical activity questionnaire, were almost positive and increasingly associated with CRF in the crude model. However, in the adjusted model (for age, gender, mother education and BMI) this association was observed only for the highest categories regarding frequency in organized sports outside school and participation in sports competitions. The results highlight the participation of children

and adolescents in organized activities and competitive sports to achieve health-related fitness benefits. Efforts should be made to ensure that high levels of moderate to vigorous exercise are sufficiently maintained over time to enhance health-related stage in CRF. References 1. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-1243.

### YEAR-ON-YEAR IMPROVEMENT IN OUTCOMES FROM A COMMUNITY CHILDHOOD OBESITY INTERVENTION : RECOMMENDATIONS FOR A PHASED APPROACH

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**Introduction** Evidence supports a multidisciplinary family-based approach to childhood obesity treatment (Oude Luttikhuis et al., 2009). Using this evidence to implement interventions in real world community settings can be a challenge. The Medical Research Council (2008) recommends a stepped approach with a feasibility phase to explore delivery processes, plus potential impact of the intervention. This study explored changes in child BMI SDS during the feasibility phase of a UK community-based childhood obesity intervention. **Methods** The Getting Our Active Lifestyles Started (GOALS) intervention supported families with overweight children (aged 4 to 16, >91st%ile BMI for age and sex) through an 18-session programme of diet (Fun Foods), physical activity (Move It) and behaviour change (Target Time). The feasibility phase covered three fiscal years, each with developments to the intervention and its components. Seventy-seven children completed GOALS (23 during year 1, 27 during year 2 and 27 during year 3). Change in child BMI SDS pre- to post-intervention (6 months) was measured using paired samples t-tests. Associations between year of participation and the proportion of children reducing BMI SDS were explored using the Chi-squared test of independence. **Results** One outlier who completed during year 1 was removed (BMI SDS change was -0.71 compared with a range of -0.40 to 0.33 for the other cases), leaving 76 cases for analysis. When pooling the whole cohort, child BMI SDS change pre- to post- intervention was -0.06 (n=76, SD 0.16, p=0.001). Change was highest for children attending in year 3 (-0.12 (n=27, SD 0.14, p=0.000)). There was a significant association between year of participation and proportion of children reducing BMI SDS ( $\chi^2(2) = 8.575$ , p=0.014). In the first year 9/22 (41%) decreased BMI SDS, the second year 16/27 (59%) and the third year 22/27 (81%). **Discussion** We found a year-on-year improvement in outcomes during the feasibility phase of GOALS. This data highlights the merits of taking a phased approach to develop complex evidence-based interventions prior to experimental trial. References Medical Research Council (2008) Developing and evaluating complex interventions: new guidance. Available to download at [www.mrc.ac.uk/complexinterventionsguidance](http://www.mrc.ac.uk/complexinterventionsguidance). Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V.A., O'Malley, C., Stolk, R.P. & Summerbell, C.D. (2009). Interventions for treating obesity in children (Review). The Cochrane Collaboration: Wiley

## Oral presentations

### OP-PM37 Sports Medicine and Rehabilitation 2

#### EFFICIENCY OF SKELETAL MUSCLE ACTIVITY AFTER REHABILITATION IN PATIENTS WITH CARDIAC DISEASE

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**Introduction** Patients with chronic cardiovascular disease are shown to have secondary changes in the skeletal muscle, which can contribute to decreased functional capacity and exercise intolerance. Previous studies show that supervised exercise rehabilitation programs are beneficial in the recovery phase of these patients but the exact effect of exercise on skeletal muscle activity is unknown. Therefore the aim of the study was to determine the effect of a medically supervised 12-wk exercise program on the EMG activity of the lower legs during the 6 min walk test. **METHODS:** 10 Patients with ischaemic heart disease and 14 healthy matched controls consented to partake in this study. Electrodes were placed on the vastus lateralis, vastus medialis, medial and lateral gastrocnemius muscles of the right leg. Resting heart rate (HR) and blood pressures (BP) were taken. They then walked around a 70 m track for 6 min, trying to cover as much distance as possible. HR and rating of perceived exertion were measured every minute during the test. Post 1 min recovery HR and BP was recorded. After 12 wks the same protocol was repeated. The EMG was normalized to the participants walking at a normal pace over 10 m. **RESULTS:** Patients showed a 19.7 % ( $\pm 104$  m) improvement in distance covered Post rehabilitation (p=0.00), whereas the Controls did not improve. Additionally, average HR increased significantly from  $97 \pm 5$  bpm to  $112 \pm 5$  bpm during the 6 min walk test Post rehabilitation (p=0.007). The EMG activity was not significantly different between the Controls and Patients nor did EMG change during the 6 min walk test Post rehabilitation for all muscles; VM= $115 \pm 6.2\%$  vs  $124.6 \pm 12.8\%$ ; VL= $117.3 \pm 5.2\%$  vs  $113.1 \pm 14.1\%$ ; MG= $116 \pm 7.8\%$  vs  $129.7 \pm 8.7\%$ ; LG= $128.6 \pm 6.4$  vs  $131.7 \pm 8.4\%$ . **CONCLUSIONS:** The findings of this study suggest that exercise tolerance improves following rehabilitation, yet EMG remains unchanged. Improvements in functional capacity could therefore be related to factors that relate to muscle efficiency or biomechanical advantage achieved through exercise training (1). References (1) Kuo AD, Donelan JM. Dynamic principles of gait and their clinical implications. *Phys Ther* 2010; 90:157-174.

#### CAN PATELLOFEMORAL JOINT ALIGNMENT BE ASSESSED CLINICALLY?

CAMPBELL-KARN, K.1,2, KORFF, T.2, MCDERMOTT, I.2

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**Introduction** Knee injuries account for 23-31% of lower limb injuries (Thomee et al., 1999). A common cause of knee pain is malalignment of the PFJ. Therapeutic and operative procedures are reliant upon correct diagnoses of PFJ malalignment origins. Current diagnostic methodologies include X-ray, MRI and physical examination with conflicting outcomes (Smith et al., 2009). Of specific concern is the lack of objectivity and reliability of the McConnell clinical method for measuring alignment of the PFJ carried out by Physiotherapists and Sports Therapists internationally. The aim of this study was to objectify the McConnell technique and compare it to established radiological methods. **Method** Twenty-six right knees were scanned using an MRI scanner and the radiological slides were analysed by three accepted methods for assessing patellofemoral alignment (lateral patella displacement [LPD], congruence angle and bisect offset [BO]). The participants also had their knees assessed using an objective assessment tool to replicate the McConnell technique (Patellofemoral tracking calliper [PFTC]). The radiological and clinical assessment methods were correlated using Pearson's correlation coefficient and Spearman's rho. **Results** None of the radiological methods correlated with the PFTC. Additionally, only the BO and LPD method showed a

nearly moderate correlation ( $r=0.392$ ). Discussion The lack of correlation between most of the radiological assessment methods highlights that there are still discrepancies surrounding what constitutes dysfunctional alignment of the PFJ. Further, the PFTC results do not correlate to any of the radiological methods therefore highlighting that when the McConnell method for assessing PFJ alignment is adopted, there is a severe lack of agreement with the true articulations within the joint. This highlights important factors in the current assessment methods carried out by professions including Physiotherapy, Sports Therapy and other physical therapists as they lack reliable outcome measures. From the MRI slides it should also be noted that there were a variety of other factors observed that must be considered when diagnosing PFJ alignment that cannot be assessed purely by the external osseous architecture of the knee. It is therefore controversially recommended that if PFJ malalignment is suspected, a radiological assessment is essential to understand all possible osseous and articular defects that would otherwise go unnoticed. References Smith TO, Davies L, Donell ST (2009) The reliability and validity of assessing medio-lateral patellar position: a systematic review. *Manual Therapy*, 14:355-362 Thomeé R, Augustsson J, Karlsson J. (1999) Patellofemoral Pain Syndrome. *Sports Med*, 28:245-262

## **INCIDENCE OF SPORTS INJURIES TO THE LOWER LIMBS IS HIGH IN PHYSICAL EDUCATION STUDENTS AT UNIVERSITY LEVEL**

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Incidence of sports injuries to the lower limbs is high in Physical Education students at university level Goossens L., Witvrouw E., De Clercq D. Ghent University, Department for Movement- and Sports Sciences, Department of Physiotherapy Sports injuries are widespread in the general population and especially in adolescents (\*). It was hypothesized that sports injury incidence in Physical Education students at university level is high. A detailed description of incidence, localization and type of injuries could provide us with the rationale for the development of sports injury prevention programs. Study design: 123 Physical Education students were followed prospectively during 14 weeks of classes. An e-mail reminded students weekly to register any injury they were affected by during the last week via an online survey. After complete rehabilitation, they filled out another online survey. At the end of the first semester, they completed a survey with reference to their time of exposure to sports during the course of the last 14 weeks. Results: A total of 43 new injuries in 34 students met the criteria to be a so called sports injury. This equals an injury incidence of 1,64 injuries for every 1000 hours of sports participation (men: 1,53; women: 1,92). There was an absolute risk of 34,9% for having a sports injury. 13 injuries (30,2%) took place during classes at university. 30 injuries (69,8%) were acute, 28 (65,1%) happened in a non-contact situation. Most affected body region was the lower limbs (69,8%). Injuries to the knee were most common (20,9%), followed by the lower leg (18,6%), shoulder (11,6%), ankle and upper leg (9,3% each). Discussion: Our results confirm earlier findings by Lysens (\$) who found an injury incidence of 1,7 in a comparable study group over a period of 4 years. Although this number is rather low in comparison with injury incidence in a general sports population of similar age (4,1)(#), the absolute risk in the present study is comparable with earlier findings (36,69%) in a general sports population with an average age of 27y (\*). This high risk is even more worrying in a population of physical education students since injury will negatively affect their studies and it might even interfere with their professional careers. There clearly is a majority of acute, non-contact injuries to the lower limbs. Preventive programs should focus primarily on these injuries to reduce incidence numbers in this population. (\*)Van Mechelen, W., Twisk, J., Molendijk, A., Blom, B., Snel, J., & Kemper, H. C. G. (1996). Subject-related risk factors for sports injuries: A 1-yr prospective study in young adults. *Medicine and Science in Sports and Exercise*, 28(9), 1171-1179. (\$)Lysens RJ: Study of the intrinsic risk factors in sports injuries in young adults. Doctoral thesis. Katholieke Universiteit Leuven, Leuven, Belgium, 1984 (#)Van Galen, W. and J. Diederiks. Sport- blessures breed uitgemeten. Haarlem, The Netherlands: De Vrieseborch, 1990, pp. 27-63.

## **POOR BALANCE IS A RISK FACTOR FOR NONCONTACT ANKLE INJURIES IN AMATEUR MALE FOOTBALL PLAYERS**

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Introduction There is a high ankle injury rate in football but risk factors for noncontact ankle injuries in amateur players are unclear. The aim of this study was to determine whether preseason balance and active and functional dorsiflexion ROM are predictors of ankle injuries in amateur male soccer players. Methods Amateur male football players older than 15 years and playing in local club and area representative teams were recruited. Age, competition level, past injury history, and use of bracing or taping were obtained by questionnaire. Preseason screening assessed ankle dorsiflexion lunge range of motion (ROM), functional strength, balance and ROM by single-leg incline squat on a 10° incline wedge, and 2-legged balance for 20 s on an electronic wobble board. The team trainer or physiotherapist recorded injuries that resulted in a missed training session or game, and the circumstances of injury. Logistic regression was used to determine whether the independent variables ('worst' ankle dorsiflexion lunge, 'worst' single leg incline squat, competition level, age, BMI, previous history of ankle injury, ankle bracing or taping) were predictors of sustaining a noncontact ankle injury. Results Data from 65 players (median age 16.8 y, IQR 16.0-21.7, range 15.2-31.7) were analysed. Only 4 (6.2%) players incurred a noncontact ankle injury and none had a previous ankle injury or preventatively taped or braced. These variables were therefore not included in the model. All other variables (best 'on' balance, 'worst' dorsiflexion lunge, 'worst' single leg incline squat, competition level, age and BMI) were independent of one another with  $r < 0.6$ , except age and BMI ( $r = 0.64$ ), and 'worst' incline squat and 'worst' dorsiflexion lunge ( $r = 0.62$ ), but all were included in the model as these factors were considered important to analysis. The final model retained all variables as it explained a greater percentage of the variance (adjusted  $R^2$  38.7%). Despite the low injury rate, players with poor balance scores in the preseason were at significantly greater risk of incurring a noncontact ankle injury. For every 1.24 s decrease in performance on the balance test (i.e. maintaining the edge of the wobble board off the floor for fewer total seconds) the risk (odds) of being injured increased by a factor of 0.29 (95% CI, 0.12-0.87;  $P = .023$ ). Discussion In amateur male football players, poor pre-season double leg balance, as quantified by the wobble board balance test, is a risk factor for sustaining a noncontact ankle injury during the competition season. Other potential predictors for increased risk of ankle injury including the dorsiflexion lunge test, single leg incline squat test and demographic characteristics were not significantly associated with injury risk. As balance is a modifiable risk factor, improving balance may decrease ankle injury risk.

**DOES A MEDICAL COMPRESSION-SOCK INFLUENCE FATIGUE?**

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**Introduction** The fatigue resistance is an essential factor in training and competition in most sports and demanding exercise (Ament et al., 2009). The purpose of this study was to assess if the use of medically prescribed compression-sock (CS) reduces fatigue during intense exercise and positively influences the electromyographic activity of gastrocnemius muscle. **Methods** Forty subjects (20 males and 20 females with a mean age of  $28.7 \pm 7.3$  yrs) performed 60 consecutive maximal toe-raises (plantar flexion). The frequency of plantar flexion lasted about 3s per plantar flexion and was controlled via a metronome and recorded via Optojump (Microgate, Bolzano, Italy) measuring instrument. After 10 min recovery, we conducted the second trial identical to the first trial. During the first trial of 60 plantar flexion exercises, the subject wore the CS on dominant or non-dominant leg. Only one lower leg used the CS and the sequence of first exercise trial was conducted in random order. At the end of first trial we removed the CS from the leg and in the middle of recovery phase (after 5 min) we applied the CS to the opposite leg. The electromyographic measurements were conducted via bipolar surface electrodes measuring both gastrocnemius muscle heads (long and short head). **Results** Our data revealed that electromyographic signals were significantly lower ( $p < 0.05$ ) during both trials as well as during recovery phase with CS on vs. trials without CS. **Conclusion** The reduction in electromyographic signals with CS suggests that there was greater resistance to fatigue compared to no CS. This may be due to an increased venous return that was enhanced via CS and an increased venous circulation that may have influenced the removal of local waste products formed in gastrocnemius muscle (Ali et al., 2007). **References** Ali A, Caine MP, Snow BG (2007). Graduated compression stockings: Physiological and perceptual responses during and after exercise. *J Sports Sci* 25, 413-419. Ament W, Verkerk GJ (2009). Exercise and fatigue. *Sports Med* 39, 389-422.

**LONGITUDINAL EXCURSION OF THE SCIATIC NERVE DURING THE SLUMP TEST IN A HAMSTRING INJURED ATHLETE.**

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**Introduction** Scar tissue, has been proposed to tether the sciatic nerve in the posterior thigh in athletes presenting with hamstring strains (Turl and George, 1998) subsequently reducing the mobility of the nerve, leading to secondary nerve damage. This case study highlights the effect a hamstring injury has on the longitudinal excursion of the sciatic nerve in the posterior thigh when measured during the slump test. **Method** A 20 year old male, semi-professional rugby union player sustained a posterior thigh injury 11 days prior to participating in this study. An isokinetic dynamometer was used in passive mode to conduct a modified slump test. With the hip and knee placed in 90° and 50° flexion respectively, the athlete maintained thoracic flexion and either cervical flexion or extension. The ankle joint was then passively moved by the dynamometer (10°/sec) 10° into plantar-flexion or dorsi-flexion from a neutral position. B mode ultrasonography was used to record the movement of the sciatic nerve in the posterior thigh during the slump test, in addition to confirming the presence of a muscle strain. An adaptive block matching algorithm using cross-correlation was used to dynamically track the movement of the sciatic nerve, during both isolated movements of the ankle joint. Excursion of the nerve was measured during a total of 20° dorsi-flexion and 20° plantar-flexion. **Results** Evidence of haematoma within the hamstring muscle group was discovered lying in close proximity to the sciatic nerve. During the slump test, the sciatic nerve moved more in the injured limb (0.65mm) than the uninjured one (0.19mm) when the cervical spine was flexed and the ankle dorsi-flexed; a finding also discovered when the spine was extended. When the cervical spine was maintained in flexion and the ankle moved into plantar flexion the sciatic nerve moved a greater longitudinal distance in the injured limb (0.79mm) than its uninjured counterpart (0.29mm). However, the same was not evident when the spine was extended during ankle plantar flexion; a difference which was minimal (0.07mm). **Discussion** In this case study, the presence of hamstring strain did not affect sciatic nerve longitudinal excursion in the posterior thigh during the slump test. The hypothetical tethering of the nerve during hamstring injury must be questioned, as it required significant muscle damage in Carmody and Prietto's (1995) case study to cause entrapment of the sciatic nerve following hamstring injury. **References** Carmody, C. & Prietto, C. (1995). *J Bone & Joint Surg*, 77, 1100-1102. Turl, S.E. & George, K.P. (1998). *J Ortho & Sports Phys Ther*, 27, 16-21.

**Oral presentations****OP-PM43 Muscle and Strength Training****INFLUENCE OF FREQUENCY AND DURATION OF STRENGTH TRAINING FOR EFFECTIVE MANAGEMENT OF NECK PAIN**

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**Introduction** An increasing number of studies provide evidence for the effectiveness of strength training at the workplace in managing musculoskeletal pain. Specific strength training is a promising type of physical exercise for relieving neck and shoulder pain in office workers. However, the optimal combination of frequency and exercise duration remains unknown. This study investigates how a 20-week intervention with one hour of specific strength training for the neck- and shoulder muscles is most effectively distributed over a working-week. **Methods** We performed a cluster randomized controlled trial with 447 working-age office workers who were allocated to one of three intervention groups or a reference group. The first intervention group was offered training for one 60-minute session a week (1WS) ( $n=115$ ), the second was offered training three times 20-minute a week (3WS) ( $n=122$ ), and the third was offered training for nine 7-minute sessions a week (9WS) ( $n=113$ ). The reference group was not offered any training (REF) ( $n=97$ ). The three intervention groups performed high intensity strength training with supervision 50% of the sessions. Participants answered a questionnaire at baseline and follow-up including the Standardized Nordic questionnaire for musculoskeletal disorders. **Results** After 20 weeks all three intervention groups achieved significant reduction in neck pain compared to the REF group. From a baseline pain rating of 3.3 (SD 2.2) 1WS experienced a reduction of 1.5 (95%CI 0.9 to 2.1). From 3.2 (2.4) 3WS experienced a reduction of 1.4 (0.9 to 2.0), and from 3.1 (2.3) 9WS experienced a reduction of 1.4 (0.8 to 2.1). There was no significant difference between any of the intervention groups. **Discussion** A 20-week intervention with one hour of specific strength training is effective for reducing non-specific neck pain in office workers. Further, 1WS, 3WS, and 9WS were equally efficient. This implies a large degree of flexibility for companies and employees regarding time distribution when incorporating specific strength training into a weekly work schedule.



## THE EFFECTS OF STRENGTH AND POWER TRAINING ON PHYSICAL PERFORMANCE IN PREFRAIL COMMUNITY-DWELLING OLDER ADULTS

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**Introduction** The benefits of regular strength and power exercises on mobility enhancement in older adults have been well established. However, due to the lack of research, it is still unclear which resistance training modalities should be prescribed for older adults in the state of prefrailty or frailty. The aim of the present study was to compare the effects of strength training versus power training on functional performance in prefrail older adults (NCT00783159). **Methods** The trial was based on a prospective randomized controlled single-blind study design. Out of 298 community-dwelling older adults (>65 years) who volunteered for participation, 69 were diagnosed as prefrail according to the definition of Fried et al (2001). The included prefrail participants were randomly assigned into a strength training, power training or control group. The strength and power training comprised a 60min x 2days exercise program over 12 weeks. All participants were supplemented with vitamin D3 orally before entering the intervention period. The primary outcome was the Short Physical Performance Battery (SPPB). Secondary outcomes were muscle power, appendicular lean mass (aLM) measured by DXA and self-reported functional deficit (SF-LLFDI). **Results** Participants in both training groups significantly ( $p=.011$ ,  $p=.012$ ) increased their SPPB score compared to the control group, with no statistical difference among training groups ( $p=.465$ ). No between-group differences were found in changes in aLM ( $p=.660$ ), muscle power ( $p=.294$ ) and SF-LLFDI ( $p=.571$ ). Muscle power significantly increased ( $p=.017$ ) under vitamin D3 intake. **Conclusions** Strength and power training were effective in increasing the physical performance in prefrail community-dwelling older adults. Contrary to the findings in other studies with non-frail older adults, no differences were found between both training modalities. This implies that in the state of prefrailty, strength and power training may be equally effective. However, with regard to drop-out rates, strength training appears to be advantageous compared to power training. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop WJ, Burke G, McBurnie MA; Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci.* 2001;56(3):M146-56

## VOLUME, INTENSITY AND TIMING OF MUSCLE POWER POTENTIATION ARE VARIABLE

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Volume, intensity and timing of muscle power potentiation are variable Behm, D.G.1, Chaouachi, A.2, Abed, M.F.2, Poulos, N.3, Drinkwater, E.J.4 1: Newfoundland, Canada, 2: Tunis Tunisia, 3. Aspire, Qatar, 4. Bathurst Australia **Introduction** Whereas muscle potentiation is consistently demonstrated with evoked contractile properties, the potentiation of functional and physiological measures is more inconsistent. The objective of the study was to compare a variety of conditioning stimuli volumes and intensities over a 15-minute recovery period. **Methods** Twelve volleyball players were subjected to conditioning stimuli that included 10 repetitions of half squats with 70% of 1 repetition maximum (10 x 70%1RM), 5 x 70%1RM, 5 x 85%1RM, 3 x 85%1RM, 3 x 90%1RM, 1 x 90%1RM, and control. Jump height, peak and mean power, velocity and peak force were measured at baseline, 1, 3, 5, 10, and 15 minutes. Data were analyzed with a 2-way repeated measure ANOVA. Further analysis of magnitude-based inferences was conducted on the isolated peaks of each dependent variable. **Results** The ANOVA indicated significant decreases in jump height and velocity at 10 and 15 min recovery with impaired power at 5, 10 and 15 min recovery and no significant change in force. This should not be interpreted that no potentiation occurred. Each dependent variable reached a peak at a slightly different time post-intervention: peak jump height (2.83 min $\pm$ 2.32), mean power (3.62 min $\pm$ 3.01), peak power (2.57 min $\pm$ 1.88), and peak velocity (2.57 min $\pm$ 1.81). Differences in peak times were all trivial or small (i.e.  $d<0.50$ ), though all comparisons with peak force (6.57 min $\pm$ 5.33) were large ( $d>0.80$ ), which is to say the peak force reached its peak substantially later than the other dependent variables. In assessing just the peak data, magnitude-based inference revealed both the 5x70 and 3x85 protocol elicited changes that exceed 75% likelihood of exceeding the smallest worthwhile change (SWC) for peak power (89% and 80% likely respectively) and velocity (77% and 87% likely respectively). The 10x70 also had a substantial likelihood of potentiating peak velocity above the SWC (75% likely). The 5x70 protocol had an 80% likelihood of exceeding the SWC in mean power. **Discussion** Most measures peaked at one-, three-, or five-minutes though this peak was often not greater than the smallest worthwhile change. There was sufficient inconsistency in the timing of the peak that there was no statistically significant potentiation in the repeated measures ANOVA. Magnitude-based inferences revealed that while no protocol had a substantial likelihood of potentiating the peak vertical jump above the SWC, the 5x70 protocol had the most consistent substantial likelihood (i.e. >75%) of increasing the peak of most dependent variables, in particular power as well as peak velocity. We were unable to consistently predict if these peaks occurred at 1-, 3, or 5 minutes post-stimulation though declines after 5 minutes seems probable.

## EFFECT OF 12 WEEKS OF AEROBIC VERSUS RESISTANCE TRAINING ON PERCEIVED APPETITE AND CIRCULATING LEVELS OF APPETITE-RELATED HORMONES

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**Introduction** Aerobic exercise training has been shown to improve appetite regulation by leading to more sensitive eating behaviour in response to previous food intake (Martins et al., 2007). However, the role of appetite-related hormones in mediating this response is not clear. Furthermore, it is not known whether similar benefits would be achieved with regular resistance training. Therefore, the purpose of this study was to investigate the effect of 12 weeks of aerobic versus resistance training in previously sedentary volunteers on perceived hunger and satiety, as well as a range of appetite-related hormones in both the fasted state, and in response to a standardised test meal. **Methods** Thirty three previously inactive, overweight males were allocated to either an aerobic-based exercise training group (AER;  $n = 12$ ), a resistance-based training group (RES;  $n = 13$ ) or a control group (CON;  $n = 8$ ). The AER and RES groups participated in 12 weeks of exercise training (3 sessions per week). AER participated in aerobic-based activities such as stationary cycling, treadmill walking and the cross trainer. RES completed a range of resistance-based exercises for each major muscle group of the body. Perceived hunger and satiety, together with a range of appetite-related hormones (active ghrelin, leptin, pancreatic polypeptide and peptide tyrosine tyrosine) were assessed pre and post-intervention in both the fasted state and in response to a standardised test meal. **Results** There was no change in perceived hunger in the fasted state following the intervention period in any group. There was no change in perceived hunger in response to the standardised meal in CON or AER, but perceived hunger was higher 2 hours after the meal post-training in RES ( $p < 0.05$ ). With respect to perceived satiety, there was no difference following the intervention period in CON or RES, while perceived satiety

was higher in the fasted state following AER training ( $p < 0.05$ ). These observations were associated with lower circulating leptin in both AER and RES following training, while levels of active ghrelin, pancreatic polypeptide and peptide tyrosine tyrosine were not altered as a result of training in either the fasted state or following consumption of the test meal. Discussion Regular aerobic exercise training may assist in weight management by stimulating satiety, while an equivalent period of resistance training may stimulate hunger sooner after eating. The role of appetite-related hormones in these changes is unclear and requires further investigation. References Martins C, Truby H, Morgan LM. (2007). *Br J Nutr*, 98, 834-842.

### **SIMILAR HYPERTROPHIC AND STRENGTH GAINS IN YOUNG MEN AFTER TRAINING WITH MAXIMAL SHORTENING OR LENGTHENING CONTRACTIONS MATCHED FOR TOTAL WORK**

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Introduction Acute infusion and chronic resistance training studies have suggested that performance of eccentric (lengthening) contractions result in greater increases in protein synthesis and hypertrophy than performance of concentric (shortening) contractions. We aimed to determine whether training-induced increases in muscle size and strength differed between maximal lengthening (LC) and maximal shortening (SC) contractions when total external work is equivalent. Methods Nine healthy young males completed a 9-wk isokinetic (0.79 rad/s) resistance training program of the elbow flexors whereby they performed LC with one arm and an equivalent volume of total external work with the contralateral arm as SC. Results Training increased isometric peak torque for both LC ( $9.6 \pm 5.8\%$ ; mean  $\pm$  SE) and SC ( $20.7 \pm 9.8\%$ ) with no difference between conditions. There were also similar increases in isokinetic peak torque at both slow (0.79 rad/s) and fast (5.24 rad/s) velocities and both shortening and lengthening contractions for both LC ( $\sim 8$ -10%) and SC ( $\sim 9$ -20%). Despite a  $\sim 40\%$  greater work per repetition with LC, training increased work per repetition similarly for both LC ( $17.2 \pm 6.3\%$ ) and SC ( $22.1 \pm 8.9\%$ ). The pQCT-measured increase in muscle cross-sectional area with training was also similar between LC ( $6.5 \pm 0.6\%$ ) and SC ( $4.6 \pm 0.4\%$ ). Discussion Given that we equated both total external work as well as the training intensity (i.e. maximal effort contractions), we hypothesize that the exercise provided a sufficient and equivalent stimulus to induce similar levels of skeletal muscle remodelling and, hence, muscle hypertrophy. Strength gains with maximal LC and SC resistance training were also similar in magnitude. We conclude that increases in muscle size and strength with short-term unilateral resistance training are unrelated to muscle contraction type when matched for both contraction intensity (maximal) and total external work. Funding provided by NSERC.

### **MUSCLE FIBRE HYPERTROPHY AFTER TIME-OF-DAY-SPECIFIC RESISTANCE TRAINING**

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MUSCLE FIBRE HYPERTROPHY AFTER TIME-OF-DAY-SPECIFIC RESISTANCE TRAINING Sedliak, M.1, Cvecka, J.1, Buzgo, G.1, Hamar, D.1, Laczo, E.1, Zelko, A.1, Zeman, M.2, Sedlak, P.3, Ahtiainen, J.P.4, Hakkinen, K.4, Hulmi, J.J.4, Nilsen, T.5, Raastad, T.5 1: FTVS UK (Bratislava, Slovakia), 2: PriF UK (Bratislava, Slovakia), 3: SCHA Kramare (Bratislava, Slovakia), 4: JYU (Jyväskylä, Finland), 5: NIH (Oslo, Norway) Introduction Muscle strength is typically lower in the morning compared to the afternoon but this performance deficit is reduced by regular morning training (Souissi et al., 2002). Much less is known with regards to hypertrophy. The only study performed on humans found a tendency to smaller gains in muscle size, measured by MRI, when repeatedly training in the morning compared to the afternoon (Sedliak et al., 2009). However, no data are available at the level of muscle fibres. This study examined the effect of time-of-day-specific resistance training on muscle fibre hypertrophy. Methods Fourteen untrained men (mean  $\pm$  SD, age  $24 \pm 3$  yrs, body mass  $77.4 \pm 5.82$  kg, height  $181 \pm 8.35$  cm) were pair-matched based on pre-training MVC and BMI index. Thereafter, participants were randomly divided into 2 training groups: Morning (M,  $n=7$ ) and Afternoon (A,  $n=7$ ). M and A trained for 11 weeks 2-3 times a week between 07:30-08:30 h and 16:00-17:00 h, respectively. Both groups underwent identical hypertrophy resistance training with all sessions being supervised. Another 7 subjects served as controls (C). Muscle biopsies were taken from the right vastus lateralis one week prior to and one week after the training. Muscle specimens were analysed for muscle fibre cross-sectional areas (CSA). Results The M and A group increased significantly their CSA from  $5298 \pm 835$  to  $6168 \pm 988$   $\mu\text{m}^2$  (17.6%) and from  $5836 \pm 1001$  to  $7125 \pm 1108$   $\mu\text{m}^2$  (23.0%), respectively. The C group CSA did not significantly change ( $6138 \pm 1016$  to  $5755 \pm 1107$   $\mu\text{m}^2$ , -5.9%). The Wilcoxon Signed rank test showed significant differences between pre- to post training in M ( $p=0.016$ ) but not in A ( $p=0.128$ ) or C ( $p=0.310$ ). Discussion Resistance training increased muscle fibre CSA both in the M and A groups. However, hypertrophic training adaptation was more variable in the M group with 3 out of 7 subjects having no increase in CSA. There was only 1 subject out of 7 in the A group with CSA increase smaller than 10%. Similarly high inter-individual variability in hypertrophic adaptation, when training in the morning, has been reported before (Sedliak et al., 2009) and it could, at least partly, come from diurnal differences in hypertrophic signalling pathways in muscle cells (Sedliak et al., 2010). References Souissi et al., (2002) *J Sports Sci*, 11, 929-937. Sedliak et al., (2009) *J Strength Cond Res*, 23, 2451-2457. Sedliak et al., (2010) Abstract, 7th International Conference on Strength Training, 2010, Bratislava, Slovakia

## **Oral presentations**

### **OP-PM47 Physiology: Brain and Central Fatigue**

#### **EFFECT OF BRAIN NEUROTRANSMITTERS MODULATION ON SUPRASPINAL FATIGUE**

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*UNIVERSITÉ LIBRE DE BRUXELLES*

Effect of brain neurotransmitters modulation on supraspinal fatigue <sup>1</sup>Klass M, <sup>2</sup>Roelands B, <sup>1</sup>Levenez M, <sup>2</sup>Fontenelle V, <sup>2</sup>Pattyn N, <sup>2</sup>Meeusen R, <sup>1</sup>Duchateau J <sup>1</sup>Laboratory of Applied Biology, Université Libre de Bruxelles and <sup>2</sup>Department of Human Physiology and Sports Medicine, Vrije Universiteit Brussel, Belgium. Introduction Prolonged cycling and running exercises induce a failure of the nervous system to drive the muscle at its maximal capacity ('central fatigue'; Millet and Lepers 2004). Using transcranial magnetic stimulation (TMS), it has been shown that part of central fatigue is due to an insufficient output from the motor cortex ('supraspinal fatigue'; Todd et al 2003; Klass et al 2008). Although, the underlying mechanisms are not yet understood, a few studies suggested that supraspinal fatigue could be related to a change in the brain concentration of dopamine and noradrenaline (Roelands and Meeusen 2010). To investigate the poten-

tial link between neural fatigue and changes in brain concentration of these two neurotransmitters, we combined neurophysiological methods and pharmacological manipulation of brain neurotransmitters. **Methods** Changes in performance of a prolonged cycling exercise (60 min at 55% Wmax followed by a time trial which required the subject to complete a work equal to 30 min at 75% Wmax as quickly as possible) were tested in well-trained subjects after acute oral administration of a placebo, a dopamine or a noradrenaline reuptake inhibitor under normal temperature conditions (18°C). Voluntary activation, corticospinal excitability and excitation-contraction coupling changes were also tested in the knee extensors using TMS and motor nerve electrical stimulation before and after the cycling exercise. **Results** When noradrenaline reuptake inhibitor was administered, more time was needed to complete the time trial (~9%) as compared with the placebo condition, and it was accompanied by a supraspinal fatigue (voluntary activation reduced by ~6%). In contrast, there was no significant effect of dopamine reuptake inhibitor on these two parameters. However, corticospinal excitability was unchanged and excitation-contraction coupling similarly reduced after the time trial in the three conditions. **Discussion** Our results suggest that contrary to dopamine, noradrenaline plays a key role in the development of supraspinal fatigue during prolonged cycling exercise at 18°C. Because corticospinal excitability was not modified after the time trial, noradrenaline appears to affect more specifically the supraspinal circuits "upstream" to the motor cortex. As a consequence, the output from the motor cortex becomes insufficient to drive the muscles optimally. **References** Klass M et al. *J Neurophysiol* 99:1096-1104 (2008) Millet GY and Lepers R. *Sports Med* 34:105-116 (2004) Roelands B and Meeusen R. *Sports Med* 40:229-246 (2010) Todd G et al. *J Physiol* 551:661-671(2003) Supported by a grant of the Fonds National de la Recherche Scientifique of Belgium (FC82578)

### BRAIN ACTIVATION AND PERCEIVED EXERTION DURING CYCLING: A FMRI PILOT STUDY.

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An increased interest has emerged on the magnitude of brain control during exercise. This study aimed to apply functional magnetic resonance imaging (fMRI) to assess whole cerebral function during a cycling exercise, and the relationship to the ratings of perceived exertion (RPE). An MRI compatible cycling ergometer was specifically built for this study (Jaguaré Protótipos Ltda, Brazil) in which the torque generated was transferred through a cardan system and attached to a cycling ergometer (Computrainer, Racemate, Inc., USA) positioned outside the MRI room. Seven healthy male adults were positioned in a MRI scanner (3T Magnetom Allegra, Siemens, Erlangen, Germany), with special care taken to optimize the subjects' comfort in an atypical, horizontal position and to avoid head motion. Structural magnitude prepared rapid gradient echo (MPRAGE) images with a 1x1x1mm<sup>3</sup> resolution were acquired at rest (9 min). Blood oxygen level dependent (BOLD) imaging was then performed as the subjects completed a stochastic cycling block protocol which consisted of a 10 s instruction period, followed by 6 trials of 2 min cycling interleaved with 16 s rest intervals between each trial. Whole brain fMRI data were acquired every 2 s. The workload was determined depending on the fitness level and weight of each participant, and was kept constant during all trials. Subjects were asked to maintain a constant cadence of 60 rpm. In addition, subjects reported their RPE using the Borg scale for perceived exertion (6-20) at 1 min intervals through the audio connection. For data analysis, after motion correction, contrasts were established as cycling vs rest and RPE < 15 vs RPE > 15 using the BrainVoyager software (Brain Innovation, Maastricht, Netherlands). The multi-subject analysis revealed ipsilateral Cerebellum and contralateral Post-central Gyrus activations for cycling vs rest comparison ( $p < 0.001$ ). Cingulate Gyrus and Precuneus were significantly activated in two single-subjects analysis when RPE > 15 were compared to RPE < 15. The findings of the present study propose the possibility of analyzing the activation of brain functional areas during cycling exercise, which could potentially relate to central processes of consciousness of exercise intensity.

### PREVIOUS SHORT-TERM TRAINING INFLUENCES BRAIN ACTIVITY DURING TASK OBSERVATION AT REST

KELLER, M., LEUKEL, C., LAUBER, B., TAUBE, W.

UNIVERSITY OF FRIBOURG

PREVIOUS SHORT-TERM TRAINING INFLUENCES BRAIN ACTIVITY DURING TASK OBSERVATION AT REST Keller, M.1, Leukel, C.1&2, Lauber, B. 2, Taube, W.1 1: UOSS (Fribourg, Switzerland), 2: IFSS (Freiburg, Germany) **Introduction** Previous studies have demonstrated that brain activation is modulated during task observation (Gangitano et al. 2001). Furthermore, motor experience seems to be relevant for brain activation when observing a movement (Orgs et al. 2008). In this context, Aglioti et al. 2008 showed that elite basketball players who observed free shots predicted the success earlier and more precisely than individuals with visual experience and novices. Furthermore, the athletes showed an additional selective increase in motor activation during the observation of non-scoring shots. Therefore, the activity of the motor cortex seems to be dependent whether the observed movement corresponds to the internal representation of this particular movement. In line with this, we hypothesized that the observation of a previously trained fast dynamic plantarflexion results in a different cortical excitability compared to the observation of an unknown tonic plantarflexion task due to the better internal representation of the previously trained task. **Methods** Nine subjects were instructed to train fast concentric plantarflexions in an ankle torque ergometer. After the training session, two videos showing different movements were displayed: first, a video of a fast dynamic plantarflexion and second, a video of an isometric plantarflexion. To test changes in the corticomotoneuronal transmission of monosynaptic and polysynaptic corticospinal pathways to the  $\alpha$ -motoneurons, the soleus H-reflex was conditioned by TMS to the motor cortex (M1). The first detectable facilitation of the H-reflex was determined after M1-conditioning and expressed as percentage of a control stimulus. **Results** The conditioned H-reflexes of the early facilitation, which indicate the contribution of direct corticospinal pathways, were significantly higher when subjects observed the untrained tonic contraction (121 %) compared to watching the dynamic task (108.3%;  $p < 0.04$ ). During action observation no changes in ankle torque and soleus bEMG were observable. **Discussion** The present results suggest that short-term training of a dynamic plantarflexion task leads to augmented brain activation when observing a non-trained tonic plantarflexion instead of the previously trained dynamic one. Therefore, the data suggest that cortical activity increases to a higher extent when subjects observe a movement, which does not correspond to their internal representation. This facilitation might reflect a mental effort to change the observed movement in the direction of the trained one. **References** Aglioti et al. (2008) *Nature Neuroscience*, 11(9), 1109-1116. Gangitano et al. (2001) *Neuro Report*, 12(7), 1489-1492. Orgs et al. (2008) *Eur J Neurosci* 27:3380-3384.

**CEREBROVASCULAR AND CORTICOMOTOR FUNCTION DURING PROGRESSIVE PASSIVE HYPERTHERMIA**

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**Introduction** Hyperthermia has been shown to impair the central nervous systems ability to voluntarily activate muscle and to reduce cerebral blood flow. However, the relationship between this altered cerebrovascular function and supraspinal failure of motor drive has yet to be investigated. **Methods** We examined the integrative effects of passive heating on cerebral perfusion, oxygenation and alterations in central motor drive. Eight subjects underwent passive hyperthermia (0.5°C increments in core [rectal] temperature [T<sub>c</sub>] from normothermia [37 ± 0.3 °C] to the limit of thermal tolerance [T-LIM; 39 ± 0.4 °C]). Cerebral oxygenation, blood flow velocity in the mid cerebral artery (CBFV) and respiratory responses were measured continuously each 0.5°C increase in T<sub>c</sub>. At each level, supramaximal femoral nerve stimulation and transcranial magnetic stimulation (TMS) were performed to assess neuromuscular and cortical function, respectively. Measurements were also made during a period of induced isocapnia (ISO; by administration of 5% CO<sub>2</sub>), which was performed randomly either before or after measurements made at T-LIM. **Results:** CBFV was reduced by ~20% from +0.5°C until T-LIM; however cerebral oxygenation was initially increased until +1.0°C but returned to baseline values thereafter. Maximal voluntary contraction of the knee extensors was decreased at T-LIM (-9 ± 10.3%, P<0.05) and maximal electromyographic (EMG) activity of the Vastus Lateralis was decreased at +1.0°C until T-LIM (-26.6 ± 23.2% at T-LIM, P<0.05), whilst the amplitude of the compound muscle action potential was unchanged. Cortical voluntary activation (VA), assessed by TMS, was decreased at +1.5°C and at T-LIM by 10.8 ± 8.4% and 22 ± 23.3%, respectively (P<0.05). Corticospinal excitability (measured as the EMG response produced by TMS) was unaltered. The reductions in cortical VA were correlated with reductions in CBFV (R<sub>2</sub> = 0.659, P= 0.06), but were not related to changes in end tidal CO<sub>2</sub>. Interestingly, during ISO, MVC and cortical VA were similar to baseline values. During this period, hyperventilation was attenuated (VE decreased towards baseline). Subsequent analysis revealed a correlation between reductions in cortical VA and increases in VE (R<sub>2</sub> = 0.7, P<0.05). **Discussion** These results indicate that descending voluntary drive becomes progressively impaired as T<sub>c</sub> is increased by more than +1.0°C, and this may be brought about, in part, by altered cerebral perfusion. In addition, afferent feedback from increased respiratory work might be integrated upstream of the motor cortex and subsequently modulate cortical output.

**NO EFFECT OF INDUCED BLOOD ALKALOSIS ON CEREBRAL DEOXYGENATION DURING SUPRAMAXIMAL EXERCISE**

PERREY, S.

MONTPELLIER-1 UNIVERSITY, UFR STAPS

**NO EFFECT OF INDUCED BLOOD ALKALOSIS ON CEREBRAL DEOXYGENATION DURING SUPRAMAXIMAL EXERCISE** Perrey, S<sup>1</sup>, Thomas, C.2,3, Delfour, R.3,4, Leprêtre, P.M.5, Dorel, S.4, Bishop, D.6, Hanon, C.3 <sup>1</sup> Movement to Health (Montpellier, France), <sup>2</sup> STAPS department (Evry, France), <sup>3</sup> INSEP (Paris, France), <sup>4</sup> Motricité, Interaction, Performance (Nantes, France), <sup>5</sup> UPJA (Amiens, France), <sup>6</sup> ISEAL (Melbourne, Australia) **Introduction** Identification of the precise roles of the brain in regulating exercise performance in response to metabolic signals produced during exhaustive exercise is elusive. Cerebral oxygenation during very hard exercise drops (Rupp & Perrey, 2008) and may be linked to changes in arterial blood gases (Nielsen, 2003). The aim of this study was to investigate the impact of sodium bicarbonate ingestion on blood-gas variables and cerebral de-oxygenation response to supramaximal cycling exercise. **Methods** Eleven trained male cyclists (age 26.4±3.3 years; body mass 74.3±11.9 kg) took part in the study. On two different visits, they performed 70-s all-out test at fixed pedalling rates (calculated from torque-velocity protocol), 60 min after having ingested i) 0.3 g.kg<sup>-1</sup> body mass of sodium bicarbonate (BIC) or ii) 0.2 g.kg<sup>-1</sup> body mass of sodium chloride (placebo; PLA). The supplements were administered in a blind, randomized order. The initial work rate of Δ50 was sustained constant during the first 20-s, then subject were asked to maintain constant their pedalling rate (isokinetic model). The power Δ50 was defined as the intensity midway between the VO<sub>2</sub>peak (determined during a 20W/min incremental test) and the work requiring 100 % of maximal mechanical power extrapolated from previous torque-velocity tests. During both all-out tests, the cerebral oxygenation was monitored by one pair of continuous-wave infrared spectroscopy (Artinis, Oxymon MKIII, The Netherlands) probe positioned over the left prefrontal cortex between Fp1 and F3, according to international EEG 10-20 system. Blood samples (85 µl) were taken at the earlobe, before and 0, 5 and 8 minutes of recovery for pH, bicarbonates. **Results** The overall performance was significantly improved with BIC compared to PLA conditions (572 W vs. 557 W, P<0.01). With BIC, pH and bicarbonate concentrations values were significantly higher at rest and during the recovery period (P<0.001). For both conditions, cerebral oxygenation decreased significantly over time but no significant difference was observed according to the experimental conditions. **Discussion** While exercise performance was improved, our findings suggest that frontal lobe oxygenation is not modulated by preexercise blood alkalosis. Association between maximal exercise performance and hemodynamics responses in the brain might not be influenced by metabolic strain associated with muscle metabolism. **References** Nielsen HB. (2003). *Scand J Med Sci Sports*, 13, 339-358. Rupp, T, Perrey S. (2008). *Eur J Appl Physiol*, 102, 153-163.

**BRAIN BLOOD FLOW ADAPTATIONS TO INTENSE-INTERVAL COMPARED WITH ENDURANCE TRAINING**

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1: OU (DUNEDIN, NEW ZEALAND); 2: WU (OREGON, USA) AND 3: UBC (KELOWNA, CANADA)

**Introduction:** Aerobic fitness and cerebral blood flow (CBF) are positively related. Preliminary evidence indicates that resting CBF and its responsiveness to CO<sub>2</sub>, an important regulator of CBF, is improved following endurance training. Maximal-intensity interval training has recently been shown to match traditional endurance-based training in improving energy metabolism. It is not known whether such intense training may also provide comparable adaptations within the cerebrovasculature. Therefore, the purpose of this study was to examine cerebrovascular adaptations to endurance (END) versus repeat high-intensity interval training (RHIE). **Methods:** Participants were 12 healthy but untrained adults (5 males, 7 females; age 23 ± 4 y; VO<sub>2</sub>max 38 ± 5 mL/min/kg). They were ranked within sex for VO<sub>2</sub>max and assigned in randomised then alternating order to an 8-wk supervised RHIE or endurance cycle ergometer training using established protocols, before a 7-wk washout and crossover. RHIE progressed from four to six 30-s intervals 3 d/wk, whereas END progressed from 40 to 60 min at 65% HRmax 5 d/wk. Middle cerebral artery blood velocity (MCAv, Transcranial Doppler), MAP (Finometer), heart rate (HR), and the partial pressure of end-tidal carbon dioxide (PETCO<sub>2</sub>) were measured at rest before and <3 d after training. In addition, cerebrovascular responses to hypercapnia (5% CO<sub>2</sub>; 3 min) and matched hypocapnia (forced hyperventilation; 2 min) were assessed at rest before and following training. Females were tested on days 4-10 of the menstrual cycle. Inferential analysis was via spreadsheets at [www.newstats.org](http://www.newstats.org). **Results:** Whereas mean (±SD) resting MCAv tended to be higher across END (by 4 ± 14 cm/s) and be lower across RHIE (by -4 ± 6 cm/s), the differential effect of training regime was unclear (95% CI: -19 to +3, P=0.15). Across the training regimes, cere-

brovascular responses to hypercapnia (change:  $-0.03 \pm 1.10$  and  $0.06 \pm 1.20$  cm/s/mm Hg, for END and RHIE respectively) and hypocapnia (change:  $-0.35 \pm 0.96$  and  $0.00 \pm 1.30$  cm/s/mm Hg) were not measurably affected by either training regime. Conclusion: Although fundamentally different forms of training have been shown to improve the endurance phenotype of muscle and its vasculature, the present data do not clearly support an effect of (8 wk) training per se, nor an effect of training type, on cerebrovascular function. Given the link between impaired brain blood flow and many cerebrovascular diseases, further research seems warranted to clearly establish the direct relation between improved cerebrovascular function and exercise, including different exercise modes and regimes.

**18:00 - 19:30**

## Oral presentations

### OP-PM44 Muscle Activity 1

#### CHANGES IN METABOLIC AND BIOMECHANICAL RESPONSES AFTER HIGH-INTENSE RUNNING EXERCISE

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**Introduction** Few works have described implications of high-intense interval training work on biomechanics and physiology related to such fatiguing demand through the task. These changes are related to decrease in energy offer, muscle activation, and impairments in the excitation-contraction coupling. Consequently, some changes in kinematics, such as stride length (SL) and stride frequency (SF), may impair running technique. In this way, the main objective of the present study was to verify the effects of an interval training session on physiological (blood lactate [LAC], glucose [GLU], heart rate [HR], ventilation [VE], perceived exertion [PE]) and biomechanical parameters (SF, stance phase duration [STA], swing phase duration [SWI]). **Methods** Ten healthy men ( $25 \pm 5$  years;  $173 \pm 5.1$  cm;  $74 \pm 9$  kg;  $11.6 \pm 4.7$  % body fat) performed the following tests on different days: 1) an incremental test in a treadmill (Micromed, Centurion, Brasilia, Brazil), in order to determine maximal aerobic capacity (vMAX) and the anaerobic threshold (AT), by means of ventilatory method (Micromed, FlowMet, Brasilia, Brazil); 2) 5-min running at the AT intensity (PRE); 5 minutes after, a warm up followed by an interval training session (8 x 1min at vMAX, 1 min at a recovery intensity [50%vMAX]). Immediately after the interval training session, a new 5 minutes running at the AT intensity was performed (POST). The two sessions were separated by, at least, 48 hrs between them. During the last 20-seconds of the PRE and POST exercises, 60Hz images were registered. Stride frequency (SF) stance phase (STA) and swing phase (SWI) were accessed by free-software Motion Analysis Tools®, mean values of five strides were considered for analysis. Three-min after the PRE and POST conditions, LAC [LAC] and [GLU] were measured. Other parameters (HR, VE, PE, SF, STA, SWI) were recorded at the last 20-seconds for PRE and POST. The comparisons between PRE and POST were made using a two tailed Students Paired t test set at  $p < 0.05$ . **Results** Significant changes ( $p < 0.05$ ) were found between PRE and POST for [LAC] (PRE =  $2.8 \pm 0.9$  mmol/L; POST =  $8.49 \pm 3.3$  mmol/L) and [GLU] (PRE =  $95 \pm 1$  mg/dL; POST =  $121 \pm 2$  mg/dL). Significant increases in HR (PRE vs POST):  $163 \pm 1$  vs  $182.2 \pm 9$  bpm, VE ( $73 \pm 11$  vs  $89 \pm 14$  /min), RPE ( $11 \pm 2$  vs  $14 \pm 3$ ) and SF ( $82 \pm 3$  vs  $85 \pm 4$  /min) were also found between PRE and POST ( $p < 0.05$ ). However, STA and SWI presented no changes when PRE and POST were compared ( $P > 0.05$ ). **Conclusion** Running interval training exercise performed at maximal intensity presented effects in physiological parameters, as the [LAC] [GLU], HR and VE, as consequence of the increased intensity used (compared to the AT intensity), which leads to higher muscle fatigue. At the same time, the increased RPE supports these changes, since at the same intensity the effort seems to be heavier. In addition, kinematic behaviors, such as for SF, were altered concomitantly, which could be related to difficulties to maintain same performance, through muscle activation and range of motion during running.

#### CONCURRENT FATIGUE AND POTENTIATION IN ENDURANCE ATHLETES

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UNIVERSIDADE CATÓLICA DE BRASÍLIA

**Purpose:** countermovement jump (CMJ) and maximum running speed over a distance of 20 m were evaluated for examination of the concurrent fatigue and postactivation potentiation (PAP) in endurance athletes after an incremental field running test. **Methods:** twenty-two endurance athletes performed two attempts of CMJ on a force plate and maximum running speed test prior to and following the Université de Montréal Track Test (UMTT). **Results:** the results showed an improvement in CMJ height (3.6%) after UMTT that correlated with the increment in peak power (3.4%); with a concurrent peak force loss (-10.8%) that correlated with peak power enhancement. The athletes maintained their 20 m sprint performance after exhaustion. Cluster analysis reinforced the association between CMJ and peak power increments in responders with a reported correlation between peak power and sprint performance increments ( $r = 0.623$ ;  $p = 0.041$ ); non-responders showed an impairment of peak force, vertical stiffness, and a higher vertical displacement of the center of mass during the countermovement that correlated with lactate concentration ( $r = -0.717$ ;  $p = 0.02$ ). **Conclusions:** it may be suggested that PAP could counteract the peak force loss after exhaustion, allowing the enhancement of CMJ performance and the maintenance of sprint ability in endurance athletes after the UMTT. From these results, the evaluation of CMJ after incremental running tests for the assessment of muscular adaptations in endurance athletes may be recommended.

#### ESTIMATION OF CRITICAL TORQUE DURING INTERMITTENT ISOMETRIC KNEE EXTENSION IN MEN WITH DIVERSE AEROBIC STATUS.

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For every exercise there is a critical intensity above which output can not be maintained for a long time (30-60 min) without progressive fatigue. Classically, establishing this critical exercise intensity is time consuming and difficult to perform as it involves a series of exhausting exercise tests at different intensities and days. For repetitive isometric knee extensor contractions, Burnley (2009) published a short alternative test to establish critical torque (CT): 60 maximal contractions (3 s with 2 sec rest in between). In the last 6 contractions torque

was found to be similar to the classically determined CT. He studied 8 healthy (probably untrained) subjects and found little variation in CT (25-35% MVC). In the present study we investigated whether this short test could be used to reveal differences in aerobic training status in 16 male subjects with VO<sub>2</sub>-max ranging from 44.7 to 69.6 mL/kg/min. We expected to find a higher CT than Burnley (2009) and we also expected CT to be positively related to aerobic training status (VO<sub>2</sub>-max). However, we were concerned about the large central fatigue component of the torque decline found by Burnley. Therefore we also included an alternative test on a separate occasion. This test involved six series of 60 sub maximal contractions (3s on, 2 s rest) in total at intensities around the expected CT (40% MVC). Changes in electrically stimulated torque, EMG and tissue oxygenation (near-infrared spectroscopy) of the knee extensor muscles were used as indicators for fatigue during each series and torque was changed (steps of 5 % MVC) to the level where signs of fatigue were absent (CT<sub>submax</sub>). CT<sub>all-out</sub> was 52%  $\pm$  10% MVC (compared to 28.7 $\pm$ 4.3% in Burnley), which was significantly ( $P < 0.05$ ) higher than CT<sub>submax</sub> (39%  $\pm$  8.6% MVC). During the sub maximal test 12 out of 16 subjects, including the seven with the highest CT<sub>all-out</sub>, showed indications of peripheral fatigue at torques comparable to CT<sub>all-out</sub>. Therefore, although CT<sub>all-out</sub> was significantly related to CT<sub>submax</sub> ( $r^2 = 0.93$ ), it seemed to be an overestimation of CT, particularly for subjects with high CT. Moreover, only CT<sub>submax</sub> was significantly related ( $r^2 = 0.43$ ) to VO<sub>2</sub>-max and CT<sub>all-out</sub> was not ( $r^2 = 0.17$ ). We conclude that our sub maximal test, which relates to the aerobic training status and is hardly affected by central fatigue, is more suitable to establish CT than a maximal test. M Burnley (2009) Estimation of critical torque using intermittent isometric maximal voluntary contractions of the quadriceps in humans. *J Appl Physiol* 106:975-983.

## ASSOCIATION BETWEEN MECHANICAL EFFICIENCY AND MUSCLE METABOLISM DURING LEG EXERCISE

LAAKSONEN, M.S., KALLIOKOSKI, K.K., KEMPPAINEN, J., TAKALA, T., KNUUTI, J., NUUTILA, P., KYRÖLÄINEN, H.  
MID SWEDEN UNIVERSITY

Association between mechanical efficiency and muscle metabolism during leg exercise Laaksonen, M.S. (1), Kalliokoski, K.K. (2), Kempainen, J. (2), Takala, T. (3), Knuuti, J. (2), Nuutila, P. (2), Kyröläinen, H. (4) 1: Swedish Winter Sports Research Centre, Mid Sweden University, Sweden, 2: Turku PET Centre, University of Turku, Finland, 3: Oulu Deaconess Institute, University of Oulu, Finland, 4: Dept. of Biology of Physical Activity, University of Jyväskylä, Finland Introduction Mechanical efficiency (ME) may have a crucial role in endurance performance. As ME is affected by several metabolic factors in working muscle it is of interest to clarify how muscle blood flow as well as oxygen, fatty acid and glucose uptakes are associated to ME and further on endurance performance. Methods 17 healthy male subjects with varying training backgrounds were recruited and divided into efficient (EF,  $n=8$ ) (ME $>17\%$ ; age  $24 \pm 1$  yrs, BMI  $23 \pm 1$  kg m $^{-2}$ , VO<sub>2peak</sub>  $53 \pm 3$  mL kg $^{-1}$  min $^{-1}$ ; ME  $20.5 \pm 1.3$  %) and non-efficient (NE,  $n=9$ ) (ME $<17\%$ ; age  $23 \pm 1$  yrs, BMI  $23 \pm 1$  kg m $^{-2}$ , VO<sub>2peak</sub>  $52 \pm 3$  mL kg $^{-1}$  min $^{-1}$ ; ME  $15.4 \pm 0.3$  %) groups. ME was determined during bicycle exercise at 45% of VO<sub>2peak</sub> using indirect calorimetry. During 70-min dynamic knee-extension exercise muscle blood flow (mBF) as well as muscle oxygen (mVO<sub>2</sub>), glucose (mGU) and free fatty acid (mFAU) uptakes in quadriceps femoris muscle were measured using positron emission tomography and arterio-venous blood sampling. Results During knee-extension exercise the delivery of oxygen, glucose and free-fatty acids was similar between the groups (all NS). Respiratory quotient in working muscle averaged  $0.82 \pm 0.16$  and  $0.82 \pm 0.10$  for EF and NE, respectively (NS). The work-load normalized mBF (EF  $35 \pm 14$  vs NE  $34 \pm 11$  mL 100g $^{-1}$  min $^{-1}$ ), mVO<sub>2</sub> (EF  $4.1 \pm 1.2$  vs.  $3.9 \pm 1.2$  mL 100g $^{-1}$  min $^{-1}$ ) and mGU (EF  $31 \pm 18$  vs.  $26 \pm 23$   $\mu$ mol 100g $^{-1}$  min $^{-1}$ ) were all similar between the groups (all NS). However, mFAU was higher in EF group (EF  $3.1 \pm 1.7$  vs. NE  $1.7 \pm 0.6$   $\mu$ mol 100g $^{-1}$  min $^{-1}$ ,  $p < 0.05$ ) and in addition, it was also linearly related to ME ( $r = 0.56$ ,  $p < 0.05$ ) in entire study group. None of the measured variables reported here were correlated to peak power output or VO<sub>2peak</sub>. Discussion According to the present results free-fatty acid uptake is associated to mechanical efficiency in working skeletal muscle. This finding is in line with earlier studies where increased muscle fatty acid uptake has been observed after endurance training (e.g. Kiens et al. 1993). Increased fatty acid uptake in more efficient subjects is likely explained by decreased glycolytic/oxidative capacity ratio (Goldsmith et al. 2010) or increased mitochondrial substrate oxidation with unaltered ATP production (Befroy et al. 2008). References Befroy et al. (2008) PNAS 105(43): 16701-6 Goldsmith et al. (2010) Am J Physiol Regul Integr Comp Physiol 298: R79-R88 Kiens et al. (1993) J Physiol 469: 459-478

## ASSOCIATION BETWEEN FEEDFORWARD AND REFLEX MUSCLE ACTIVITY WITH REACTIVE LEG STRENGTH AND STIFFNESS IN BOYS

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INTRODUCTION Previous research has demonstrated a limited amount of common variance between squat and countermovement jump performance with a reactive strength index (RSI) and leg stiffness in children (Lloyd et al., in press). It is speculated that different neural control mechanisms account for this lack of association. Therefore, the aim of the present study was to determine how much of the variance in RSI and leg stiffness could be explained by neural control mechanisms. METHODS Thirty-two boys aged 9-15 years old participated in the study. RSI (jump height/contact time) was calculated during five maximal rebound jumps. Leg stiffness was calculated from contact and flight time during rapid hopping at 2.5 Hz. EMG recordings were collected from the vastus lateralis (VL) and soleus (SOL) of the dominant leg. EMG data was smoothed using a linear envelope employing Butterworth fourth order zero lag filters (20 Hz high pass, 50 Hz low pass). EMG activity was normalized by integrating the processed EMG data over total ground contact time and calculating the contribution during specific phases; feedforward background activity (0-30 ms, BGA) and short (31-60 ms, M1), medium (61-90 ms, M2) and long (91-120 ms, M3) latency reflexes. RESULTS Body mass explained 77.6% of the variance in absolute leg stiffness, with the addition of VL BGA and M2 activity improving this to 87.3%. BGA was the sole predictor of leg stiffness expressed relative to body size, explaining 41.5% of the variance. Up to 56.8% of the variance in the RSI could be explained by an equation including all VL activity (0-120 ms), body mass, VL M3 and VL BGA. The SOL and VL could generally be used interchangeably within the predictive equations without any loss of predictive strength. DISCUSSION Absolute leg stiffness is primarily determined by body mass, influencing peak ground reaction force, with some contribution from feedforward and reflex muscle activity. However, BGA was the sole predictor of relative leg stiffness, explaining 41.5% of the variance. While RSI was related to BGA, performance was also associated with reflex muscle activity. Rapid hopping requires a high rate of force development and this appears to be associated with BGA in boys. Reactive strength during maximal rebounding involves longer contraction times, greater joint displacements and is associated with both feedforward and reflex activity in boys. While feedforward and reflex muscle activity have been shown to account for a reasonable amount of the variance in RSI and relative leg stiffness in boys other unaccounted factors still need to be identified. REFERENCES Lloyd et al. (in press). J Sports Med Phys Fitness.

## ACUTE NEUROMUSCULAR RESPONSES ASSOCIATED WITH STRENGTH- AND HYPERTROPHY-TYPE WORKOUTS

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**Introduction** Hypertrophy-type (HYP) resistance exercise (RE) is typically designed to elicit changes in fibre size whereas strength-type (STR) RE is usually employed to improve strength via mainly neural adaptations. Although previous studies have investigated the acute responses to different RE workouts (McCaulley et al. 2009), the mechanisms responsible for different long-term adaptations are still widely debated. Thus, this study examined the acute neuromuscular responses to STR and HYP workouts which utilised the back squat exercise. **Methods** Seven trained males ( $23.6 \pm 2.7$  years) completed a STR workout (4x6 repetitions at 85%1RM, 5 min rest intervals), a HYP workout (4x10 repetitions at 70%1RM, 90s rest intervals) and a control condition (CON) in a randomised cross-over design separated by at least 48 hours. Subjects performed 3x4s maximal isometric back squats (100o knee flexion), by using a modified squat rack attached to a Kistler force platform (1000 Hz), immediately pre- and post- each workout. Several kinetic performance variables were determined and investigated statistically by using a two-factor within subjects ANOVA. Results Repeated contrast tests showed a greater reduction in Peak Isometric Force following the HYP (-18.06%) than CON condition (-1.21%) ( $p=0.017$ ). Also the HYP workout resulted in greater reductions in the rate of force development (RFD) during the initial 0.05s (-21%,  $p=0.023$ ) and 0.1s (-29%,  $p=0.047$ ) of the force-time curve as well as greater increases in the time required to produce 500N (92%,  $p=0.018$ ) when compared with the CON condition. The STR workout was characterised by a greater reduction in RFD during the initial 0.2s of the force-time curve (-0.19%,  $p=0.034$ ) as well as greater increases in the time required to produce 250N (28%,  $p=0.025$ ) when compared to the CON condition. No significant differences were observed between the STR and HYP conditions for any variable. **Discussion** Both workouts resulted in acute neuromuscular fatigue possibly via different pathways. The acute reductions in RFD following the STR workout may have resulted from central fatigue whereas the reductions in RFD and PF following the HYP workout may be indicative of central and peripheral fatigue (Hakkinen et al. 1994; McCaulley et al. 2009). Although STR and HYP workouts are typically prescribed in order to emphasise different long-term adaptations, marked differences in the acute neuromuscular responses were not observed. Such findings may question the future prescription of similar workouts when aiming to elicit distinctly different neuromuscular stimuli. **References** Hakkinen, K. (1994) *Electromyography & Clinical Neurophysiology* 34(4): 205-214. McCaulley, G.O., McBride, J.M. et al. (2009) *European Journal of Applied Physiology*, 105: 695-704.

## Oral presentations

### OP-SH09 Sport Management

#### A PROPOSED ADAPTATION OF THE EFQM TO PHYSICAL ACTIVITY PROGRAMMES FOR THE ELDERLY – DEVELOPMENT OF A SELF-ASSESSMENT TOOL USING A MODIFIED DELPHI PROCESS

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**Background:** There has been a growing concern in designing physical activity (PA) programmes for elderly people, because evidence suggests that such health promotion interventions may reduce the deleterious effects of the ageing process. The Physical Activity and Health Branch of the Centers for Disease Control and Prevention holds that complete programme evaluations are a necessary prerequisite to continuous quality improvements. The development and efficient use of quality assessment tools requires considerable resources - human, temporal and financial. Being able to refine, adapt and create tools that are suited to the realities and contexts of PA programmes for the elderly, to support its continuous improvement is, therefore, crucial. Thus, the aim of this study was to develop a self-assessment tool for PA programmes for the elderly. **Methods:** A 3-round Delphi process was conducted with 43 national experts in PA for the elderly, management and delivery of PA programmes for the elderly, sports management, quality management and gerontology, asking experts to identify the propositions that they considered relevant for inclusion in the self-assessment tool. All rounds were conducted via the Internet. Experts reviewed a list of proposed statements, based on the criteria and sub-criteria from the European Foundation for Quality Management Excellence Model (EFQM) and PA guidelines for older adults. They rated each proposition from 1 to 8 (disagree to agree) and modified and added propositions. After each round, we calculated the percentage of agreement on each statement and provided these data in the next round. Propositions receiving either bottom or scores of greater than 70% were considered to have achieved consensus to drop or retain, respectively. **Results:** In round 1, of the 196 originally-proposed statements (best practice principles), the experts modified 41, added 1 and achieved consensus on 93. In round 2, they were presented with 104 propositions, of which they modified 39 and achieved consensus on 53. In the last round, of 51 proposed statements, the experts achieved consensus on 19. After 3 rounds of rating, they had not achieved consensus on 32 propositions. The resulting tool consisted of 165 statements that assess nine management areas involved in the development of PA programmes for the elderly: five criteria assess Enablers (Leadership, Policy & strategy, People, Partnership & resources and Processes), and four criteria assess Results (Customer results, People results, Society results and Key performance results). **Conclusion:** Based on experts' opinions, a self-assessment tool was found in order to assess quality of PA programmes for the elderly. Information obtained with evaluations would be useful to organizations seeking to improve their services, customer satisfaction and, consequently, adherence to PA programmes.

#### THE CHINESE ELITE SPORT DEVELOPMENT: CENTRALISED PLANNING MEETS THE MARKET

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**Introduction** The paper locates the PRC's current policy toward global sport and the Olympic Movement in its historical context. In order to analyse the behaviour of the Chinese state we adopt Houlihan's (1994: 370) concepts of 'reach' and 'response' which focus attention on global actors and pressures external to the country and state and the capacity of states to determine their response. The article examines the extent to which, and the manner in which, the Chinese government managed its relationship with the Olympic following its re-engagement with international elite sport competition in the mid 1970s. **Methods** Data were collected from a number of sources including official government documents, news media, a series of 40 interviews from China's sport administrative system including General Administration of Sport (GAS), Chinese Olympic Committee (COC) and six national sport associations and 16 Chinese sports academics from

inside and outside China between 2005 and 2010. Results As regards the "reach" of global culture in the Chinese context, it has been a case of China reaching out to bring in global influences rather than global influences pushing their way in. This is seen especially in the slogan - "Sending human capital out and bringing foreign resources in" by which athletes, coaches, managers and scientists were dispatched to learn new knowledge and skill from the outside world, and foreign experts, sponsors and companies were welcomed into China to bring new resources to promote the Chinese elite system. Discussion To a large extent, China has been enthusiastic about absorbing those international influences and, rather than seeing them as a threat, they have seen them as a resource. According to GAS (2003: 5) "after winning the bid to host the 2008 Beijing Olympics in 2001, we will promote China's economic and social development in the new era, open China's doors more widely and deeply, and raise China's status on the international scene. All of these will have a huge impact on China's future." This assessment echoed Deng's 'open door' policy which implied not only an economic involvement with the capitalist world - through trade, investment and technology transfer - but also an opening up to carefully selected ideas and cultural forms originating in the west. The foregoing discussion indicates that the government of the PRC has been effective, so far at least, in controlling the extent and impact of greater commercialisation at the Olympic elite level. However, China's involvement in global commercialised Olympic sport has been relatively brief and it remains to be seen whether the government will be able to maintain its control over the extent of engagement over the longer term. References GAS. (2003). Strengthening and progressing sport in the new era: The compilation of Chinese sport regulation in the PRC (2000-2002). Beijing: China Law Press. Houlihan, B. (1994) Homogenization, Americanization and Creolization of sport: varieties of globalisation, *Sociology of Sport Journal*, 11:356-375.

## **MEASURING AND MODELING ORGANIZATIONAL SOCIAL CAPITAL IN SPORT ORGANIZATION ISLAMIC REPUBLIC OF IRAN**

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Introduction Social capital which is embedded in social interactions and resources of plays is currently a very important research era in sports and sports organizations. Therefore, Measuring social capital and designing model of social capital in Sport organization of Islamic Republic of Iran are makeup of the ultimate goals of this study. Method We used descriptive research method in order to describe the current situation of social capital in the population conducting a survey of staff. The instrument was constructed and validated in the study in three phases: pilot, semifinal, and the final phase which was aimed to validating. For modeling social capital the mathematical model of structural equation modeling was used by Lisrel(8.50) software. Result Using a reliable and valid research tool which was checked in this study, Social capital in the Sport Organization was measured. Level of social capital was significantly lower than moderate level (from 97.83 in 2010). Scores related to the dimensions of social capital in the Sport organization except for 'organizational citizenship behavior' were lower than average. For modeling social capital in Sport Organization three models based on three perspectives which were community-oriented, institutional, and networks was tested using structural equation modeling. Finally, due to the Lisrel good fit parameter outcome institutional model parameters were better fit than network model, and community-oriented in Sport Organization (Chi Square=1.79 P-value=0.18, RMSEA=0.052). Discussion Considering there was no relationship between each of the dimensions of social capital and its importance, there was any inference that the Sport Organization currently benefits their social capital to become continuous (Krishna, 2001). Due to the institutional model of social capital concluded that the main source of social capital in Sport organization of Iran is institutional trust which means that that continued good corporate function such as, reliability, competence and accountability towards their community, causes internal consistency (North 1998). Resource Amiri, A. N., & Ramazan, M. (2010). Studying the impact of organizational Organic Structure On Knowledge productivity effective factors case study: manufacturing unit in a Domestic Large Industrial Group. *Euopian journal os Scientific Research*, 91-1101. Eriksson, M., Dahlgren, L., Janler, U., Weinehall, L., & Emmelin, a. M. (2010). Social Capital, Gender and Educational Level – Impact on Self-Rated Health. *The Open Public Health Journal*, 9-10. KAISER, A. (2010). BRIDGING SOCIAL CAPITAL FORMATION IN A FAITH-BASED ORGANIZATION. Graduate School of Wayne State University. ProQuest LLC. Kouvonen, A., Kivimäki, M., Vahtera, J., Oksanen, T., Elovainio, M., Cox, T., et al. (2007). psychometric evaluation of a short measure of social capital at work. *BMC Public Health*.

## **EQUESTRIANISM AND GENDER DURING THE 20TH CENTURY. A COMPERATIVE STUDY UK AND SWEDEN**

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The aim of this chapter is to analyze changing gender and social class patterns in equestrian sports in Sweden and Great Britain during the 20th century. 100 years ago equestrian sports were strongly connected to men and masculinity. Men worked together with and used horses in agriculture, forestry, in the transport sector and in the army. A real man was a "horse man". It is also important to recognize that very few people used the horse for riding as horses were mainly used as draught animals. In Sweden horse riding was connected to the army and to the upper class. In today's Sweden equestrianism is strongly connected to women, girls and femininity on all levels (Hedenborg 2007, 2008, 2009). Furthermore the contemporary equestrian sector is of great economic importance (as important as the dairy sector, or cattle sector) to Swedish economy and horse riding is popular and not only restricted to members of the upper class. Less is known about the development in Great Britain, despite the fact that Great Britain has since long been seen as a very important place for the development of equestrian sports. In order to understand the process of changing gender codes and the growth of the sector in Sweden and to explore and understand the development in Great Britain in the 20th century, this chapter examines articles on the equestrian competitions of the Olympic games in 1912, 1924, 1932, 1936, 1948, 1952, 1956, 1964 and 1972 in Swedish and British magazines (Hästen, Idrottsbladet, Horse & Hound).

## **MANAGEMENT CONTROL IN SWEDISH SPORT**

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Swedish sport involves nearly 3 million out of a total of 9 million inhabitants. The Swedish Sports Confederation (RF), which is the highest decision-making organization, has 70 different sport associations which in turn together contain about 20 000 clubs, all with different roles and situations. Sport in Sweden is essentially based on a non-profit idea with voluntary leadership. The main financing comes from state and municipal grants, membership fees, competition and training fees, lottery incomes and incomes from entrance fees. In some types of sports, especially where the elite sport performers have high financial compensation (as soccer and icehockey), sponsorship is



getting a more and more important source. However, the number of professional athletes is just a small part of the total number of Swedish athletes. Instead, we can talk about sport in Sweden as a broad people movement with collaboration between elite activities and sport for all. The Swedish Sports Confederation has in the policy declaration "Sport will" pointed out a range of statements, which together creates a form of norms and values for all associations and clubs under the umbrella of RF. They present a vision and talk about the idea of sport as an activity to enjoy ourselves, to feel good and to get fitter. They also point out that sport consists of training and fun, competition and display. Moreover, sport promotes physical, psychological, social and cultural development. In "Sports will" four important core values are also presented: a) enjoyment and community, b) democracy and participation, c) everyone has the right to take part, and d) fair play. As we can note, sport in Sweden is a big and important movement including a great number of socially related goals. The extent to which these norms and values emerge in a clear way in the associations' goals and activity plans has been studied (Söderholm, 2007). In the 58 studied associations, Söderholm could identify 396 different goals, which were grouped into six categories. The most common goals were related to organizational challenges. Not until in fifth place came socially oriented goals. The foregoing leads us to the following research questions: 1. To what extent do the sport associations act in order to follow the sport movement's overall norms and values? 2. What type of management control tools are used to ensure high achievement? The results reported in this presentation are based on document studies and interviews in five strategically selected sport associations. One interesting result is that the sport movement uses management control tools, originally developed and used in the Business Community. According to a theoretical framework built on the so-called New Institutional Theory we can see this as an example of how different types of ideas flow between different organizational fields or sectors.

## THE SPECIALIZATION PROCESS IN PORTUGUESE AND BRAZILIAN SOCCER CLUBS: A HOLISTIC APPROACH

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THE SPECIALIZATION PROCESS IN PORTUGUESE AND BRAZILIAN SOCCER CLUBS: A HOLISTIC APPROACH Cavichioli, F.1, Gonçalves, C.E.2, Maoski, D.1, Cheluchinhak, A.1, Sperotto, R.1, Joay, A.1 1: UFPR/ CAPES (Curitiba, Brasil), 2: FCDEF (Coimbra, Portugal) Introduction The specialization process of the young soccer players is studied using the holistic model, identifying and analyzing the opinions and interventions of the managers and coaches of youth teams of two soccer clubs, from Portugal and Brasil. The aim of the study is to research the path to specialization as a process of teaching and learning, seeking to improve and discipline both the body and the athletes' ways of thinking and acting. Methods Two managers and eight coaches from youth teams (from 10-18 years) of two top clubs, one from Portugal, the other from Brazil, were interviewed. Ten semi-structured interviews were performed, to identify professional structure, recruiting, education, security and citizenship. Content analysis was used to examine the interviews. A field diary was also kept, to identify the ecological dimension of education and the power relations inside the club and with other clubs, and training methods: 32 observations of games, practices and social activities were performed. Results Results show a real concern to educate the athletes under a multi-dimensional perspective, targeting specific skills, academic achievement and citizenship. Players are instructed to more active in tactical interpretation of the game and in life outside sport. To train athletes to reach the professional level is seen as a process essentially pedagogic. Discussion The opinions of managers and coaches show their intention to optimize the players natural abilities, but also to follow a planned process to foster the incorporation of a soccer habitus. While the portuguese club sees the sell of the players to other professional clubs as a possible consequence of a long-term process, for the brasilian club, to sell the players is the main goal. There is a convergence relating the control, discipline and rationalization aiming to create a professional ethos since early ages. References BOURDIEU, P. O poder simbólico. 2. ed. Rio de Janeiro: Bertrand Brasil, 1998. DUNNING, E. Sport Matters: sociological studies of sport, violence and civilization. London/ New York: Routledge, 1999. BARDIN, L. Análise do conteúdo. Edições 70: Lisboa, 1998.

## Oral presentations

### OP-SH07 Athlete and Coach Psychology

#### COACHES' REFLECTIONS ON INCIDENTS OF ATHLETE EMOTIONAL ABUSE

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COACHES' REFLECTIONS ON INCIDENTS OF ATHLETE EMOTIONAL ABUSE Stirling, A. E. Faculty of Physical Education & Health, University of Toronto, Canada Introduction Concern for athlete well-being has long existed, however research specifically on relational athlete maltreatment has emerged only recently. The majority of athlete maltreatment research has explored athletes' perspectives on experiences of abuse in sport (Stirling, 2009). A few studies have been conducted to-date examining coaches' perspectives on sexually abusive coach-athlete relations (Bringer, Brackenridge, & Johnston, 2002; 2006; Toftegaard-Neilson, 2001), but no research has yet examined coaches' perspectives on the perpetration of emotionally abusive coaching behaviours. The purpose of this study therefore, was to explore coaches' reflections on incidents of emotional abuse in sport. Methodology and Methods The methodological approach used for the study was a constructivist and symbolic interactionist approach to grounded theory. Participants included nine elite coaches, seven male and two female. Coaches ranged in age from 38-68 years of age, with 18-47 years of coaching experience. In-depth semi-structured interviews were conducted with each participant, and data were coded using open, axial, and selective coding techniques. Results The following themes emerged from the raw data; coaches' care for the athletes, the nature of the coach-athlete relationship, previous incidents of harmful coaching behaviour, and perceived reasons for use of these harmful coaching practices. Discussion Coaches' reflections about the reasons for choosing to use emotionally abusive behaviours in the coach-athlete relationship are interpreted to suggest two distinct origins for the perpetration of this behaviour. Applied and theoretical recommendations are discussed. References Bringer, J. D., Brackenridge, C. H., & Johnston, L. H. (2002). Defining appropriateness in coach-athlete sexual relationships: The voice of coaches. *Journal of Sexual Aggression*, 8, 83-98. Bringer, J. D., Brackenridge, C. H., & Johnston, L. H. (2006). Swimming coaches' perceptions of sexual exploitation in sport: A preliminary model of role conflict and role ambiguity. *The Sport Psychologist*, 20, 465-479. Stirling, A. E. (2009). Definition and constituents of maltreatment in sport: Establishing a conceptual framework for research practitioners. *British Journal of Sports Medicine*, 43, 1091-1099. Toftegaard Neilson, J. (2001). The forbidden zone: Intimacy, sexual relations and misconduct in the relationship between coaches' and athletes'. *International Review for the Sociology of Sport*, 36, 165-182.

**EXPLORING THE RELATIONSHIP BETWEEN PASSION AND ATHLETIC PERFORMANCE**

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Exploring the Relationship Between Passion and Athletic Performance Darren Peters Australian Catholic University Introduction Passion is the highest or strongest form of emotion (Frijda, 2007). Passion towards an activity can be defined as a strong inclination toward an activity which is liked, important, consumes a significant amount of personal time and energy, and becomes internalised into a person's identity (Vallerand et al., 2003). There are two forms of passion, obsessive and harmonious. Passion has been indirectly and positively associated with performance through a mastery orientation, and indirectly and negatively associated with performance through an avoidance orientation (Vallerand et al., 2008). The aim of this study was to determine if athletes with high and obsessive passion are less successful in sport. Methods Two separate survey research studies were conducted. Participants were a sample of elite (n=56) and non-elite (n=105) Australian athletes. The Sport Environment and Passion Scale were used. Passion Scale items derived from the Gambling Passion Scales (Rousseau et al., 2002). Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted to validate scale items. Descriptive statistics were used to indicate the incidence of Passion by type. Structural Equation Modelling, using total data-set, was used to determine relationships between passion and performance. Results Overall, the EFA and CFA analyses indicated internal consistency and support for the two factor Passion structure proposed by Vallerand et al (2003). Some harmonious passion items required attention. Passion was found to have a direct and positive influence on practice, and direct and negative influence on performance. Discussion Motivation is required for an initial and prolonged involvement in sport. Being over motivated can lead to poor performance (Davis, 2009). This small study confirms this general direction, albeit by inference rather than experimental control. It is the first to declare a direct and negative relationship exists between a person's passion and their performance. This type of finding supports a general view that emotions are an important factor in human performance. References Davis, H. (2009), Pre-dispositional and situational processes underlying choking under pressure: An application of the Self-Determination Theory. Thesis, University of Ottawa, Canada. Frijda, N. (2007), Laws of Emotion. Lawrence Erlbaum Associates Inc., Mahwah, New Jersey. Rousseau et al., (2002), Passion and Gambling: On the Validation of the Gambling Passion Scale, Journal of Gambling Studies, Vol. 18, No. 1, Spring. Vallerand et al., (2003), Les Passions: On Obsessive and Harmonious Passion, Journal of Personality and Social Psychology, Vol. 85, No. 4, p756-767. Vallerand et al., (2008), Passion and performance attainment in sport, Psychology of Sport and Exercise, Vol. 9, p373-392.

**ATHLETE MALTREATMENT: WHEN DOES THE PRACTICE OF PHYSICAL CONDITIONING BECOME A FORM OF ABUSE?**

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Athlete Maltreatment: When Does the Practice of Physical Conditioning Become a Form of Abuse? The purpose of this presentation is to raise questions about the use of excessive physical activity and physical punishment within the framework of athlete maltreatment. Needless to say, pushing one's body physically is not only an inherent part of sport training but is a requirement for skill acquisition and performance enhancement. Moreover, it is the coach's role, in part, to encourage athletes to push themselves out of their 'comfort zone' physically and psychologically in order to become more fit or skilled. Apart from legitimate uses of physical conditioning for athlete development however, there are also anecdotal examples of the use of physical conditioning for the purposes of punishment. Directing a team to engage in exhausting conditioning as punishment for poor performance or undesirable behaviors such as arriving late for practice or missing curfew are some examples. In such cases, physical conditioning is used for the sole purpose of punishment and is unrelated to the enhancement of an athlete's physical condition. It is the supposition of this presentation that under certain conditions the use of physical conditioning represents a form of physical and perhaps emotional abuse. Interestingly, despite a substantial body of literature on sexual abuse within the coach-athlete relationship and emerging literature on emotional abuse, no empirical research exists on physical abuse and neglect. This is perplexing given sport's emphasis on the body and physicality, its focus on disciplining of the body, and the commonplace use of physical conditioning practices. In this presentation, we will explore the conditions under which the coach's implementation of physical conditioning represents a form of maltreatment versus a legitimate method for performance enhancement and athlete development.

**TEAM-REFERENCED PERCEIVED COACHING ENVIRONMENT, NEEDS SATISFACTION, AND WELL-BEING IN ELITE HOCKEY PLAYERS: AN EXTENSION OF BASIC NEEDS THEORY.**

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Introduction. Studies testing the tenets of Basic Needs Theory (BNT; Deci & Ryan, 2002) have focused on individual-defined views regarding the social environment, reported need satisfaction and indices of athlete welfare (Reinboth & Duda, 2006). No research to date has taken a systematic approach to measuring the relevant motivational processes and well-being dimensions when referenced at a group level. Moreover, there has been limited testing of BNT in elite youth athletes and teams (Adie, Duda & Ntoumanis, 2008). Assessing whether predictions emanating from BNT are supported when defined in terms of perceived team-based perceptions may assist future research aimed at developing our understanding of the complexity of motivation in team sports. This study aimed to i) explore the interplay between perceptions of the coaching climate evident on the team, BN satisfaction for the team as a whole, and positive and negative indicators of team "health", and ii) test the role of BN satisfaction in mediating the relationship between dimensions of the coaching climate and team well- and ill-being indices. Method. Cross-sectional design. 224 (M age =17.59 years) elite junior field hockey players completed a multi-section questionnaire assessing perceptions of the autonomy supportive and controlling features of the coach-created team environment, satisfaction of the needs for team competence and autonomy, and perceived relatedness in terms of coach and teammates, and indicators of team well-being (subjective vitality) and ill-being (physical and emotional exhaustion). Results. Preliminary analyses using structural equation modeling partially support a model indicating satisfaction of the team-referenced BNs to be positively predicted by perceptions of an autonomy supportive coaching environment. Competence, relatedness to coach, and relatedness to teammates emerged as positive predictors of vitality. The model demonstrated reasonable fit to the data (Chi-squared =1125.3, p <0.01; RMSEA=.07; CFI=.90; TLI=.89). Tests of mediation on the BNs aim to reveal their role in explaining the relationships between perceived coaching climate and well- and ill-being outcomes. Discussion. Initial findings partially support the tenets of Basic Needs Mini-Theory when the central constructs are group rather than individual-referenced, and indicates the importance of particular needs in promoting aspects of team emotional health. References. Adie, J.W., Duda, J.L., & Ntoumanis, N. (2008) Autonomy support, basic need satisfaction

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### DRIVE FOR MUSCULARITY: ROLE OF EXERCISE STATUS AND PHYSICAL SELF-BELIEVES

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Men have reported significant discontent with their bodies. Associated with this dissatisfaction is the desire to attain a more muscular physique. The Drive for Muscularity (DFM) in men has been associated with poor self-esteem and higher levels of depression. DFM may be interpreted as dissatisfaction with current levels of muscularity but can be an expression of concerns with performing behaviours aimed toward increasing muscularity. This study investigated the role of physical self-description in predicting levels of DFM in a sample of men who were either engaging in weight training, aerobic exercise or were sedentary. Participants were 564 males aged between 18 and 55 years (M age = 26.24 years, SD = 7.93). Of these 216 were classified as regular weight trainers, 148 as regular exercisers and 200 as sedentary. The study was approved by a University Research Ethics Committee and participants provided informed consent prior to participating. The participants completed the Drive for Muscularity Scale (DMS) the Physical Self-Description Questionnaire (PSDQ) and the Balanced Inventory of Desirable Responding (BIDR). Regression analysis for the DMS Attitude scale showed that the PSDQ factors health (beta = .12), physical self-concept (beta = .29), endurance fitness (beta = .18), and self-esteem (beta = -.22) explained 7.3% ( $P < .001$ ) of the variance. For DMS Behavior scale physical activity (beta = -.46), body fat (beta = -.15), sport competence (beta = -.15), strength (beta = -.23) and self-esteem (beta = .26) explained 25.2% ( $P < .001$ ) of the variance. The MANOVA for DFM was significant ( $P < .001$ ;  $\eta^2 = .17$ ) as were the follow-up ANOVAs (Attitude:  $P = .01$ ;  $\eta^2 = .02$ ; Behavior:  $P < .001$ ;  $\eta^2 = .31$ ). Tukey post-hoc comparisons revealed a significant higher score for the active group in comparison to the weight training group for attitude and behavior. The MANOVA for the PSDQ was significant ( $P < .001$ ;  $\eta^2 = .44$ ). Follow-up ANOVA show significant differences for all 11 scales of the PSDQ. Post-hoc comparisons confirmed that the sedentary group scored significantly lower on all scales in comparison to the weight training and active groups. The weight training group scored higher on health, physical activity, and strength than the active group which in turn scored higher on endurance fitness. DFM seems to be influenced by exercise status. Men mainly engaging in aerobic exercise reported a significantly higher DFM than those who weight trained. Therefore, DFM is also a concern for men who do not weight train, not just those who actively try to change their muscular structure. Furthermore, different physical self-descriptors as measured by PSDQ underlie the Attitude and Behavior scales of the DMS. Behavioral intervention targeting men's self perceptions need to be cognizant of exercise status and the different aspects of the physical self-descriptions and their interplay to be effective in changing negative attitudes and behaviors towards the self.

### THE EFFECT OF DEHYDRATION AND MODERATE ALCOHOL CONSUMPTION ON COGNITIVE FUNCTION AND REACTION TIMES

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Cognitive function and neurological reaction times are important for many aspects of daily living. Extensive literature exists on the deleterious effects alcohol consumption has on these variables. Studies examining the impact of dehydration on human cognitive function however have not always demonstrated performance decrements. No literature currently exists investigating cognitive performance when moderate alcohol intake is combined with mild/moderate levels of dehydration. This study examined the impact of mild and moderate dehydration on the effects of alcohol induced cognitive impairment. Nine healthy males (age,  $22.6 \pm 3.8$ y; mean $\pm$ SD) participated in 4 randomised, single-blind trials (separated by 7d) designed to induce dehydration through exercise for a target of 2.5% body mass loss. Following a 1h recovery period in a thermo-neutral environment (23deg, 67% RH) a 4-task Cambridge Neuropsychological Test Automated Battery (CANTAB), mood rating questionnaires and subjective estimates of alcohol-related symptoms were completed (test 1). Participants were then either provided with no water (D), a small amount of water equivalent to 50% body mass loss (P) or a large amount of water equivalent to 150% body mass loss (F) over a 2h period. Following the rehydration phase, participants consumed a set volume of alcohol (A) or placebo (P) to incorporate the conditions DP, DA, PA, and FA. The alcoholic beverage was consumed over 10min in a volume individually calculated and intended to raise breath alcohol concentration to  $\sim 0.05$  g/100ml. Following an absorption period (30min), participants completed a second rating of symptoms and the CANTAB test battery (test 2). Differences between test 1 and test 2 CANTAB mean responses were compared for all trial conditions. No significant differences were observed in mean CANTAB scores of choice reaction time, executive functioning and response inhibition between any of the trial conditions. No differences were observed between trial conditions for ratings of alcohol intoxication however subjective impairment responses revealed differences between trial conditions, with participants declaring a greater willingness to operate a motor vehicle after alcohol ingestion in fluid replacement conditions (PA & FA) compared to the dehydration condition (DA). Rehydration following exercise resulting in fluid loss may impact on alcohol related risk-taking behaviour and may pose implications for post match fluid replacement if a moderate amount of alcohol is also consumed

## Oral presentations

### OP-PM38 Vibration

#### WHOLE BODY VIBRATION AND OXIDATIVE STRESS

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Introduction Oxidative stress following exercise is derived via the mass action of reactive oxygen species formed by the elevated oxygen consumption and metabolism, phagocytotic activity e.g., with muscle damage, ischemia-reperfusion, and mechanical stress (1). The exercise Whole Body Vibration (WBV) causes mechanical stress, and increases blood flow and oxygen consumption (2). However, the

level of any exercise or oxidative stress damage induced by WBV is unknown although it is being proposed as an effective neuromuscular-training and therapeutic tool. This study was designed to determine the acute and chronic level of oxidative stress induced by WBV in comparison to muscle damage inducing exercise, and a metabolic equivalent exercise. Methods Twenty-one untrained females (age  $23.9 \pm 5$  years; height  $1.65 \pm 0.08$  m; mass  $70.1 \pm 15.8$  Kg) were randomised to one of three training groups: WBV (26Hz; Galileo plate; 1min vibration/1min rest; 5mm amplitude;  $20^\circ$  knee flexion), Downhill Running (DHR;  $-10.5\%$ , 11 K/h) or a Walking control (W; 4.5 km/h). They completed 3x20min weekly supervised sessions for 8 weeks. Baseline venous blood samples were collected for acute; pre-, immediately post, 24-h post, and chronic effects; after 8 weeks. Creatine Kinase (CK) and Isoprostane (lipid peroxidation) activity and percentage change from baseline were compared between groups at the different measurement points via Repeated Measures ANOVA. Paired analysis between final and baseline values was performed to determine any training effects. Results The CK for DHR was significantly elevated ( $p=0.02$ ) compared with WBV and W at 24h post exercise, but not between W and WBV. Overall WBV was always higher than W but not significantly so. Significant Group ( $P<0.05$ ) and Measurement Period ( $P<0.05$ ) main effects were seen for the percentage changes of CK. There was also a significant ( $P<0.05$ ) main effect for the Measurement Period for percentage change of Isoprostane, but no difference between groups. All groups showed an increase in Isoprostane immediately post-exercise, but lower than baseline at 24h and 8 weeks. There were significant ( $P<0.05$ ) Measurement Period and Group main effects for Isoprostane activity, for which for WBV always appeared slightly higher than W and less than DHR, but was the most stable between measurement periods. Isoprostane measured at 8 weeks was not different from baseline for any of the groups. Conclusions An acute bout of WBV does not incur significant muscle damage. Lipid peroxidation increased immediately post-exercise and decreased by 24h, but no significant training effect was seen. WBV had a consistently higher level of lipid peroxidation and muscle damage compared to the metabolic equivalent exercise of walking, but less than DHR. References 1. Urso et al. (2003) *Toxicology* 189:51-54. 2. Cochrane et al. (2008) *Arch Phys Med Rehabil* 89:815-21

### THE EFFECTS OF A 6-WEEK NEUROMUSCULAR TRAINING PROGRAM ON KNEE JOINT MOTOR CONTROL DURING SIDECUTTING IN HIGH-SCHOOL FEMALE ATHLETES

WAXMAN, J., TUTALO SMITH, S., WALSH, M., NOYES, F.

MIAMI UNIVERSITY

The Effects of a 6-Week Neuromuscular Training Program on Knee Joint Motor Control During Sidecutting in High-School Female Athletes Waxman, J.1, Tutalo Smith, S.2, Walsh, M.1, and Noyes, F.2 1: Miami University (Oxford, OH, USA) 2: Cincinnati Sportsmedicine Research and Education Foundation (Cincinnati, OH, USA) Introduction Anterior Cruciate Ligament (ACL) injuries occur 4 to 8 times more frequently in female athletes than in male athletes, causing increased focus on the prevention of ACL injury in female athletes. A majority of these injuries occur in non-contact situations that involve landing, sidecutting, or sudden deceleration. The medial hamstring muscles have been found to play an important role in resisting anterior-directed shear on the tibia and in protecting against movements that commonly cause excess valgus. Current research has demonstrated that prophylactic neuromuscular training induces a positive change in the pattern of neuromuscular activation of the hamstring muscles during sidecutting, potentially reducing the risk of ACL injury. The purpose of the current study was to implement a 6-week neuromuscular training program prior to the athlete's upcoming competitive season and to experimentally analyze the neuromuscular adaptation mechanisms elicited by this type of training during a standardized sidecutting maneuver known to be associated with non-contact ACL injury. Methods Twenty-five healthy female athletes were included in the current study. The athletes were split into two groups, those that previously participated in the training program (previous participants) and those that have not (first time participants). All participants were tested for electromyography (EMG) activity in the vastus medialis (VM) and lateralis (VL), rectus femoris (RF), semitendinosus (ST), and biceps femoris (BFcl) during a standardized sidecutting maneuver pre and post a 6-week prophylactic neuromuscular training program. The RMS EMG amplitude was obtained at time periods of 10 and 50 milliseconds both before and after foot strike on the target area. RMS EMG amplitude was then normalized to the peak RMS EMG amplitude recorded during the sidecutting maneuver. The mean of five trials was calculated for each participant. Results A series of mixed-design ANOVAs examined each muscle group at pre and post training, controlling for training experience. There were significant differences found in the VM and VL in the 50-ms time interval before foot strike, the VL 10-ms before foot strike, and in the ST 50-ms after foot strike. Discussion The neuromuscular training program used in this study was shown to elicit changes in EMG activity. However, the observed neuromuscular adaptation during sidecutting conflicts with previous research, which has used a training program longer in duration. These findings suggest that 6-weeks may not be enough time to induce neuromuscular adaptations that could potentially reduce the risk for non-contact ACL injury.

### HEMODYNAMIC RESPONSES TO VIBRATION IN HUMAN CALF MUSCLE

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HEMODYNAMIC RESPONSES TO VIBRATION IN HUMAN CALF MUSCLE Zange, J.1; Illbruck, A.1,2; Molitor, S.1; Kohl-Bareis, M.2; Rittweger, J.1 1: DLR, Institute of Aerospace Medicine, (Cologne, Germany); 2: University of Applied Technology Koblenz, Rhein-Ahr-Campus (Remagen, Germany) Introduction During whole body vibration training leg muscles moderately increase their energy turn-over (Zange et al. 2009) and absorb part of the kinetic energy by conversion into heat (Cochrane et al. 2008). This entails the need for appropriate blood supply. The present study focuses on the hemodynamic response to passive vibration in terms of blood content and blood oxygenation in the unloaded calf muscle exploring the relative contribution of the arterial and the venous compartment. The hypothesis was that venous restriction would prevail over arterial vasodilatation. Methods The subjects ( $n=12$ , male) sat in front of a vibration platform with their bare right foot affixed to the platform. The test included 2 intervals of 3 min vibration at either 15Hz or 25Hz (permutated order,  $\pm 2.5$  mm amplitude), followed by 3 min recovery. Near infra-red spectroscopy (Geraskin, 2009) was used for measuring hemoglobin oxygen saturation ( $SmO_2$  in %) and the concentrations of oxygenated, desoxygenated, and total hemoglobin ( $HbO_2$ ,  $HbH$ ,  $tHb$ ) in the m. gastrocnemius medialis. EMG was recorded for the detection of reflex responses. Results Within the first 30s of vibration  $SmO_2$  increased from  $56 \pm 7\%$  to  $68 \pm 4\%$ . After having reached this maximum,  $SmO_2$  slowly decreased until it reached a steady state at  $63 \pm 5\%$  after almost 1.5 min of vibration. In the recovery phase  $SmO_2$  linearly decreased back to base line. No significant differences were found for frequency and the order of vibration intervals. The initial increase of  $SmO_2$  corresponded to a large decrease in  $HbH$ , a small increase in  $HbO_2$ , and a decrease in  $tHb$ . The EMG was super-imposed by artefacts at the vibration frequency and its harmonics and did not reveal any evidence of muscular activity. Furthermore, there was no evidence for a reflex contraction by visual observation or subjects' sensation. Discussion These observations suggest that in the unloaded calf muscle 15 and 25 Hz vibration initially cause a mechanical removal of predominantly desoxygenated blood from the capillaries and venules. Afterwards a moderate mismatch between oxygen supply and consumption was indicated by the decrease in  $SmO_2$  followed by a steady state indicating a balance. After vibration full recovery was reached

within 3 min without indications of a reactive hyperemia. Of note, all these very clear changes occurred in the absence of EMG activity. The responsible mechanisms could e.g. be related to vasomotor responses or to basic muscle tone and need to be established by further studies. Reference: Cochrane DJ, Stannard SR, Sargeant AJ, Rittweger J (2008) *Eur J Appl Physiol* 103: 441-448 Geraskin D, Boeth H, Kohl-Bareis M (2009) *J Biomed Opt* 14(4): 044017 Zange J, Haller T, Müller K, Liphardt AM, Mester J (2009) *Eur J Appl Physiol* 105: 265-270

### EFFECT OF WHOLE BODY VIBRATION ON THE H-REFLEX IN NORMAL GRAVITY AND MICROGRAVITY

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**Introduction:** During space flights, astronauts suffer from structural (bone and muscle loss) and functional changes (impairment of balance and movement control in response to changes within the neuromuscular system). Space agencies are exploring the suitability of whole body vibration (WBV) as a training regimen for astronauts to counteract the degeneration caused by weightlessness. However, the effect of weightlessness on the neuromuscular system and the interaction of microgravity and WBV have not been studied yet. Therefore, the purpose of this study was to investigate (1) how weightlessness affects Ia afferent transmission with respect to the soleus (SOL) and gastrocnemius medialis (GM) muscles and (2) if gravitational alterations modulate Ia afferent transmission during WBV. **Methods:** Fourteen subjects participated in this experiment that was conducted during a parabolic flight campaign with exposure to microgravity (0g) and normal gravity (1g). Ia afferent transmission was evaluated in four different conditions: 1g and 0g without WBV; 1g and 0g with WBV. For that purpose, H-reflexes were elicited by peripheral nerve stimulation. H/M recruitment curves were recorded in SOL and GM in each of the four conditions and Ia afferent transmission was assessed by their corresponding Hmax/Mmax-ratios. **Results:** (1) SOL (0g:  $0.45 \pm 0.10$ ; 1g:  $0.47 \pm 0.12$ ) and GM Hmax/Mmax-ratios (0g:  $0.29 \pm 0.12$ ; 1g:  $0.27 \pm 0.10$ ) were statistically equal and showed no changes due to different gravity levels. (2) In 1g, SOL and GM Hmax/Mmax-ratios showed a distinct reduction (SOL -58%  $p < 0.05$  and GM -51%  $p < 0.05$ ) during WBV compared to conditions without WBV. Likewise in 0g, SOL and GM Hmax/Mmax-ratios were highly decreased (SOL -57%  $p < 0.05$  and GM -44%  $p < 0.05$ ) compared to conditions without WBV. **Discussion:** The main findings were: (1) WBV causes drastic reductions in Ia afferent transmission and (2) these reductions are independent of the gravitational condition. It has been shown that WBV induces stretch reflex responses that cause muscle contractions (Ritzmann et al. 2010). This contractile stimulation has been successfully utilized in training programs to compensate for disuse in long term bed rest studies (Belavý et al. 2009). Based on the finding that Ia afferent transmission is not affected by gravitational changes, it might be concluded that vibration-induced benefits typically observed in 1g might also be achieved in 0g. For space conditions, WBV could be recommended as a training modality, either applied alone or in combination with strength training to counteract atrophic muscle deteriorations effectively. **References:** Ritzmann R, Kramer A, Gruber M, Gollhofer A, Taube W. (2010). *Eur J Appl Physiol* 110(1):143-51. Belavý DL, Miokovic T, Armbrecht G, Rittweger J, Felsenberg D. (2009). *J Musculoskelet Neuronal Interact* 9(4):225-35.

### EFFECTS OF DETRAINING AFTER RESISTANCE TRAINING WITH WHOLE BODY VIBRATION ON MUSCLE FITNESS IN UNTRAINED ADULTS

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**Introduction** Various physiological aspects of detraining (that is, complete cessation of training) effects after resistance training (RT) have been investigated. Recently, RT combined with whole-body vibration (WBV) has become popular for untrained middle-aged populations. Several reports have demonstrated that RT with WBV enhances muscle power and strength (Marin et al. 2010a; Marin et al. 2010b). However, the effects of detraining after RT combined with WBV on muscle fitness in untrained individuals have not been demonstrated. The present study investigates the effects of 5-week detraining after 13-week of RT coupled with or without a WBV program on muscle strength and power. **Methods** Thirty-two participants (22-49 years of age) were randomly assigned to groups that performed RT with (RT-WBV,  $n = 16$ ; Frequency, 35 Hz; Amplitude, 2mm; Power Plate® Next Generation) or without (RT,  $n = 16$ ) WBV. Training intensity was progressively increased by using external loading. We investigated the effects of 5-week detraining after a 13-week exercise program with WBV by measuring maximal isometric and isokinetic knee extension, as well as isometric lumbar extension strength, countermovement-jump height, knee extension endurance and sit-ups. **Results** Maximal isometric and concentric knee extension strength was significantly higher in the RT-WBV, than in the RT group after the training. However, decreases were significant only in the RT-WBV ( $-11.5 \pm 9.2\%$  and  $-19.9 \pm 18.0\%$ , both  $p < 0.05$ ), whereas maximal isometric and concentric knee extension strength was retained in the RT group after detraining. Maximal isometric lumbar extension strength increased significantly more in the RT-WBV, than in the RT group, and neither group lost a significant amount of strength after detraining. **Discussion** Although knee extension strength was lost in the RT with WBV group, maximal isometric lumbar extension strength was retained in both groups after the detraining. Exercises for back extensor muscles in the present study were performed at a lower training intensity than for the lower extremities. Taking the results of maximal isometric knee and lumbar extension strength and the possibility that skeletal muscle groups might respond differently to detraining into consideration, muscle strength losses might depend in part on training intensity and the specific muscle group examined in RT coupled with WBV. **In conclusion**, these results suggest that high plasticity of gains in muscle strength might occur in response to detraining RT combined with WBV in healthy untrained adults. **References** Marin et al. (2010a) *J Strength Cond Res*, 548-556. Marin et al. (2010b) *J Strength Cond Res*, 871-8.

### THE EFFECTS OF WHOLE-BODY VIBRATION TRAINING ON BALANCE AND GAIT IN THE ELDERLY: A PILOT STUDY

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**Introduction** A human is in stable posture as long as the line of action of the person's weight vector passes within the base of support. For effective maintenance of postural stability during standing, functional activities and gait, quick coordinated responses to environmental perturbations are important. Since aging is associated with a decline of balance, muscle mass, and mobility, it impacts on postural control. Some 80% of falls in the elderly are caused by balance disturbances during everyday movements. Exercise programs that include a balance-training component have shown to be effective in preventing falls (Sherrington et al., 2008). In the last decade whole-body vibration (WBV) has become a therapeutic modality to train postural control of elderly (Merriman & Jackson, 2009). However, the effects of this intervention are not always clearly documented. Consequently the aim of this study was to assess the effects of a four-week

stochastic resonance whole-body vibration (SR-WBV) training program on balance and gait in the elderly. **Methods** Twenty elderly volunteers aged 65 to 90 years (78.46 sd. 7.4 years) were randomly assigned to intervention (IT) and sham-training (ST) groups exercising 3 times a week during four weeks with a minimum of one day rest in between. All participants stood on the device with slightly flexed knees. IT (n=7) received 5 sets of 1 minute SR-WBV (5Hz, Noise 4) with 1 minute of rest in between whereas ST (n=10) received 5 sets of 1 minute SR-WBV (1Hz, Noise 1) with 1 minute of rest in between. All participants performed pre- and post-training tests of dynamic balance the Extended Timed Get Up-and-Go Test (ETGUG; Wall et al., 2000). Gait (20 m walk) was assessed under standardized single task (ST) and dual task (DT) conditions. **Results** Two dropped out of knee pain and one of personal reason. Baseline comparisons revealed no significant differences for demographic variables. Pretests showed only for ETGUG 12-18m ( $p=0.045$ ) a borderline significant difference between groups. Following the four-week training period, ETGUG indicated a significant decrease in the time needed to perform the walking parts of the test for IT: 2-8m (-14.6%,  $p=0.018$ ), 12-18m (-7.9%,  $p=0.018$ ). ST conditions showed no changes in this test. **Discussion** The results indicated a beneficial effect of SR-WBV with 5Hz vibration frequency on dynamic balance in contrast to those training with a 1 Hz frequency. Low volume SR-WBV exercises over 12 units with 5 Hz might provide a sufficient stimulus to the nerve-muscle system to improve dynamic balance at the ETGUG. These findings warrant further research in deconditioned elderly populations with postural control impairments.

## Oral presentations

### OP-PM35 Physical Activity Ageing

#### ACTIVE OLDER ADULTS ARE LESS AFFECTED BY THE FEAR OF FALLING

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**BACKGROUND AND PURPOSE:** Fear of fall (FoF) is a major health problem among elderly, restricting their mobility and independence. The purpose of this study was to determine the impact of FoF in the activities of daily living (ADLs) in elderly. **SUBJECTS AND METHODS:** A cross-sectional study was designed to determine the effect of FoF and its consequences regarding perception of health (PH), falls prevalence (FP), physical activity (PA) and functional fitness (FF) among 160 Portuguese older adults (73.4±6.2 yrs; 71.9% women). FoF, PH and FP, were assessed by specific questionnaire. PA was calculated through YPASI[1]. FF was evaluated by UG and CS tests from SFT[2], and balance obtained through "item 4, 5, 6 and 7" of FAB Scale[3]. Mann-Whitney and Chi-Square test were done to identify differences between PH, PA, FF, FP according to FoF and how it affects the ADLs. Logistic regression analyzes (forward conditional) were performed. **RESULTS AND DISCUSSION:** FoF was reported by 50.0% and associated avoidance of activity by 21.1%. The factors related with FoF are: Women ( $x^2 = 26.00$ ;  $p = 0.000$ ), poor PH ( $x^2 = 7.06$ ;  $p = 0.008$ ), visual health perception (VHP) ( $x^2 = 8.43$ ;  $p = 0.004$ ), FP ( $Z = 0.342$ ;  $p = 0.001$ ), medications ( $Z = -2.96$ ;  $p = 0.003$ ), poor FF, namely agility ( $Z = -2.51$ ;  $p = 0.012$ ), lower limb strength ( $Z = -2.41$ ;  $p = 0.013$ ) balance ( $Z = 4.87$ ;  $p = 0.000$ ) and PA energy expenditure in household activities ( $Z = -2.21$ ;  $p = 0.028$ ) and walking ( $Z = -2.58$ ;  $p = 0.010$ ). The factors related with impediment to ADLs are: Women ( $x^2 = 4.64$ ;  $p = 0.031$ ) as poor PH ( $x^2 = 8.43$ ;  $p = 0.004$ ), VHP ( $x^2 = 11.15$ ;  $p = 0.001$ ) and hearing health ( $x^2 = 14.63$ ;  $p = 0.006$ ), age ( $Z = -2.02$ ;  $p = 0.044$ ), FP ( $Z = 2.36$ ;  $p = 0.018$ ), fractures ( $x^2 = 4.43$ ;  $p = 0.0035$ ), sitting time ( $Z = 2.24$ ;  $p = 0.25$ ) and walking time ( $Z = -3.40$ ;  $p = 0.001$ ), recreational activities time ( $Z = -2.34$ ;  $p = 0.018$ ), and balance ( $Z = -3.78$ ;  $p = 0.000$ ). The logistic regression model for the outcome FoF shows that men (OR = 0.071; 95% CI -0.020-0.246), good balance (OR = 0.795; 95% CI -0.700-0.903) and VHP (OR = 0.178; 95% CI -0.178-0.850) are protective predictors of FoF. Male gender and good balance are also protective predictors to the impediment outcome (OR = 0.240; 95% CI -0.059-0.982; OR = 0.808; 95% CI -0.726-0.899, respectively). **CONCLUSION:** Men seem to be protected for FoF and its impact in ADLs. However, be more active especially by increasing walking and achieve good balance could have a positive effect on autonomy of the elderly. **References:** [1] Dipietro, et al (1993) MSSE 25(5), 628-642; [2] Rikli & Jones (2001) SFT Manual. HK; [3] Rose (2002) Fall Proof. HK

#### RELATIONSHIP BETWEEN FUNCTIONAL FITNESS, BMI, BLOOD PRESSURE AND SELF-RATED HEALTH IN ELDERLY INVOLVED IN AN INTERVENTIONAL EXERCISE PROGRAM

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**INTRODUCTION:** Physical activity is directly associated to an increased quality of life among elderly people by increasing their functional capacity and independence. Thus, the aim of this study was to analyze the relationship between self-rated health (SRH) and functional fitness, BMI and blood pressure of elderly involved in an interventional exercise program. We hypothesized that subjects who obtained better results in functional tests tend to have a better SRH and low levels of BMI and blood pressure. **METHODOLOGY:** These are preliminary results of an interventional program developed in Maia/Portugal, comprised of 900 subjects, aimed to evaluate the effects of different training methodologies. Our sample consists of 167 subjects, aged 60 to 74. The functional capacity was measured by Rikli & Jones (1999) functional fitness battery. The SRH was evaluated by the international questionnaire Medical Outcome Study – 36 items from health survey- short version (SF-36). BMI and blood pressure were evaluated according to international procedures. Statistical analysis was performed using SPSS (Windows version 17.0) and the level of significance was set up at  $p \leq 0.05$ . **RESULTS:** SRH was significantly associated with four different functional tests ( $p \leq 0.05$ ). Subjects who belong to the 4th quartile in tests related to locomotion correspond to those subjects who had the best perception of health and the lowest levels of BMI blood pressure. **CONCLUSION:** We observed that SRH, BMI and blood pressure are associated to functional fitness, especially in those tests related to locomotion capacity.

#### CORRECTNESS OF HOME EXERCISE PERFORMANCE IN OLDER ADULTS

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**Introduction** Due to low costs and high accessibility home-based exercise seems to be an appropriate alternative to supervised exercise to preserve functional status in old age. However, the concept of home-based exercise relies on the belief that exercises are performed correctly so that they are likely to be effective and do not harm the participants. A home-based exercise program, approaching and supporting community-dwelling elderly via their general practitioner (GP) and an exercise therapist (ET), has been developed (HOMEfit). A

feasibility study was conducted to allow modifications before entering the next phase of research. To assess suitability of exercises for the program, correctness of exercise performance was assessed. Methods The 12-week intervention (single arm trial) included home exercises (walking for exercise plus a choice of strength, flexibility and balance exercises from a given set of 16) and consultations provided by an ET in the GP's practice and via telephone. Based on the participant's abilities, needs and experiences the ET set up an individualized program. Selected exercises were taught within 4 personal consultations. Participants received a pictorial guidebook. At the end of the intervention all exercises practiced within the course of the program were rated by the ET (Friedrich et al. 1996): grade 1 - the exercise is performed correctly and the treatment goal is reached; grade 2 - the exercise is not performed correctly and the goal is not reached but no negative impact is to be expected; grade 3 - the exercise is performed incorrectly, the goal is not reached and there is reason to believe that the exercise might have harmful effects. Results Correctness of exercise performance was assessed in 74 participants (median age 76 (70-86) years; 58% females). Between 67 and 100% (mean 85%) performed the respective exercise correctly (grade 1). Only 1 patient performed 1 exercise in the way that it might have harmful effects (grade 3). From the given set of exercises, 3 were performed by less than 10% of patients within the course of the program. Conclusion The present evaluation permitted us to select the most appropriate exercises for the consecutive study. An additional personal consultation might improve correctness of exercise performance. Reference Friedrich, M., Cermak, T., Maderbacher, P. (1996) The effect of brochure use versus therapist teaching on patients performing therapeutic exercise and on changes in impairment status. *Physical Therapy*, 76, 1082-88. The study was funded by the German Federal Ministry of Education and Research (01ET0720).

### **MULTIPLE JOINT FUNCTION WITH AGEING: FORCE-VELOCITY AND POWER-VELOCITY RELATIONSHIPS**

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Introduction Previous studies have documented the decline in neuromuscular function, particularly muscular power, of single joints with ageing. However, the extent to which force or velocity are responsible for the loss in power is equivocal. Furthermore, multiple joint movements (e.g. simultaneous extension of the ankle, knee and hip) may be more relevant to mobility and locomotion, but have received little attention. This study compared the neuromuscular function of young vs. older men during a multiple joint leg press action. The force-velocity and power-velocity relationships were assessed and the contribution of force and velocity to the decline in power evaluated. Methods Twenty-one older men (OM, 66 ± 3 yrs) and twenty-three young (YM, 24 ± 2 yrs) completed a familiarisation session followed by two main trials which involved assessment of the non-dominant leg with a leg press dynamometer instrumented to record force (Kistler 92868A, force plate, London, UK) and displacement (linear transducer, Micro-epsilon Ltd, Ortenburg, Germany). During the first main trial participants completed a series of maximum and explosive isometric contractions followed by an assessment of 1RM lifting strength. During the second main trial, participants completed maximum dynamic contractions, 3 attempts at each of 5 different loads of 60, 45, 30, 15 and 0 % of their 1RM. For these contractions displacement was used to derive velocity and calculate power. The highest instantaneous peak power achieved at each load and the associated force and velocity values were used to plot the force-velocity and power-velocity relationships, and these were fitted with a quadratic function. For the power-velocity relationship this facilitated the calculation of maximum power (Pmax) and of the optimal velocity (Vopt) and optimal force (Fopt) as the co-ordinates of the optima of the quadratic function. Results The force-velocity relationship was lower for the OM as reflected by their 21% lower maximum isometric strength compared to the YM (2053 ± 284 vs. 2585 ± 487 N; p<0.001). The power-velocity relationship was also lower for the OM compared to the YM, as shown by the 30% reduction in Pmax (1136 ± 176 vs. 1663 ± 278 W; p<0.001), the 12% slower Vopt (1.43 ± 0.16 vs. 1.62 ± 0.32 m.s<sup>-1</sup>, p<0.05) and 22% lower Fopt (797.4 ± 93.6 vs. 1025.8 ± 220.5 N; p<0.001). Explosive isometric strength (peak rate of force development) was 24% lower for the OM compared to the YM (9340 ± 2723 vs. 11605 ± 3655 N.s<sup>-1</sup>, p<0.05). Discussion Older men had substantially lower power during a functionally relevant multiple joint leg press movement than younger men, and whilst force and velocity were both lower in older men, the decrease in force contributed more to the decline in power.

### **IDENTIFICATION OF SARCOPENIC OBESITY IN POSTMENOPAUSAL WOMEN: A CUTOFF PROPOSAL**

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Introduction: Sarcopenic obesity has been pointed as an important cause of frailty among older adults but lack of clear criteria for its identification leads to limitation in clinical and research settings. The purposes of the present investigation were: 1) to develop an approach for identifying postmenopausal women who are deficient in fat-free mass (FFM) relative to their fat mass (FM) and height (i.e., sarcopenic obesity); 2) to calculate the prevalence of inadequate FFM in that population; and 3) to examine whether there are associations between the proposed classification and health-related phenotypes. Methods: A total of 607 women were included in this cross sectional study and were categorized into two subsets: 1) Older women with mean age of 66.8 years (n = 258) and 2) 349 young women aged 18-40 years. All volunteers underwent body composition assessment through dual energy x-ray absorptiometry. The proposed cutoff value corresponded to an index of FFM relative to FM and height two standard deviations below the mean of the young reference group. Results: Definition of older women presenting sarcopenic obesity was conducted based on comparison of FFM index distribution in the young reference group versus the older volunteers. The proposed classification generated a sarcopenic obesity prevalence of 19.8% that was associated with reduced absolute and relative muscle strength and aerobic fitness indexes among the older participants. Conclusions: These results demonstrate reduced functional capacity for those below the proposed cutoff and suggest applicability of the approach as a definition for sarcopenic obesity. Future studies should further investigate its potential use in clinical settings and examine its association with other clinical outcomes such as cardiovascular and metabolic risks.

### **SKELETAL MUSCLE SIZE, STRENGTH AND 'QUALITY' IN UNTRAINED YOUNG AND ELDERLY MEN, AND IN ELDERLY ATHLETES**

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Introduction Elderly people can develop problems of mobility, in part due to age-related loss of muscle mass and strength. Strength, however, deteriorates at a faster rate than muscle mass, resulting in reduced specific force (strength when normalised to muscle size) (Goodpaster et al 2006). Maintaining high levels of exercise throughout adulthood and into old age does not prevent the age-related loss of muscle strength (Aagaard et al 2007), but we hypothesised that highly active elderly would show some preservation of muscle specific

force. Methods Knee extensor maximum voluntary isometric contraction torque (MVC) was measured using dynamometry and muscle architecture was measured by ultrasound scanning at the mid-point of each of the quadriceps (Quads) muscles in 11 young (Y: age  $22 \pm 1$  years) and 15 old men (O: age  $72 \pm 1$ ) with average levels of physical activity, and in 11 master-athlete runners (MA: age  $76 \pm 2$ ) who were competing in the European Veteran Athletics Championships in 2010. Muscle specific force was expressed as MVC normalised to the sum of muscle thickness of the Quads muscles (Qt), as measured from ultrasound scans. Data are mean  $\pm$  SEM. Results MVC was higher in Y compared with O and MA ( $272 \pm 43$ ,  $175 \pm 39$  and  $192 \pm 39$  Nm, respectively  $P < 0.0005$ ), but was not significantly different between O and MA ( $P = 0.551$ ). The Quads thickness was also greater in Y compared with O and MA ( $102 \pm 12$ ,  $86 \pm 7$  and  $81 \pm 12$  mm, respectively;  $P = 0.006$ ), but was not significantly different between O and MA ( $P = 0.532$ ). MVC was positively correlated with Qt ( $r = 0.629$ ;  $P < 0.0005$ ). Specific force (MVC/Qt) was higher in Y compared with O, but did not differ significantly between Y and MA ( $2.7 \pm 0.3$ ,  $2.1 \pm 0.5$  and  $2.4 \pm 0.5$  Nm/mm in Y, O and MA, respectively). Quads fascicle length was similar in all groups and only minor differences were seen between groups in pennation angles. Discussion Many years of exercise in elderly people does not prevent the deterioration in muscle size and strength, but does preserve muscle quality in terms of its strength normalised to muscle size. The results suggest that exercise training could be a way to combat the age-related deterioration of muscle quality, which is an important component of the overall loss of muscle function. References: Goodpaster et al 2006, J Gerontol, 61A(10); p1059-1064. Aagard et al 2007, Med Sci Sports Exerc, 39(11); 1989-96. Acknowledgements: We acknowledge MYOAGE (nr. 223576) funded by the European Commission under FP7.

## Oral presentations

### OP-PM26 Molecular 1

#### ACUTE METABOLIC RESPONSE TO LOW-VOLUME, HIGH-INTENSITY CONTINUOUS OR INTERVAL WORK-MATCHED EXERCISE

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Introduction High-intensity interval training (HIT) induces skeletal muscle remodeling similar to traditional endurance training despite a markedly lower total exercise volume and training time commitment (1,2). However, the relative importance of the "pulsed" nature of the HIT stimulus remains unclear. Our purpose was to determine whether a single bout of all out exercise would elicit similar acute metabolic changes as compared to an intermittent maximal cycling protocol matched for total work. We hypothesized that performing a given amount of work at maximal intensity would result in similar acute metabolic changes in human skeletal muscle, regardless of whether the exercise was performed in a continuous or interval manner. Methods Eight men ( $22 \pm 1$  y,  $48 \pm 2$  mL $\cdot$ kg $^{-1}\cdot$ min $^{-1}$ ) performed two exercise trials in random order at least 1 wk apart. During one session, subjects performed 4 x 30 s all out sprints separated by 4 min of rest (repeated Wingate tests; INT). In the other trial, subjects performed an isovolumetric amount of work ( $67.0 \pm 2.4$  kJ) but as a single continuous all-out effort (ISO). Skeletal muscle biopsies were taken before and immediately after each trial and analyzed for various metabolites and signaling proteins linked to mitochondrial biogenesis. Results Mean power averaged over the 4 sprints was  $557 \pm 16$  W, whereas mean power during the single bout was  $287 \pm 18$  W. Total exercise time was  $3:58 \pm 0:09$  (range: 3:23-4:30 min:s) in ISO, compared to 4 x 30 sec = 2 min over a 14 min training time commitment (including recovery) in INT. Both INT and ISO resulted in similar changes in muscle glycogen (net decrease: INT =  $140 \pm 39$ ; ISO =  $121 \pm 32$  mmol $\cdot$ kg dry wt $^{-1}$ ) and lactate contents (net increase: INT =  $57.5 \pm 6.7$ ; ISO =  $48.7 \pm 8.2$  mmol $\cdot$ kg dry wt $^{-1}$ ) (all main effects for time,  $P < 0.05$ ). Similar main effects were found for the phosphorylation status of signaling proteins p38 MAPK (increased 3-fold), ACC (increased 2-fold), and Akt (decreased 50%), with no difference between treatments. Discussion A few minutes per day of very intense exercise induces similar metabolic disturbances and activation of signaling pathways linked to skeletal muscle remodeling, regardless of whether that work is performed continuously or in an interval manner. These data add to the growing body of evidence that suggests very intense exercise training is extremely potent and time-efficient. It remains to be determined whether chronic training using an ISO-based protocol induces adaptations similar to traditional high-volume endurance training, as we have previously shown after an INT-based protocol (1,2). References 1. Burgomaster K, et al. (2008). J Physiol, 586, 151-160. 2. Gibala M, et al. (2006). J Physiol, 575.3, 901-911.

#### COMPARABLE EFFECTS OF MODERATE INTENSITY EXERCISE ON CHANGES IN ANORECTIC GUT HORMONE LEVELS AND ENERGY INTAKE TO HIGH INTENSITY EXERCISE

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There is growing interest in effects of exercise on plasma gut hormone levels and subsequent energy intake (EI) but the effects of mode and exercise intensity on anorectic hormone profiles on subsequent EI remains to be elucidated. We aimed to investigate whether circulating peptide YY3-36 (PYY3-36) and glucagon-like peptide-1 (GLP-1) levels depend on exercise intensity which could affect subsequent EI. Ten young male subjects (mean  $\pm$  S.D., age;  $23.4 \pm 4.3$  years, body mass index;  $22.5 \pm 1.0$  kg/m $^2$ , and maximum oxygen uptake (VO $_2$  max);  $45.9 \pm 8.5$  ml/kg/min) received a standardized breakfast, which was followed by constant cycling exercise at 75% VO $_2$  max (high intensity session), 50% VO $_2$  max (moderate intensity session), or rest (resting session) for 30 min. At lunch, a test meal was presented, and the EI was calculated. Blood samples were obtained during three sessions for measurements of glucose, insulin, PYY3-36 and GLP-1 which includes GLP-1 (7-36) amide and GLP-1 (9-36) amide. Increases in blood PYY3-36 levels were dependent on the exercise intensity (effect of session:  $P < 0.001$  by two-way ANOVA), whereas those in GLP-1 levels were similar between two different exercise sessions. Of note, increase in area under the curve (AUC) values for GLP-1 levels was negatively correlated with decrease in the EI in each exercise session (High:  $P < 0.001$ , Moderate:  $P = 0.002$ ). The present findings raise the possibility that each gut hormone exhibits its specific blood kinetics in response to two different intensities of exercise stimuli and might play differential roles in regulation of EI after exercise.



## THE SOLUTE CARRIER FAMILY 22 GENE RS2457571 POLYMORPHISM DOES NOT INFLUENCE OXYGEN UPTAKE RESPONSES TO A SIX WEEK AEROBIC TRAINING PROGRAMME

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**Introduction** Timmons et al. (2010) used RNA expression profiling and previously published QTL analyses to identify 11 single nucleotide polymorphisms (SNP) accounting for 23% of the interindividual variance in endurance-training induced gains in maximal oxygen uptake in the HERITAGE Family study (Bouchard et al. 1995). Most of these polymorphisms had not previously been associated with exercise responses and hence represent a novel set of exercise response mediators that need independent replication. Here we present preliminary data regarding the potential association between one of those polymorphisms, the solute carrier family 22 gene (SLC22A3 rs2457571 SNP), and data derived from McPhee et al. (2009). **Methods** 61 previously sedentary women followed a 6 week supervised cycle training programme. 1 legged cycling peak oxygen uptake (1LVP) and 2 legged cycling maximal oxygen uptake (2LVM) were measured before and after the training programme. DNA was extracted from 200 µL whole blood using spin columns (Qiagen, Crawley, UK). Genotyping was performed via real-time PCR using a Chromo4 machine (BioRad, Hemel Hempstead, UK) and a pre-designed Taqman® SNP genotyping assay (Applied Biosystems, Warrington, UK). **Results** Mean 1LVP increased from 1.9 L/min to 2.1 L/min (delta 1LVP = 0.2 L/min), and 2LVM increased from 2.4 L/min to 2.7 L/min (delta 2LVM = 0.3 L/min) (both  $P < 0.0005$ ). Following univariate analysis and analysis of covariance using baseline body mass and physical activity as covariates for baseline data and training data respectively, no significant association between the SLC22A3 rs2457571 SNP (CC=14, CT=32, TT=15) and baseline values or changes in any of the functional measures was observed (e.g.  $P=0.562$  for the interaction between genotype and delta 2LVM). **Discussion** Our study failed to show any association between the functional data and the SLC22A3 rs2457571 SNP. However, very recent work by Bouchard et al. (2011), using precisely the same data set as Timmons et al. (but different methods to identify candidate genes), also fails to replicate the findings. In that context, it is unsurprising that we fail to replicate the Timmons et al. observation in a completely independent cohort with different training intensity and volume. **References** Bouchard C, Leon AS, Rao DC, Skinner JS, et al. (1995). *Med Sci Sports Exerc*, 27(5), 721-9. Bouchard C, Sarzynski MA, Rice TK, Kraus WE, et al. (2010). *J Appl Physiol*, DOI:10.1152/jappphysiol.00973.2010. McPhee JS, Williams AG, Degens H, Jones DA. (2010). *Eur J Appl Physiol*, 109, 1111-8. Timmons JA, Knudsen S, Rankinen T, Koch LG, et al. (2010). *J Appl Physiol*, 108, 1487-96.

## EFFECTS OF 12-H MECHANICAL VENTILATION ON FIBRE-SPECIFIC EXPRESSION OF ALPHA-ACTININ-3 PROTEIN IN RAT DIAPHRAGM

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**Introduction:** Alpha-actinin-3 protein and its gene expression become a focus of attention on athletic performance since alpha-actinin-3 protein is restricted to fast fiber in mammalian skeletal muscle. We recently reported that hind-limb unloading increases alpha-actinin-3 expression with slow-to-fast muscle fiber shift in the atrophied rat soleus muscle (Ogura et al., 2009). We have been also reported that mechanical ventilation (MV) rapidly induces muscle atrophy in rat diaphragm which is mainly composed of fast fibres (Powers et al., 2009). Those observations indicate that atrophic stimuli with MV may cause a different response of alpha-actinin-3 protein in diaphragm. Thus, the purpose of this study was to examine the effects of 12-h mechanical ventilation on fibre-specific expression of alpha-actinin-3 protein in rat diaphragm. **Methods:** Adult Wistar rats were randomly divided into either a control (n=8) or a 12-h of MV (n=8) group. Mechanically ventilated animals were anesthetized, tracheostomized, and ventilated with 21% O<sub>2</sub>. Animals in the control group were acutely anesthetized but were not exposed to MV. After the treatment, diaphragms were removed and immunohistochemical detection of muscle fiber type (Type I, Type IIa and Type IIb/dx) and alpha-actinin-3 expression were performed. **Results:** MV resulted in fibre selective atrophy of Type II b/dx in the cross-sectional area (CSA). Percentage of CSA did not change in Type I fibre, whereas that of type II b/dx decreased ( $P < 0.05$ ) after MV. Type I fibres did not express alpha-actinin-3 in all animals. In contrast, alpha-actinin-3 expressed in all of Type II b/dx fibres. Interestingly, alpha-actinin-3 expression were observed in 14% of Type IIa fibres, and this percentage did not change regardless of MV. **Conclusion:** Our results indicated that 1) 12-h of MV has caused selective atrophy of the Type II b/dx fibre, and 2) expression pattern of alpha-actinin-3 protein was not effected by 12-h of MV. **References** Ogura Y, Naito H, Kakigi R, Akema T, Sugiura T, Katamoto S, Aoki J. (2009). *Acta Physiol*, 196(3), 341-349 Powers SK, Kavazis AN, Levine S. (2009). *Crit Care Med*, (10 Suppl), S347-353

## EFFECTS OF CONTINUOUS AND INTERVAL AEROBIC EXERCISE UPON EXPRESSION OF PGC-1 $\alpha$ AND FOXO1 IN HUMAN SKELETAL MUSCLE

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**Introduction** Choosing an optimal aerobic exercise protocol for improving aerobic performance is an important task for endurance training and rehabilitation. The aim of the present study was to compare expression of master regulator of mitochondria biogenesis – PGC-1 $\alpha$ , FOXO1 and PDK4 mRNA in human skeletal muscle after continuous (CE) and interval (IE) aerobic exercise sessions. **Methods** For this purpose the 12 physical active men performed CE (workload at lactate threshold (LT), 50 min) and IE (3 min 81% LT + 2 min 127% LT) x 10 equalized in duration and mean power output. The subjective perception of exertion was evaluated and capillary blood were drawn before and during exercise session for determination of lactate, glucose and free fatty acid concentration. Biopsies were taken from m. vastus lateralis before and 10 min, 1, 3, 5 h after the exercise. **Results** Mean workloads per body weight in CE and IE session were  $2.25 \pm 0.16$  and  $2.23 \pm 0.15$  W (kg of body weight)<sup>-1</sup> accordingly. In IE lactate concentrations just after intensive bout at the 20-th, 30-th, 40-th and 55-th min were significantly higher than lactate concentrations at the same time points in CE. No differences were found between CE and IE in subjective perception of exertion as well as in blood concentrations of glucose and FFA. PGC-1 $\alpha$  mRNA abundance rapidly rose after the first hour of recovery for both CE and IE sessions and did not change between 3 and 5 h after exercise. The increment of PGC-1 $\alpha$  mRNA abundance 3 h after IE session was significantly higher than after CE ( $p < 0.05$ ):  $8.4 \pm 1.0$ - and  $5.6 \pm 0.8$ - fold correspondingly. Significant increments of FOXO1 mRNA were revealed 3h after IE and CE:  $2.1 \pm 0.3$ - and  $1.6 \pm 0.2$ - fold correspondingly. At the 1st h of recovery FOXO1 mRNA abundance after IE was higher than after CE ( $p < 0.05$ ). PDK4 mRNA abundance did not change after both CE and IE sessions. **Discussion** The current study demonstrated that at the transcriptional level IE had higher potential for improvement of mito-

chondrial biogenesis than CE equalized in duration and mean workload. The expression of PGC-1 $\alpha$  mRNA after CE positively correlated with relative workload indicating that the relative intensity of CE is of major importance for exercise-induced rise of PGC-1 $\alpha$  mRNA expression.

## Oral presentations

### OP-PM21 Cardiovascular: Disease

#### PROGNOSTIC VALUE OF TIME TO VEQCO2 NADIR IN PATIENTS WITH HEART FAILURE

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**Introduction** In patients with heart failure (HF), the gradient of the slope relating minute ventilation to carbon dioxide production (VE/VCO<sub>2</sub> slope) is greater than normal, so that for a given volume of carbon dioxide production, the ventilatory response is greater.(1-4) Another way of characterising the relation between VE and VCO<sub>2</sub> is the instantaneous ratio of ventilation to carbon dioxide production, the ventilatory equivalent for CO<sub>2</sub> (VEqCO<sub>2</sub>). In normal subjects, VEqCO<sub>2</sub> falls at the outset of exercise and rises toward the end. Patients with mild heart failure exhibit a similar pattern, although those with more severely affected patients, VEqCO<sub>2</sub> increased from the start of exercise.(5) We hypothesised that the time to VEqCO<sub>2</sub> nadir may be an important prognostic marker in patients with HF. **Methods** Left ventricular function was determined from 2D echocardiography and left ventricular systolic dysfunction (LVSD) was diagnosed if LVEF was  $\leq 45\%$ . Patients underwent a symptom-limited, treadmill maximal CPET. We included a healthy control group who had no evidence of cardiorespiratory disease. Results 423 patients with HF (mean age  $63 \pm 12$  years; 80% males; left ventricular ejection fraction  $36 \pm 6\%$ ; peak oxygen uptake  $22.3 \pm 8.1$  mL $\cdot$ kg<sup>-1</sup> $\cdot$ min<sup>-1</sup>; VE/VCO<sub>2</sub> slope  $34 \pm 8$ ) were included in the study. Seventy eight healthy participants (62% males; age  $61 \pm 11$  years) were recruited as controls. One hundred and eighteen patients died during follow-up with a median follow up of  $8.6 \pm 2.1$  years in survivors. Time to VEqCO<sub>2</sub> (nadir) was shorter in patients than controls ( $327 \pm 204$ s v  $514 \pm 187$ s;  $P=0.0001$ ). Time to VEqCO<sub>2</sub> (nadir) was similar as a percentage of the total exercise duration ( $55 \pm 23\%$  v  $60 \pm 17\%$ ;  $P=0.077$ ). The strongest univariable predictors of all-cause mortality were: VEqCO<sub>2</sub> (nadir) ( $\chi^2 = 47.9$ ), peak oxygen uptake ( $\chi^2 = 53.0$ ), VE/VCO<sub>2</sub> slope ( $\chi^2 = 31.7$ ), and time to VEqCO<sub>2</sub> (nadir) ( $\chi^2 = 23.7$ ). In multivariable Cox regression VEqCO<sub>2</sub> (nadir) ( $\chi^2 = 8.8$ ), peak systolic blood pressure ( $\chi^2 = 6.0$ ), age ( $\chi^2 = 6.6$ ) and time to VEqCO<sub>2</sub> (nadir) ( $\chi^2 = 3.8$ ) were the strongest independent predictors of all-cause mortality. **Discussion** The time to VEqCO<sub>2</sub> (nadir) following maximal exercise testing provides additional prognostic information in patients with HF. **References** 1. Ingle L, Eur J Heart Fail 2008; 10(2):112-8. 2. Clark A, Coats A. Eur Heart J 1992;13(12):1698-1708. 3. Ingle L, Goode K, Carroll S, Sloan R, Cleland JGF, Clark AL. Int J Cardiol 2007;118(3):350-355. 4. Clark AL, Volterrani M, Swan JW, Coats AJS. Heart. 1997;77(2):138-146. 5. Clark AL, Poole-Wilson PA, Coats AJS. J Am Coll Cardiol 1992;20(6):1326-1332.

#### EFFECTS OF INSTITUTIONAL REHABILITATION VERSUS HOME-BASED INTERVAL TRAINING ON PEAK OXYGEN UPTAKE AND HEALTH RELATED QUALITY OF LIFE IN CORONARY ARTERY BYPASS PATIENTS

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**Introduction** Rehabilitation after coronary artery bypass grafting (CABG) is commonly organized as either institutional or home-based exercise training. Aerobic interval training has been shown to be effective in increasing peak oxygen uptake (VO<sub>2</sub>peak) in subjects with cardiovascular disease. We determined the effect a standard institutional rehabilitation program (IR) versus home-based interval training (HINT) upon VO<sub>2</sub>peak. **Secondary outcome measures** were health related quality of life (QoL) and blood markers of cardiovascular disease. **Methods** CABG (n = 26) patients were randomised to either IR (n = 14) or HINT (n = 12), 7.5 (SD 2) weeks postoperatively. VO<sub>2</sub>peak was tested on treadmill at baseline and again six months later. We used the heart disease specific Mac New questionnaire of health related quality of life (QoL). Blood was sampled after overnight fasting. The IR group stayed at a rehabilitation centre for four weeks and followed a standard rehabilitation program of exercise and education about healthy lifestyle. At discharge they received individualised home exercise prescriptions and were telephone monitored twice during the follow up period. The HINT group received information on how to do aerobic interval training at home (4 x 4 minutes of exercise with 85-95% of individual heart rate maximum, 3 times per week for six months). They were asked to register the amount and intensity of exercise. HINT received no formal supervision during follow up. **Results** Both groups increased VO<sub>2</sub>peak ( $p < 0.005$ ); IR from  $25.6$  (SD  $4.0$ ) mL/min/kg to  $30.2$  (SD  $4.3$ ) mL/min/kg and HINT from  $23.8$  (SD  $5.4$ ) mL/min/kg to  $27.7$  (SD  $6.5$ ) mL/min/kg with no significant difference between the groups ( $p = 0.51$ ). The physical and social domains of QoL increased significantly in both groups, with no differences between the groups. High density lipoprotein (HDL) increased significantly only after IR, from  $1.1$  (SD  $0.3$ ) mmol/l to  $1.4$  (SD  $0.2$ ) mmol/l ( $p=0.03$ , group difference  $p = 0.021$ ). In the HINT group all patients reported to have exercised 4.0 (range 2-7) times per week, 41% of these exercise sessions was interval training with high intensity. **Conclusion** IR and HINT gave equal increases in VO<sub>2</sub>peak and QoL six months after baseline. HDL increased more after IR. This study implies that CABG patients may administer a home-based exercise program of aerobic interval training and that compliance is good.

#### COMPARISON OF BASELINE VALUES OF TOTAL SERUM NITRITE/NITRATE IN SEDENTARY OBESE AND PRE-OBESE MALE SUBJECTS, WITH OR WITHOUT TYPE 2 DIABETES

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**Introduction** It is now widely accepted that hypertension and endothelial dysfunction are associated with an insulin resistant state, and thus with the development of Type II diabetes mellitus (T2DM). Insulin signalling is impaired in target cells and tissues, indicating that common molecular signals are involved. Nitric oxide (NO) regulates cell metabolism, insulin signalling and secretion, vascular tone, neurotransmission and immune system function. NO<sub>2</sub> synthesis is essential for vasodilation, the maintenance of blood pressure and glucose uptake. Consequently, reduced NO<sub>2</sub> results in insulin resistance and hypertension. Therefore, the aim of this study was to com-

pare metabolic parameters and tNOx levels (an indirect measurement of NO<sub>1</sub> synthesis) in obese and pre-obese individuals with and without T2DM. Methods Fourteen sedentary male subjects [6 obese controls (C) vs. 5 obese and 3 pre-obese T2DM; age 54±9 years] were selected according to their BMI [≥30kg/m<sup>2</sup> for obese and 25-27kg/m<sup>2</sup> for pre-obese subjects (WHO, 2004)] and were evaluated for fasted values of blood glucose, HbA1c, lipid profile, plasma glycerol levels, serum insulin, CRP and tNOx. Body composition was measured by DEXA and VO<sub>2</sub>max was estimated with a submaximal incremental treadmill test. Results Fasting glucose (C=5.2±1.2 vs. T2DM=7.0±0.89 mmol/L), HbA1c (C=6.0±0.2 vs. T2DM=7.3±0.5%) and serum insulin (C=11.1±5.4 vs. T2DM=30.9±12.5 µU/L) were higher in T2DM, as expected. Obese T2DM demonstrated lower levels of tNOx (C=21.1±2.4 vs. T2DM=12.7±3.5 µM). Interestingly, in pre-obese T2DM a higher level of tNOx was observed when compared with controls and obese T2DM (33.8±7.2 µM). No differences in glycerol, CRP and estimated VO<sub>2</sub>max were found. Discussion The fact that pre-obese T2DM have higher while obese T2DM have lower levels of tNOx could, at least in part, provide a link between obesity, T2DM, insulin resistance and hypertension as previously hypothesized [1]. Our preliminary results indicate that elevated nitric oxide levels associated with pre-obese individuals may counter the adverse affects of adipose tissue derived inflammatory factors which are major factors in the development of cardiovascular complications, insulin resistance and beta-cell failure in associated with obesity. This hypothesis is now under investigation. References 1. Newsholme P, Homem De Bittencourt PI, O'Hagan, C., De Vito G, Murphy C, Krause MS. Clin Sci (Lond) 118: 341-349, 2010.

### EFFECT OF AEROBIC TRAINING ON PLASMA ADIPONECTIN CONCENTRATIONS IN OBESE WOMEN.

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Introduction Adipose tissue secretes multiple proteins known as adipocytokines that modulate various biological functions. One of these adipocytokines is adiponectin, which is reduced with obesity, which increases insulin resistance, dyslipidaemia and diabetes. (Mujumdar et al. 2011). Hence, the aim of this study was to analyse the effect of aerobic training for 12 weeks on plasma adiponectin concentrations and metabolites. Methods Twenty-four obese women (age, 35-41 years; BMI, 32.2 ± kg/m<sup>2</sup>) took part to the study. Participants were divided in three groups: diet group (D; -500 kcal.day<sup>-1</sup>, n=8), aerobic exercise group (E; n=8), aerobic exercise + diet group (E+D; n=8). Subjects underwent a 12 week training program (4days/week, 60 min.day<sup>-1</sup>) at 50-70 % of VO<sub>2</sub> peak. Fasting plasma levels of adiponectin and lipids were measured in all subjects before and after the program. 3 Result In the three groups we showed a decrease in body weight (P<0.05), BMI (P<0.05), % Fat (P<0.05), HDL-cho (P<0.05) but we detect an increase in VO<sub>2</sub> max in group E (21.18%; P<0.05) and in group E+D (25.19 %; P<0.05). Adiponectin levels increased significantly in the D (P<0.05), E (P<0.05) and E+D groups (P<0.01). In the subjects of the E+D group, adiponectin levels exhibited a significant negative correlation with body mass (-0.52; P<0.01). Furthermore in the D group, significant correlations were observed between adiponectin levels and body mass (r=-0.42; P<0.05) and between the TC/HDL-C ratio and body mass (0.36; P<0.05). Discussion Our results are in agreement with the results of the study of Nuamo et al. (2010), who have shown that aerobic exercise intensity alters adiponectin concentrations in middle-aged obese men. Elloumi et al. (2009) demonstrated also that exercise training combined with energy restriction increases adiponectin levels. On the other hand, several authors have shown that circulating adiponectin did not change whereas a decrease in body mass, fat mass and an increase in cardio respiratory fitness were noticed (Dvorakova-Lorenzova et al. 2006). These findings show that the combined program of diet restriction and aerobic exercise training is necessary to improve body mass loss, adiponectin levels, as well as metabolic parameters in obese women. References Numao S, Katayama Y, Hayashi Y, Matsuo T, Tanaka K. (2010). Metabolism. 60:186-942. Mujumdar PP, Duerksen-Hughes PJ, Firek AF, Hessinger DA. (2011). Scand J Clin Lab Invest. [Epub ahead of print]. Elloumi M, Ben Ounis O, Makni E, Van Praagh E, Tabka Z, Lac G. (2009). Acta Paediatr. 98:1487-93. Dvorakova-Lorenzova A, Suchanek P, Havel PJ, Stavek P, Karasova L, Valenta Z, Tintera J, Polendne R. (2006). Metabolism 3:359-65.

### IMPACT OF EXERCISE TRAINING AND/OR DIET ON THE LIPOPROTEIN-LIPID PROFILES IN YOUNG OVERWEIGHT MALES

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This study examined the independent and combined effects of exercise training, weight loss and changes in dietary quality on the serum lipid profile in sedentary, healthy and overweight young men. 106 men 18-25 y with BMI>25 were randomly assigned to four groups, Control (C), Diet (D), Exercise (E) and Exercise and Diet (ED). Height, weight, percent body fat (BF%), TC, HDL-C, TG and LDL-C were measured before and after an 8-week intervention period. Subjects in the two exercise groups walked five times a week, 45 minutes per session, at 60-80% of maximum heart rate (MHR). Duration and intensity of exercise were gradually increased over a three week period from 25-30 minute/sessions at 60% to 65% of MHR during week 1 to 45 minutes at 70% to 80% MHR from weeks 4 through 8. Subjects in the two non-walking groups (control and diet) reported to the exercise facility five days per week for 45 minutes of stretching and mild range of motion calisthenics. The intent was to keep heart rate below 100 beats per minute. One-way ANOVA was the statistical test (α= 0.05). Relative to control group, the ED and D groups displayed a 4.6% and 3.9% reduction in body mass, 10 and 7% reduction in BF%, 31 and 28% reduction in TG. LDL-C fell by 14% in ED group. For each kg of weight loss there was a decrease of 0.06, 0.03 and 0.017 mg/dL in TC, LDL-C and TG respectively. No change of body mass occurred in E group. Exercise alone was insufficient to stimulate change in any lipid or lipoprotein measures. These results demonstrated that weight loss mostly was due to diet, because the exercise was the same in groups E and ED. The lipid profile improved and body mass decreased.

## Oral presentations

### OP-PM18 Training and Testing: Performance

#### WORKLOAD AND RACE STRATEGY: A COMPARISON BETWEEN THREE DIFFERENT COMPETITIONS LASTING THREE TO SEVEN DAYS.

WEYDAHL, A., CALOGIURI, G.

FINNMARK UNIVERSITY COLLEGE

WORKLOAD AND RACE STRATEGY: A COMPARISON BETWEEN THREE DIFFERENT COMPETITIONS LASTING THREE TO SEVEN DAYS. Weydahl, A. 1, Calogiuri, G. 1 1: HiF (Alta, Norway) Introduction Finnmarksløpet (FL) is Europe's longest sled dog races, with a 1000km and 500km category. The race lasts up to 7-days; the 'mushers' are physically active most of the time, with little and fragmented rests. The same is the situation in the 700km biking event OffroadFinnmark (OF), taking about 5-days. The intensity and distribution of activity and rests (race strategy) determine the success in the race. Physical training that aims to improve the special abilities required, increase the chance of winning and reduce the risks of accidents, injuries, and avoid overloading the dogs. The aim of this study was to describe the athletes' workload in these competitions (FL500km, FL 1000km, and OF 700km), and the strategy that they used in the race. Methods Heart rate (HR) was continuously recorded using HR-monitor in 5 participants at the FL500km, 5 at the FL1000km, and 6 at the OF700km. Maximal oxygen consumption and peak HR were measured about a week before the competitions started. The HR data were processed using Microsoft Excel. The official race reports have been used for separating the 'active parts' (AP= while the athletes were active on the trail and working with the equipment) from the 'resting parts' (while the athletes were resting in the check-points). The data have been studied macroscopically at first, observing the distribution of the effort across the different tracks of the race. Student's t-test has been used to compare parameters describing the workload in the different competitions Results The bikers (OF) spent shorter time in the check-points (22% of the total race time) compared with the mushers (FL) (ab. 40%). The OF had long rests (>3-hours) in 31% of the check-points, while the FL500km and FL1000km had long rests in 67% and 75% of the check-points. Nevertheless in all the races the participants had the chance to sleep for about 3/4-h per day. The overall HR (mean±SD) in AP, was significantly higher for the OF and the FL500km ( $62.42 \pm 10.34$  and  $60.36 \pm 5.47$  respectively) than the FL1000km ( $50.78 \pm 2.67$ ). The FL500km had a higher range of HR in AP ( $8.61 \pm 0.66$ ) compared with the OF ( $5.92 \pm 1.22$ ), no significant difference was found compared to the FL1000km ( $9.08 \pm 3.80$ ). In all the races, the HR decreased across the competition, the closer to the arrival the lower the HR values. Discussion These competitions present big differences in terms of race-strategy and type of workload. It is not clear if the reduction of the HR values across the competitions is caused by physiological adaptation, physical exhaustion or reduction of motivation because the placing is obvious because of the distance to the closest competitor. This study provides information about HR in response to strenuous tasks as well as helpful indications in order to plan training and race strategy.

#### EFFECTS OF LOW AND HIGH-CADENCE INTERVAL TRAINING ON POWER OUTPUT IN FLAT AND UPHILL CYCLING TIME-TRIALS

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Introduction The majority of interval training studies are conducted on ergometers to control external variables and exercise intensity. The differences between laboratory and outdoor cycling have been discussed recently (Jobson et al., 2007) suggesting different physiological demands. With the use of mobile power meters, exercise intensity can be monitored in the field, which improves the ecological validity of the measurements. This study tested the effects of low-cadence (60 rpm) uphill (Int60) or high-cadence (100 rpm) level-ground (Int100) interval training on power output (PO) during 20-min uphill (TTup) and flat (TTflat) time-trials as well as on performance during a laboratory graded exercise test (GXT). Methods Eighteen male cyclists ( $\text{VO}_{2\text{max}}$ :  $58.6 \pm 5.4$  mL/min/kg) were randomly assigned to Int60, Int100 or a control group (Con). The interval training comprised of two training sessions per week over 4 weeks, which consisted of 6x5 min at the PO corresponding to the respiratory compensation point (RCP). For the control group, no interval training was conducted. During the interval training sessions and the time-trials, PO was measured with mobile power-meters (SRM). Results A two-factor ANOVA revealed significant increases on performance measures obtained from GXT ( $P_{\text{max}}$ :  $2.8 \pm 3.0\%$ ;  $p < 0.01$ ; PO and  $\text{VO}_2$  at RCP:  $3.6 \pm 6.3\%$  and  $4.7 \pm 8.2\%$ , respectively;  $p < 0.05$ ), with no significant group effects. Significant interactions between group and uphill and flat time-trial, pre vs. post-training on PO were observed ( $p < 0.05$ ). Int60 increased PO during both TTup ( $4.4 \pm 5.3\%$ ) and TTflat ( $1.5 \pm 4.5\%$ ). The changes were  $-1.3 \pm 3.6\%$ ,  $2.6 \pm 6.0\%$  for Int100 and  $4.0 \pm 4.6\%$ ,  $-3.5 \pm 5.4\%$  for Con during TTup and TTflat, respectively. PO was significantly higher during TTup than TTflat ( $4.4 \pm 6.0\%$ ;  $6.3 \pm 5.6\%$ ; pre and post-training, respectively;  $p < 0.001$ ). Discussion The performance improvements during TTup and TTflat have shown specific adaptations in response to the interval training sessions and indicate the ecological validity of the time-trials. The application of higher pedaling forces via low cadences provides a potentially higher training stimulus with a cross-over effect to flat time-trials. When evaluating power output data or prescribing training zones, it is important to note that trained cyclists are able to produce higher power outputs during uphill compared to flat time-trial conditions. References Jobson, S. A., Nevill, A. M., Palmer, G. S., Jeukendrup, A. E., Doherty, M., & Atkinson, G. (2007). The ecological validity of laboratory cycling: Does body size explain the difference between laboratory- and field-based cycling performance? *J Sports Sci*, 25(1), 3-9.

#### RELATION BETWEEN LACTATE MINIMUM AND MAXIMAL LACTATE STEADY STATE IN RUNNING AND CYCLING: A MATTER OF MUSCLE MASS?

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Introduction: The heart rate-based lactate minimum test (LMT-HR) is a highly reproducible exercise test to determine individual training intensity zones based on heart rate recommendations (Strupler et al., 2009). However, in contrast to wheelchair athletics (Perret et al., 2007), it is still not clear what the relation between the lactate minimum (LM) determined by a LMT-HR and the maximal lactate steady state (MLSS) in running and cycling is and if this relationship depends on exercising muscle mass involved. The aim of the present study was to specify these circumstances. Methods: 12 healthy, endurance trained male subjects (age:  $38 \pm 6$  y; height:  $181 \pm 5$  cm; weight:  $77 \pm 6$  kg; training volume:  $9 \pm 3$  h/wk) participated in the study. They performed a LMT-HR on a treadmill and on a cycle ergometer. Addition-

ally, several endurance exercise tests were performed to determine exercise intensity at MLSS for both modes of exercise. Data for heart rate, power output, lactate, oxygen uptake and rating of perceived exertion at LM, MLSS as well as at maximal performance level were used for analysis. Results: All measured parameters (heart rate, power output, lactate, oxygen consumption, rating of perceived exertion) revealed significantly higher values at MLSS compared to LM for both types of exercise. However, significant correlations between MLSS and LM for heart rate (running:  $r=0.809$ ,  $p<0.01$ ; cycling  $r=0.830$ ,  $p<0.01$ ) and power output (running:  $r=0.813$ ,  $p<0.01$ ; cycling:  $r=0.818$ ,  $p<0.01$ ) were found. Peak heart rate and peak oxygen uptake were significantly higher for running compared to cycling. However, the amount of exercising muscle mass seemed to have no influence on relative (expressed as percentage of maximal values) heart rate at LM in running and cycling ( $88.6\pm2.2$  vs.  $87.2\pm2.1\%$ ,  $p=0.099$ ) in contrast to relative power output data ( $70.0\pm3.3$  vs.  $55\pm4.2\%$ ,  $p=0.002$ ). Discussion: Using different exercise modes the amount of exercising muscle mass seems to influence peak heart rate and peak oxygen uptake, but not the relationship of relative heart rate values between LM and MLSS. In conclusion, the LMT-HR seems to be a helpful tool to accurately determine exercise intensity at MLSS for running and cycling with one single exercise test and allows the determination of individual training intensity zones and training recommendations. For daily clinical practice it can be assumed that heart rate at MLSS is 10-12 bpm above heart rate at LM. References: Perret C, Labruyère R, Mueller G, Strupler M. Does the lactate minimum of a heart rate-based lactate minimum test correspond to the maximal lactate steady state? *Schweiz Z Sportmed Sporttraumatol*. 55: 109, 2007 Strupler M, Mueller G, Perret C. Heart rate based lactate minimum test – a reproducible method. *Br J Sports Med*. 43: 432-436, 2009

## EFFECTS OF 12-MONTH ENDURANCE TRAINING ON HAEMOGLOBIN MASS IN 16, 21, AND 28-YEAR-OLD ELITE ENDURANCE ATHLETES

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**Introduction** It is well known that elite endurance athletes are characterised by considerably higher levels of relative haemoglobin mass (Hbmass) than untrained subjects. However, it is unclear whether these high levels are due to several years of endurance training, are due to a manifestation of optimal inherited characteristics, or a combination of both. Since lower Hbmass levels for 16-year-old athletes in comparison to adult elite athletes were observed, it has been suggested that the age period from 16 to 21 years is a sensitive phase to elevate Hbmass with endurance training (Steiner & Wehrlin, 2011). The aim of this study was, therefore, to study the effects of a 12-month endurance training period on haemoglobin mass in 16, 21 and 28-year-old athletes. **Methods** Hbmass (CO-rebreathing) was assessed three times (T1-T3) with a time span of 6 months between the measurements in elite cross-country skiers and elite triathletes in an age-stratified sample: AG16 (athlete group with mean age 16),  $n=14$ , 6.6 h/week endurance training; AG21,  $n=12$ , 13.9 h/week; AG 28,  $n=14$ , 13.6 h/week. The same measurements were also performed in 3 age-matched control groups (CG16,  $n=14$ ; CG21,  $n=14$ ; CG28,  $n=15$ ) with < 1 h/week endurance training. **Results** Relative Hbmass (g/kg) at T1 did not differ between AG16 ( $12.4 \pm 0.8$ ) and CG16 ( $12.1 \pm 1.0$ ). AG21 ( $14.3 \pm 1.1$ ) and AG28 ( $14.7 \pm 1.2$ ) disclosed higher Hbmass levels than AG16 ( $p<0.01$ ). Hbmass levels of CG21 ( $12.6 \pm 1.0$ ) and CG28 ( $12.2 \pm 1.0$ ) did not differ from CG16. Overall, absolute and relative Hbmass increased ( $p<0.01$ ) over the 12-month period but the changes in relative Hbmass (g/kg/year) did not differ statistically among the 6 subgroups. They were +0.57 (AG16), +0.29 (CG16), +0.08 (AG21), +0.26 (CG21), +0.29 (AG28), and +0.15 (CG28). Higher changes in absolute Hbmass from 16 to 17 years of age were observed than in adult subjects ( $p<0.05$ ). The change rates were highly individual, especially among the 16-year-old subjects. **Discussion and Conclusion** Absolute Hbmass of 16-year-old subjects did not increase more than could be explained by increased body weight due to maturation. High endurance training volumes appeared to have no additional influence on the development of Hbmass over a one-year training period, irrespective of age and initial Hbmass levels. However, it is unclear whether a longer time period of observation, especially between 16 to 21 years of age, would have shown a training effect on Hbmass. High increase rates of Hbmass around age 16 (due to yet unknown factors) seem to play an important role to develop high Hbmass levels in adulthood. **References** Steiner T and Wehrlin J (2011). *Med. Sci. Sports Exerc.* (Epub: February 8, 2011; in press).

## OXYGEN CONSUMPTION AND ENERGY EXPENDITURE DURING ENDURANCE TRAINING IN TEAM SPORT ATHLETES

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**Introduction:** The importance of aerobic endurance in team sports has frequently been evaluated. Two commonly used training methods in this context are long-lasting endurance runs as well as high intensity interval runs. Results of interventional studies comparing the two methods showed equal effects on endurance performance enhancement. The aim of this study was to analyse oxygen consumption and energy expenditure as possible factors of aerobic adaptation to both training methods. **Methods:** 43 players (22 male, 21 female) from 3 team sports (12 basketball, 10 soccer, 21 handball) were investigated. They completed a VO<sub>2</sub>max-Test (including determination of maximal heart rate (HR<sub>max</sub>)) and a field test for calculating run velocity at 4 mmol l<sup>-1</sup> lactate (v<sub>4</sub>). From these results individual training regimes for extensive run training (ET, 45 min at 75% of v<sub>4</sub>) and high intensity interval training (IT, 4x4 min at 95% of HR<sub>max</sub>) were defined. Each player completed one training session ET and one training session IT in a randomised order. Training intensity was controlled via heart rate measurement. During both training sessions O<sub>2</sub> and CO<sub>2</sub> were continuously measured using a portable spirometry system. Energy expenditure (EE) was calculated using the modified de Weir equation:  $EE = 3.94VO_2 + 1.11VCO_2 - 2.17 UN$  (Takala & Meriläinen 1991). **Results:** VO<sub>2</sub>max (ml min<sup>-1</sup>kg<sup>-1</sup>) values for the players were: male:  $45.3\pm3.5$ ; female:  $41.6\pm6.1$ , v<sub>4</sub> (ms<sup>-1</sup>) were: male:  $3.7\pm0.3$ ; female:  $3.3\pm0.2$ . There was no effect concerning the sport the players belonged to. Mean oxygen consumption (VO<sub>2</sub>) was significantly higher for 45 min ET ( $133.0\pm25.5$  l-l) compared to 32 min IT ( $86.0\pm15.3$  l-l). Calculated EE was also significantly higher in ET ( $620\pm121$  kcal) compared to IT ( $401\pm75$  kcal). Significant differences persisted when comparing the two training methods for the same amount of time (50 min, warm up included). A slight decrease of VO<sub>2</sub> while exercising was observed for men and women in both training methods. **Conclusion:** ET expends more VO<sub>2</sub> and higher EE compared to IT. As previous studies have shown a similar effect of the two methods on endurance performance, VO<sub>2</sub> and EE do not seem to be the major influencing factors for adaptation. Other parameters (e.g. time spent at VO<sub>2</sub>max) seem to be superior. Because of decreasing VO<sub>2</sub> during exercise, intensity control via HR seems to be questionable. The sympathetic nervous activation induces less effort for the player to reach the given heart rate zone after the first interval. **References:** Takala, J. & Meriläinen, P. (1991). Handbook of gas exchange and indirect calorimetry: Clinical window, International web journal for medical professionals.

## RESPIRATORY MUSCLE TRAINING DOES NOT IMPROVE SIMULATED SKIING PERFORMANCE IN PARALYMPIC NORDIC SKIERS

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**Introduction** Respiratory muscle strength and endurance training has been reported to improve ventilatory capacity and endurance performance in competitive wheelchair racers (Litchke et al., 2007; Mueller et al., 2008). Currently the effects of respiratory muscle endurance training (RMET) on endurance performance in Paralympic Nordic Skiers (PNS) have not been examined. This study tested the hypothesis that RMET would significantly improve ventilatory capacity and simulated Nordic skiing performance in PNS. **Methods** Six Canadian PNS (2 paraplegia, 1 visually impaired, 1 guide and 1 amputee) completed a: (1) spirometric evaluation, (2) 12 min respiratory muscle capacity test (RMC), and (3) 12 min simulated Nordic skiing performance test (SNSP) prior to and after a 12 weeks RMET performed at 60% MVV, 2 to 3/week using a Spirotiger (Fact Canada Consulting Ltd.). Cardiorespiratory responses were monitored during SNSP while sitting or standing on a double poling ergometer (Alsobrook & Heil, 2009) depending upon the disability. Near infrared spectroscopy was used to noninvasively measure muscle oxygenation of the Triceps (Tmox) and serratus anterior (SAmox) during the RMC and SNSP. Finger prick blood lactate (BLa) was measured 3 minutes post exercise. **Results** Average RMET frequency was 1.8 sessions/week. There was no significant ( $P > .05$ ) improvement in spirometric variables post training. Although RMET significantly ( $P < .05$ ) increased RMC by 11%, there was no significant ( $P > .05$ ) improvement in SNSP. RMET significantly ( $P < .05$ ) decreased SAmox (greater extraction) during the RMC by 14%. Oxygen uptake ( $\dot{V}O_2$ ), heart rate (HR),  $\dot{V}E/\dot{V}O_2$  ratio, BLa, Tmox and SAmox during SNSP were unchanged ( $P > .05$ ) post training. **Discussion** Although RMET significantly improved RMC and SAmox, the greater respiratory capacity did not translate into enhanced SNSP in these Paralympic athletes. The fact that  $\dot{V}O_2$ , HR,  $\dot{V}E/\dot{V}O_2$  ratio and BLa were unchanged implies that overall cardiorespiratory and metabolic efficiency was unaltered by RMET. These observations are in contrast to previous findings (Mueller et al., 2008) which showed significant improvements in wheelchair racing performance in paraplegics following RMET. The lack of improvement in performance in this study could be due to the athletes' forward crouching posture during the simulated race which compromised their ability to fully inflate the lungs during the SNSP. **Acknowledgments** Funding: Own The Podium, Canadian Olympic Committee, 2007. **References** Alsobrook N G & Heil D P. (2009) *Eur J Appl Physiol*, 105, 633-641. Litchke L, Russion C, Lloyd L, Schmidt E, Price L, Walker J. (2008) *J Spinal Cord Med*, 31, 65-71. Mueller G, Perret C, Hopman M. (2008) *Clin J Sport Med*, 18, 85-88.

## Invited symposia

### IS-BN07 Soccer Footwear and Surface: Performance and Injury

#### KICKING MECHANICS IN SOCCER: HOW DOES IT CHANGE AFTER FATIGUE?

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**Introduction** Kicking is the most widely studied skill in soccer. However, the kicking mechanics: kinematics and kinetics has been obscured by inadequate data treatment around ball impact [2,3]. On the other hand, the ball kicking action itself can be categorized as having a significant injury risk [4]. It can be assumed that an induced leg muscle fatigue towards the end of the match somehow disturbs maximal kicking performance and also leads to a less coordinated kicking motion, thereby making players more susceptible to injury. Our research group made a series of attempts to conduct a comprehensive analysis of the kicking mechanics and how it changes when soccer players are fatigued [1]. **Methods** A series of experiments was conducted: 1) The motion before, during and immediately after ball impact was captured (1000 Hz) and smoothed by a modified version of a time-frequency filtering to illustrate a comprehensive shank kinematics. 2) The muscle moment and motion-dependent interactive moment were computed to demonstrate the segmental interaction of the kicking leg. 3) To extract the effect of fatigue on kicking motion, a comparison was made for the kicking leg kinetics between before and immediately after leg muscle fatigue was induced. **Kinematics** In contrast to conventional data, the shank was still angularly accelerating until ball impact. The data strongly supports coaches' practical advice of kicking such as 'kick through the ball'. **Kinetics** Immediately before ball impact, the knee muscle moment decreased rapidly and began to exhibit a reverse moment. In contrast, the motion-dependent interactive moment increased rapidly in magnitude until ball impact. It can be assumed that this moment is a key to angularly accelerate the shank during the final phase of kicking. **Effect of fatigue** A reduced leg swing speed was most likely due to a significantly reduced muscle moment and motion-dependent interactive moment during kicking. These results suggest that muscle fatigue not only diminished the ability to generate force, but also disturbed the effective action of the interactive moment leading to poorer inter-segmental coordination. This could be caused by a reduced eccentric action of the knee flexors immediately before ball impact. This might increase the susceptibility to injury. **References** 1. Aprianono, T., et al. (2006). *J Sports Sci*, 24(9): 951 – 960. 2. Nunome, H., et al. (2006). *J Sports Sci*, 24(5): 529 – 541. 3. Nunome, H., et al. (2006). *J Sports Sci*, 24(1): 11 – 22. 4. Rahnama, N., Reilly, T & Lees, A. (2002). *Br J Sports Med*, 36: 354-359.

#### INJURY OCCURRENCE AND FOOTWEAR PERFORMANCE ON ARTIFICIAL SOCCER TURF

STERZING, T.

LI NING SPORTS GOODS CO., LTD.

**INJURY OCCURRENCE AND FOOTWEAR PERFORMANCE ON ARTIFICIAL SOCCER TURF** Sterzing, T. Li Ning Sports Science Research Center (Beijing, P.R. China) **Background** Since the 1960s artificial soccer turf (AST) has been controversially discussed in relation to game characteristics, injuries and, recently, also with respect to footwear. The structure of current AST (3rd generation) is characterized by a sand and rubber infilled fiber carpet covering an elastic bottom layer. In 2004 AST was included in the FIFA rules of the game as official match play surface, subject to compliance with FIFA 2star performance standards. **Injury Occurrence** Increased injury occurrence in game and practice used to be major problem of the earlier generations of AST (Arnason et al. 1996). In contrast, research shows no differences with respect to injury frequency and severity on 3rd generation AST. However, it is reported that injury types may differ as Ekstrand et al. (2006) observed more ankle sprains on AST. Thus, further investigations with respect to injury occurrence and injury type are required. **Footwear Performance** Athletic footwear function highly depends on the surface on which it is used. Hence, the implementation of AST forced the footwear industry to initiate corresponding research, especially with respect to potentially new requirements for outsole traction. **Innova-**

tive AST shoes were shown to provide superior athletic performance and biomechanical characteristics which was matched by players' perception (Sterzing et al. 2010). Additionally, the innovative footwear decreased ankle eversion joint moments during soccer specific turning movements compared to firm and soft ground shoes designed for natural grass (Müller et al. 2010). Based on those findings, it is suggested that AST footwear should use a rather high number of relatively low stud elements. Discussion Soccer injuries, AST and footwear characteristics are often directly related to each other in the public discussion. However, prospective scientific studies that investigate and provide proof of these relationships are missing. Therefore, injury risk and lower extremity loading in soccer as well as their potential interaction need to be further examined. Thereby, the concept of mechanically available versus biomechanically utilized friction during shoe ground interaction plays an important role. It illustrates the sensory motor skills of athletes to adapt their sport specific movement patterns according to varying circumstances. References Arnason A, Gudmundsson A, Dahl HA (1996). *Scand J Med Sci Sports*, 6(1), 40-45. Ekstrand J, Timpka T, Hägglund M (2006). *Br J Sports Med*, 40, 975-980. Müller C, Sterzing T, Lake M, Milani TL (2010). *Footwear Science*, 2(1), 21-28. Sterzing T, Müller C, Milani TL (2010). *Footwear Science*, 2(1), 37-49.

## **SOCCER SHOE DESIGN AND ITS INFLUENCE ON KICKING ACCURACY AND MAXIMUM BALL SPEED**

HENNIG, E.M.

UNIVERSITY OF DUISBURG-ESSEN

Introduction Soccer is the most played, most watched and most revenue-generating sport. For players to be successful they need high skill levels in handling the ball. Quickness on the field has become increasingly important in recent years. Footwear plays a central role in helping the player to perform fast movements on the field, providing comfort, and protecting the foot. Performance Criteria of Soccer Shoes A questionnaire, sent out to 250 male soccer players, revealed the most desirable features that soccer players expect from their shoes (Hennig, 2006). Comfort was the most wanted shoe quality, followed by traction, and shoe stability. Surprisingly, protection against injuries had a low priority in the catalogue of desired shoe features. It appears that players are much more concerned about performance aspects of the shoe rather than protection. Therefore, light weight and low cut shoes, which provide good traction for fast movements, are best liked by players in modern soccer. Few soccer players, however, believe that a shoe can improve their kicking accuracy and/or maximum ball velocity. Influence of Shoe Design on Maximum Ball Velocity Several shoe features influence maximum ball speed during full-instep kicks in a complex manner. In a series of studies Sterzing and Hennig (2008) showed that maximum ball speed is influenced by the type of shoe. Surprisingly, soccer players achieve equal or even higher maximum ball velocities with their bare feet. Cinematographic analyses show that players have an increased foot plantarflexion during barefoot kicks, thus allowing a stronger mechanical coupling between the foot and lower leg. The increased effective impacting mass of the lower leg may explain this finding. Shoe Design and Kicking Accuracy It is common knowledge that an increased string tension of a tennis racket results in a better accuracy of ball placement on the tennis court. However, few soccer players believe that their shoe could also help them to perform kicks with more precision. In a series of studies we could show that shoe design has an influence on kicking accuracy. Whereas barefoot kicking resulted in least precision, certain shoe upper features provided an improvement in kicking accuracy. A more homogenous pressure distribution between the shoe upper and the ball was identified as the main factor for an improvement of kicking precision. Conclusion Footwear design can influence maximum ball velocity and kicking accuracy. Especially, an increased precision of passing and for kicks on goal will help soccer players to improve their performance on the field. References Hennig, EM (2006). *Orthopaedie Schuhtechnik*, 6, 20-24. Sterzing T, Hennig EM (2008). *Exerc Sport Sci Rev*, 36(2), 91-97. Acknowledgement: Parts of this research was sponsored by Nike Inc. / USA

## **Invited symposia**

### **IS-PM11 ACSM Exchange symposium: Sports Specialization in Children, When Do We Start?**

#### **U.S. PERSPECTIVE: IS THE MICHAEL PHELPS TRAINING MODEL 'ALL WET'?**

MILLARD-STAFFORD, M.

GEORGIA INSTITUTE OF TECHNOLOGY

Over the past several decades in the United States, there has been a paradigm shift in both the philosophy and organization of competitive youth sports. Following World War II and the evidence that American youth were unfit compared to their European counterparts, youth sport leagues became increasingly available within many sectors (e.g. religious affiliated youth leagues, boys' and later girls' organizations, and the educational system). However, with the decline of both the quality and quantity of physical education in the school systems across all levels (elementary through secondary education), opportunities for sport participation in American youth has become increasingly limited to sport-specific clubs. Sport clubs are administered by their respective sport governing organization, each of which may differ dramatically in their respective requirements for coaching licensure and rules governance for the sport. No central governing body (such as the US Olympic Committee) or federal governmental agency provides support or direct oversight for clubs. Therefore, as clubs rely upon athletes' paid dues to remain financially solvent, it is commonplace for club coaches to demand sport specialization at increasingly early ages (8-10 yrs). The rise of youth sport specialization is fuelled by successful case studies (e.g., Michael Phelps at age 11 accurately identified by his coach as a future Olympic superstar), potential for financial rewards (from major sponsorships to college scholarships), overzealous parents who invest in the philosophical approach espoused by coaching dogma related to early skill acquisition and training volume. The pressure for the child to "select" their sport well before puberty appears to be the new norm in American Youth Sport culture. The key question is: what is the evidence that early sport specialization is safe, effective or advantageous? The evidence related to health and safety of youth athletes who specialize prior to growth and maturation is primarily limited to sports where maturation adversely affects performance (e.g. girls' gymnastics), overuse injuries related to growth plates (e.g. pitch counts in Little League baseball). New areas of concern have emerged such as long term exposure to chloramine gas and a link with asthma in elite swimmers. Data regarding generational trends in Masters' swimmers will be presented. There is clearly a need to provide empirical data on safe training practices in youth related to specific limits relative to volume, intensity, and frequency of training (Adolescent Athlete and the Team Physician: A Consensus Statement, *Med. Sci. Sports Exerc.* 2008) and competition to prevent overtraining and psychological "burn-out". The obesity epidemic in the US calls for a re-examination of this paradigm shift back towards a broader base of opportunity and support for children to reap health benefits of participation and skill-development across multiple sports.

**YOUTH COMPETITIONS: OPTIMAL DEVELOPMENT OF THE YOUNG ATHLETE?**

CAPRANICA, L.

*UNIVERSITY OF ROME FORO ITALICO*

Worldwide young athletes participate in sport academies and only a select few will achieve elite level due to both innate talent and deliberate practice. The psycho-physiological load and the technical aspects of youth performance vary in relation to the age and technical level of the young athletes. Therefore, it is not possible to generalize information gathered on elite athletes to young ones. In considering that competitions pose a high load on athletes, the main principle adhered to in most sport Federations is to preserve children from an excessive psycho-physiological strain. For this reason, youth competitions might apply simplified rules and reduced match duration in relation to the age of the children. However, there is a need of information on the actual requirements of different youth codes and to develop strategies aimed to promote the potential of children. Thus, the examination of youth athletes during their actual match play might increase the relevance and the applicability of the results. Because several parameters essentially influence performance, individual and team sport official youth competitions have been examined using a multidisciplinary approach, which included technical-tactical, psychological, and physiological contributions to the youth performance. Independently from match duration and pitch dimension, findings indicate that youth matches pose a high load on youth competitors similar to that observed in elite athletes. However, situational and contextual factors vary considerably between matches played by young and elite athletes. Thus, notational and match analyses that consider a wide multiplicity of movement patterns and decision-making aspects proved to be effective in providing advances in the understanding of youth sport and guidance for coaches in directing training goals. In particular, the hypothesis that competitions organized with a reduced number of players and pitch dimensions facilitate the technical and tactical aspects of play and enhance the development of sport-specific skills of players is not always substantiated. Surely, further studies on different youth competitions could provide researchers and coaches a better understanding of the development of sport-specific skills and give also insights for other youth sports. Another important issue in the development of young athletes involves their capability to combine high-level sports training and good quality education. Because in Europe the improvement of talented young athletes is the main concern of Sport Clubs and Federations, recently the European Commission promoted actions on dual careers for young athletes to encourage a dialogue between the sport and education sectors.



# Saturday, July 9th, 2011

## 08:30 - 10:00

### Invited symposia

#### IS-PM12 Respiratory Limitations to Exercise

##### EXERCISE-INDUCED RESPIRATORY MUSCLE FATIGUE: CAUSES AND CONSEQUENCES

ROMER, L.M.

BRUNEL UNIVERSITY

There is convincing evidence that the respiratory muscles fatigue in response to sustained exercise at intensities  $>85\%$   $\dot{V}\text{O}_2\text{max}$ . For example, the transdiaphragmatic pressure evoked by supramaximal stimulation of the phrenic nerves (1-100 Hz) is reduced 15 to 50% below pre-exercise baseline in subjects with a broad range of fitness and takes about 2 h to recover. That diaphragmatic fatigue is prevented when inspiratory work is reduced throughout exercise using a mechanical ventilator suggests that exercise-induced diaphragmatic fatigue is in part due to the high levels of diaphragmatic work that must be sustained throughout heavy exercise. Diaphragmatic work is not sufficient to explain all of the diaphragmatic fatigue, however, because when the resting subject mimics the magnitude and duration of diaphragmatic work incurred during exercise, fatigue does not occur. The explanation for why the diaphragm is more susceptible to fatigue during exercise may be because the diaphragm competes with the locomotor muscles for the available blood flow during heavy exercise, thereby promoting inadequate  $\text{O}_2$  transport and fatigue of the diaphragm. Exercise time-to-exhaustion is increased when the respiratory muscles are partially unloaded during exercise using either reduced density gas mixtures or mechanical ventilation, although such improvements are observed only during heavy sustained exercise ( $>85\%$   $\text{VO}_2\text{max}$ ). Furthermore, time-to-exhaustion during heavy sustained exercise is decreased when the respiratory muscles are fatigued prior to the exercise. These effects of respiratory muscle work and/or fatigue on exercise tolerance may be mediated via changes in dyspnoea. Another aspect of respiratory muscle work that might limit exercise tolerance is a reflex effect from fatiguing respiratory muscles that increases sympathetic vasoconstrictor outflow and compromises perfusion of limb muscle, thereby limiting its ability to perform work. Indeed, fatiguing contractions and accumulation of metabolites in the respiratory muscles activate metabosensitive Type III/IV afferents which, in turn, reflexively increase sympathetic vasoconstrictor activity to several vascular beds, including the working limb muscles. Concomitant increases in vascular conductance and blood flow to locomotor muscles have been observed when the normally occurring work of breathing is reduced using a mechanical ventilator during maximal exercise, but not during exercise at 50 or 75%  $\text{VO}_2\text{max}$ . Moreover, relieving much of the respiratory muscle work during heavy exercise attenuates the severity of quadriceps muscle fatigue. Such changes in quadriceps fatigue likely play a pivotal role in determining performance during heavy exercise both through direct effects on muscle force output and through feedback effects on sensory input to the CNS.

##### CONVECTIVE $\text{O}_2$ TRANSPORT EFFECTS ON PERIPHERAL AND CENTRAL FATIGUE

AMANN, M.

UNIVERSITY OF UTAH

Acute and/or chronic exposure to hypoxia places a substantial challenge on the exercising human and burdens the respiratory system with the consequence of compromised convective  $\text{O}_2$  transport. Although central and peripheral fatigue may develop independent of alterations in convective  $\text{O}_2$  transport, reductions in  $\text{O}_2$  supply exacerbate and increases attenuate the rate of accumulation. It appears that across the range of hyperoxia to severe-hypoxia the major determinant of central motor drive (CMD) and endurance performance switches from a predominantly peripheral origin to a hypoxic-sensitive central component of fatigue. We found that peripheral locomotor muscle fatigue (pLMF) is the prevailing factor limiting CMD and therefore exercise performance from hyperoxia to moderate hypoxia ( $\text{SaO}_2 >75\%$ ). In these levels of arterial hypoxemia, the development of pLMF is confined to a certain limit which varies between humans. In contrast, pLMF does not develop to this limit in severe hypoxia ( $\text{SaO}_2 <70\%$ ) and exercise is prematurely terminated presumably to protect the brain from insufficient  $\text{O}_2$  supply. Based on the observations from hyperoxia to moderate hypoxia, we outlined a model linking CMD with the  $\text{O}_2$  transport-sensitive metabolic milieu within the working locomotor muscles. Our model suggests that the metaboreflex/somatosensory feedback (group III/IV muscle afferents) from the working muscles imposes inhibitory influences on the magnitude of CMD "chosen" by the working human during high intensity endurance exercise with the purpose to regulate and restrict the level of exercise-induced pLMF. To experimentally test this model, we pharmacologically blocked somatosensory pathways originating in the working limbs during cycling exercise in normoxia. After initial difficulties with a local anesthetic (epidural lidocaine) and associated loss of locomotor muscle strength we switched to an intrathecally applied  $\mu$ -opioid agonist (fentanyl). These experiments were the first ever to selectively block group III/IV locomotor muscle afferents during high-intensity cycling exercise without affecting maximal locomotor muscle strength. In the absence of  $\mu$ -opioid receptor-sensitive neural feedback from the working limbs, CMD was increased and end-exercise pLMF substantially exceeded, for the first time, the individual critical. The outcome of these latter studies indicate that, from hyperoxia to moderate hypoxia, convective  $\text{O}_2$  transport effects on central fatigue are mediated via the impact on peripheral fatigue (intramuscular metabolic milieu) and associated effects on limb muscle afferents and the resulting CMD inhibition.

##### PULMONARY PHYSIOLOGY OF WOMEN: LIMITATIONS AND ADVANTAGES

SHEEL, W.

UNIVERSITY OF BRITISH COLUMBIA

Studies examining pulmonary gas exchange during exercise have primarily focused on young healthy males, while the female response has received limited attention. Evidence is accumulating that the response of the lungs, airways and/or respiratory muscles to exercise is

less than ideal and this may significantly compromise oxygen transport and exercise performance in certain groups of otherwise healthy male subjects. Females may be even more susceptible to exercise induced pulmonary limitations than height matched males, by virtue of their smaller lung volumes, lower maximal expiratory flow rates, and smaller diffusion surface areas. We, and others, have found that exercise induced-arterial hypoxaemia (EIAH; arterial oxygen desaturation of 3-15% below resting levels) is more prevalent and occurs at relatively lower fitness levels in females compared to males. However, few mechanisms have been identified to explain why females may be more susceptible to EIAH than males and the prevalence remains controversial. Using high resolution computed tomography we have shown that when males and females are matched for lung size, the airway luminal areas of the larger conducting airways in females are significantly smaller (14-25%) than in males. These are important observations when considering that resistance to airflow is inversely proportional to airway radius to the fourth power. This becomes physiologically relevant under conditions where ventilation is high such as exercise. We have shown that young athletic females experience expiratory flow limitation more frequently and at a lower level of ventilation than males. At rest and during very low intensity exercise the work of breathing is the same between the sexes. However, with modest increases in exercise intensity the work of breathing, for the same level of ventilation, increases more rapidly in females. This is due to a higher resistive work of breathing in females and is associated with expiratory flow limitation and a greater relative dynamic hyperinflation. Based on the abovementioned anatomical and functional sex differences in pulmonary physiology we asked whether the female diaphragm is more prone to exercise-induced fatigue. However, we found that fewer females developed diaphragmatic fatigue and that the magnitude of fatigue was significantly greater in males. This suggests that the female respiratory system that might have a distinct advantage relative to males. That is, women may be more resistant to exercise-induced diaphragmatic fatigue and the sympathetically mediated metaboreflex that originates from fatiguing inspiratory muscles.

## Invited symposia

### IS-PM13 Optimising Recovery in Sports (sponsored by Nestle)

#### DIETARY PROTEIN FOR RESTORATION, REPAIR, AND ADAPTIVE ADVANTAGE IN EXERCISE RECOVERY IN OLD AND YOUNG

PHILLIPS, S.M.

*MCMMASTER UNIVERSITY*

Protein consumption in the post-exercise period synergistically interacts to bring about increases in the synthesis of new muscle proteins more than either stimulus alone. Collectively, the summed increases in protein synthesis change the phenotype of the muscle. Our classical thinking is that if we practice high intensity resistance work the training-induced phenotype is hypertrophy and by contrast repetitive dynamic work results in expansion of mitochondrial proteins. However, recent data from our lab has caused us to question this dogma. Measurement of short-term responses using stable isotope tracers reveals far more overlap and redundancy between the two forms of exercise versus differences. The signals leading to hypertrophy are still largely unknown and those leading to mitochondrial biogenesis, while some progress has been made, are also less than clear. Rather than disparate signalling pathways the thesis that muscular contraction in dynamic or resistance work is a common stimulus to both conditions and is largely a generic stimulus. What modifies this stimulus causing it to impact on various protein 'pools' (i.e., dynamic = mitochondrial and resistance = myofibrillar) is still largely unknown, but we are beginning to make some progress in this regard. Discussion will focus on factors that differentiate protein pool-specific responses in skeletal muscle and how those are modified by nutrition and aging.

#### OPTIMISING RECOVERY POST-EXERCISE: THE ROLE OF CARBOHYDRATE AND FAT

HAWLEY, J.

*RMIT UNIVERSITY*

The major disruptions to cellular homeostasis occur during exercise, being largely dependent on the relative exercise intensity and prevailing substrate availability to the active muscles. In contrast, the post-exercise period is characterised by a general homeostatic recovery phase which includes the resynthesis of fuel stores, free radical quenching, repair of free radical-mediated damage and the restoration of intracellular electrolyte concentrations and pH. Post-exercise macronutrient intake (carbohydrate, fat and/or protein) rapidly alters the concentration of blood-borne substrates and hormones that, over time, cause marked perturbations in the storage profile of skeletal muscle and other insulin-sensitive tissues. In the hours immediately after substrate-depleting exercise, there is both a time- and fuel-dependant activation of several stress-activated protein kinases, accompanied by the up-regulation of multiple genes: these events may ultimately provide the stimulus for the chronic intracellular adaptations that occur over months and years of repeated contractile activity (i.e. training adaptation). This talk will provide a contemporary perspective of how post-exercise nutrient provision (or lack of) has the potential to activate or inhibit many biochemical pathways with putative roles in training adaptation.

#### WATER AND ELECTROLYTES FOR RECOVERY AFTER EXERCISE

MAUGHAN, R.

*LOUGHBOROUGH UNIVERSITY*

Exercise, especially in hot and humid environments, results in loss of water and electrolytes, primarily sodium, in sweat. If these losses are substantial and are not replaced before the next exercise bout, the subjective perception of effort is increased and performance is likely to be impaired. Replacement of losses requires restoration of body water volume, but ingestion of large volumes of plain water will result in a fall in plasma sodium concentration and osmolality, leading to a diuresis that may prevent full restoration of body water content. Addition of sodium in amounts equal to or greater than the sweat losses can reduce this diuresis and increase the retention of ingested fluid. The sodium may come from drinks or from ingested foods. Sweat sodium concentration is invariably less than plasma sodium concentration, but may range from about 10-80 mmol/l in healthy individuals: sweat sodium content is influenced by a number of factors, including sweating rate, acclimation status and diet, but there remains a substantial individual variability. The post-exercise diuretic response will also be influenced by other factors such as the rate of fluid ingestion and the presence of macronutrients that will slow gastric emptying. Athletes who wish to ensure effective recovery after exercise should be aware of the extent of their water and salt losses and should have a strategy in place to ensure their replacement.

## Invited symposia

## IS-BN08 Neuro-muscular system and tendons across the lifespan

## NEUROMUSCULAR FUNCTION OF THE AGEING MOTOR SYSTEM

DUCHATEAU, J., KLASS, M., BAUDRY, S.

UNIVERSITE LIBRE DE BRUXELLES

Senescence is accompanied by a marked decline in the performance of the motor system. In addition to the decrease in muscle mass (sarcopenia), there is a loss of motor neurones that reduces the number of motor units. However, surviving nerve cells can reinnervate some denervated muscle fibres, increasing the innervation ratio of the remaining motor units. Although this profound motor unit remodelling, voluntary muscle activation does not seem to contribute greatly to the weakness commonly observed in elderly adults. Even if differences in the techniques and muscles tested may explain some discrepancies between studies, the deficit in voluntary activation during an isometric maximal voluntary contraction (MVC) is often similar in physically active elderly and young adults (Klass et al., 2007). Furthermore, it was reported that when a deficit in activation is observed in elderly adults, it can be rapidly reduced with practise (Jacoby & Rice, 2002). The observation of a limited deficit in muscle activation can be surprising at first because the maximal motor unit discharge rate is significantly reduced in elderly adults during an MVC (Connelly et al., 1999). However, this age-related reduction in discharge rate is usually accompanied by a slowing of muscle contraction that shifts the muscle force-frequency relation leftward and would permit to attain maximal performance with a lower motor units discharge rate. In contrast, the age-related reduction in motor unit discharge rate at the onset of a fast (ballistic) contraction appeared to be more affected than a slow MVC (Klass et al., 2008). This decrease in instantaneous discharge rate tends to be progressively greater for the successive interspike intervals of the discharge train. These data indicate that the slowing of motor unit discharge rate likely limits, in addition to the slowing of muscle contractile properties, the maximal rate of torque development in elderly adults. Therefore, healthy ageing appears to involve neural impairments that influence the maximal capacity of motor neurones to discharge at very high frequencies. In conclusion, the age-related decline in motor unit discharge rate does not have a profound effect on the force produced during an MVC but seems to affect more substantially the performance of fast voluntary contractions. This may alter the reactive responses to nociceptive stimuli or balance perturbations, and as a consequence, makes elderly adults more vulnerable to quick changes in their surrounding environment. Connelly D.M., Rice C.L., Roos M.R. & Vandervoort A.A. J. Appl. Physiol. 87: 843-852, 1999 Jacoby & Rice C.L. J. Appl. Physiol. 93: 457-462, 2002 Klass M., Baudry S. & Duchateau J. Eur. J. Appl. Physiol. 100: 543-551, 2007 Klass M., Baudry S. & Duchateau J. J. Appl. Physiol. 104: 739-746, 2008

## MUSCULO-SKELETAL CHANGES WITH AGEING OF MASTER ATHLETES

NARICI, M.V., CAMPBELL, E.L., MCPHEE, J., SEYNNES, O.R., RITTEWEGER, J.

MANCHESTER METROPOLITAN UNIVERSITY

Introduction Ageing of the musculoskeletal system is characterised by a loss of muscle mass and strength. Typically, between 20 and 70 years of age, about 20% of muscle mass and 40% of muscle strength are lost (Narici & Maffulli 2010). Although some of this structural and functional decline is due a progressive denervation and loss of motor units, reduced physical activity and lifestyle factors exacerbate to these changes. It is thus of great interest to study lifelong trained individuals to find out whether regular physical activity affords protection against ageing of the musculo-skeletal system. Thus the aim of investigation was to compare skeletal muscle structural and functional characteristics of young adults, older sedentary individuals and lifelong trained athletes (master athletes). Methods The investigation was performed on 23 young untrained (YU) individuals aged 18-35 years, on 26 elderly untrained (EU) individuals aged 67-82 years and on 24 master athletes (MA) (sprinter and endurance runners) aged 65-81 years. Vastus lateralis muscle thickness and pennation angle were measured by ultrasonography, maximum knee extensor force was assessed by dynamometry and maximum jumping power was measured on a force platform. Data are reported as means  $\pm$ SD, statistical differences were tested with ANOVA followed by the Tuckey's post hoc test. Significance was set at  $P < 0.05$ , n.s.=non-significant. Results Muscle thickness was  $21.2 \pm 3.7$  mm in the YU,  $16.1 \pm 3.1$  mm in the EU (EU vs YU, -24%,  $P < 0.02$ ) and  $17.5 \pm 3.0$  mm in the MA (MA vs EU, +9% n.s., MA vs YU, -18%  $P < 0.02$ ). Pennation angle was  $14.6 \pm 2.9$  deg in YU (EU vs YU, -23%,  $P < 0.02$ ),  $11.3 \pm 2.6$  deg in EU, and  $13.1 \pm 2.6$  deg in MA (MA vs EU, +16% n.s., MA vs YU, -10%, n.s.). Maximum isometric force was  $273.8 \pm 51.4$  Nm in YU,  $154.4 \pm 42.7$  Nm in EU (EU vs YE, -44%,  $P < 0.001$ ) and  $193.6 \pm 41.3$  Nm in MA (MA vs EU, +26%  $P < 0.01$ , MA vs YU, -29%  $P < 0.001$ ). Maximum explosive power was  $3487.8 \pm 730$  watt in YU,  $1880.3 \pm 663.1$  watt in EU (EU vs YU -46%,  $P < 0.001$ ) and  $2478.7 \pm 670.2$  watt in MA (+32% MA vs EU,  $P < 0.001$ , MA vs YU, -29%,  $P < 0.01$ ). Discussion These findings clearly show that life-long training mitigates the loss of muscle mass, force and power in old age. The reduction in muscle thickness and pennation angles, known markers of sarcopenia (Narici et al. 2003), is significantly smaller in master athletes, indicating that life-long training (running) is effective in preserving muscle mass in old age. Distinct benefits in muscle function are also afforded by life-long training. In fact, master athletes not only show smaller decrements of muscle function but they also display considerably greater values of force (+26%) and power (+32%) with respect to untrained peers. This preservation of force and power should be viewed as a major advantage for maintaining mobility and independence in old age. References Narici MV, Maffulli N. (2010). Br Med Bull, 95, 139-59. Narici MV, Maganaris CN, Reeves ND & Capodaglio P. (2003). J Appl Physiol 95, 2229-2234.

## MUSCLE-TENDON CHANGES AND LOCOMOTOR FUNCTION IN THE ELDERLY

ARAMPATZIS, A.

HUMBOLDT-UNIVERSITY BERLIN

Several studies reported that ageing is associated with a decrease of muscle strength [4], tendon stiffness [8] and alterations in muscle architecture [9]. However old adults are able to adjust task demand on their reduced muscle-tendon capacities while performing different locomotion activities such as level walking [2,7] running [6] and stair climbing [10]. An age-related muscular readjustment may affect the joint moments in the other two planes, causing abnormalities in the knee joint loading during daily activities. Osteoarthritis is the most common form of arthritis among people over the age of 60, affecting most frequently the weight-bearing joints such as the knee [3]. Recent studies give evidence that the magnitude of the external adduction moment at the knee joint, as experienced during daily activities, results in knee pain and osteoarthritis in the elderly [1]. Stair negotiation is, next to level walking, one of the most frequently performed locomotion activities. During stair negotiation the peak compressive loads at the knee joint are approximately 28% higher than during level walking [5]. Therefore, identifying abnormalities in the mechanical loading of the knee joint within the elderly population during stair

negotiation may be important for an early diagnosis of potential risks and, thus, for the application of early therapeutic interventions. We examined the joint kinetics in the lower extremities of 28 old and 16 young adults while ascending and descending stairs. We found that old adults showed a higher external adduction moment at the knee joint ( $P < 0.05$ ) compared to the young ones indicating an increased mechanical load at the medial knee compartment. The reason for the higher knee adduction moment in the old adults was an altered control strategy during stair negotiation, probably initiated by the age-related reduction in muscle strength and tendon stiffness in the lower extremities. The higher knee adduction moment in the elderly while ascending stairs was related to a shift of muscular output towards the stronger, proximal hip musculature. The control strategy leading to the higher knee adduction moment while descending stairs was a shift of the demand from the leading to the trailing limb because of the higher muscle force potential of the trailing leg. References [1] Amin et al. 2004 *Arthritis Rheum* 51, 371-6. [2] DeVita and Hortobagyi 2000 *J Appl Physiol* 88, 1804-11. [3] Felson et al. 2000 *Ann Intern Med* 133, 635-46. [4] Frontera et al. 2000 *Am J Physiol Cell Physiol* 279, C611-8. [5] Heinlein et al. 2009 *Clin Biomech* 24, 315-26. [6] Karamanidis and Arampatzis 2005 *J Exp Biol* 208, 3907-23. [7] Karamanidis and Arampatzis 2007 *Gait Posture* 25, 590-6. [8] Mademli and Arampatzis 2006 *J Biomech* 39, 426-34. [9] Narici et al. 2003 *J Appl Physiol* 2003, 95, 2229-34. [10] Reeves et al. 2009 *J Electromyogr Kinesiol* 19, e57-68.

## Invited symposia

### IS-BN09 Evidence-based Sports Physiotherapy

#### EVIDENCE-BASED EXERCISE TRAINING IN THE PREVENTION AND REHABILITATION OF SPORTS INJURY

BANZER, W., HÜBSCHER, M.

UNIVERSITY OF FRANKFURT

Sports and recreation injuries constitute a major public health burden in developed countries. The most common sports injuries are sprains, dislocations, and ligament ruptures occurring at the ankle and knee as well as at the hand, elbow, and shoulder. Particularly, severe injuries such as anterior cruciate ligament (ACL) ruptures or ankle sprains are often associated with increased morbidity (e.g. early development of joint osteoarthritis) and long-term disability. Therefore, measures to prevent and treat these injuries are of particular interest. In view of appropriate intervention strategies, the prevention of injuries must be considered a primary goal. On the basis of previous research, it is hypothesized that proprioceptive and neuromuscular abilities in particular have a certain impact on injury risk. Furthermore, sport-related joint injuries tend to result in severe and long-term alterations in proprioceptive and neuromuscular functions that can further increase the risk of persisting functional deficits and recurrent injury. The aim of my presentation will be first to review the current evidence on specific exercise programs aimed at improving proprioception and neuromuscular function to reduce the incidence of acute sports injuries (e.g. Hubscher et al. 2010). Furthermore, I will review the effectiveness of neuromuscular rehabilitation programs for the posttraumatic or postsurgical treatment of sports injuries (e.g. Zech et al. 2010). Hubscher M, Zech A, Pfeifer K, Hansel F, Vogt L, Banzer W. Neuromuscular training for sports injury prevention: a systematic review. *Med Sci Sports Exerc.* 2010;42(3): 413-421. Zech A, Hubscher M, Vogt L, Banzer W, Hansel F, Pfeifer K. Neuromuscular training for rehabilitation of sports injuries. A systematic review. *Med Sci Sports Exerc.* 2009;41(10):1831-1841.

#### EVIDENCE-BASED STRENGTH TRAINING FOR THE PREVENTION OF NECK/SHOULDER MUSCLE PAIN IN THE WORKING POPULATION.

SJØGAARD, G.

UNIVERSITY OF SOUTHERN DENMARK

Workers with neck/shoulder pain have often been demonstrated to present lower strength in this body region than those without pain 7. Further, strength training of patients with chronic neck pain has resulted in clinically significant reduction in their pain 8. These findings lead to the hypothesis that strength training of muscles in the neck/shoulder region may relieve and prevent neck/shoulder pain among workers with monotonous repetitive work tasks including computer work. A systematic review has presented evidence for strength training to be successful in reducing pain given the training was intensive, lasted at least 10 weeks and was supervised 5. Even a preventive effect has been demonstrated 4. Mechanisms of training effect have been studied to reveal biomechanical as well as morphological key factors 2, 6. Ongoing studies will reveal the acceptable variability of training regarding mode of exercises 1 as well as time wise planning of exercises 3. References 1. Andersen, C.H., Andersen, L.L., Mortensen, O.S., Zebis, M.K., & Sjøgaard, G. Protocol for Shoulder function training reducing musculoskeletal pain in shoulder and neck: a randomized controlled trial. *BMC Musculoskelet. Disord.* 12, 14 (2011). 2. Andersen, L.L. et al. Effect of contrasting physical exercise interventions on rapid force capacity of chronically painful muscles. *J. Appl. Physiol* 107, 1413-1419 (2009). 3. Andersen, L.L. et al. Protocol for Work place adjusted Intelligent physical exercise reducing Musculoskeletal pain in Shoulder and neck (VIMS): a cluster randomized controlled trial. *BMC Musculoskelet. Disord.* 11, 173 (2010). 4. Blangsted, A.K., Sjøgaard, K., Hansen, E.A., Hannerz, H., & Sjøgaard, G. One-year randomized controlled trial with different physical-activity programs to reduce musculoskeletal symptoms in the neck and shoulders among office workers. *Scand J Work Environ Health* 34, 55-65 (2008). 5. Coury, H.J.C.G., Moreira, R.F.C., & Dias, N.B. Evaluation of the effectiveness of workplace exercise in controlling neck, shoulder and low back pain: A systematic review. *Revista Brasileira de Fisioterapia* 13, 461-479 (2009). 6. Nielsen, P.K. et al. Effect of physical training on pain sensitivity and trapezius muscle morphology. *Muscle Nerve* 41, 836-844 (2010). 7. Sjøgaard, G. et al. Neuromuscular assessment in elderly workers with and without work related shoulder/neck trouble: the NEW-study design and physiological findings. *European Journal of Applied Physiology* 96, 110-121 (2006). 8. Ylinen, J.J. et al. Effects of twelve-month strength training subsequent to twelve-month stretching exercise in treatment of chronic neck-pain. *J Strength Cond Res* 20, 304-308 (2006).

#### EVIDENCE-BASED PRACTICE IN TREATMENT OF ARTHRITIC AND NON-ARTHRITIC PATELLOFEMORAL PAIN

CALLAGHAN, M.,

CENTRE FOR REHABILITATION SCIENCE

Patellofemoral pain can be a debilitating and painful problem in the arthritic and non-arthritic knee joint. Treatment for both conditions are usually non-surgical with physiotherapy providing the mainstay of treatment. Physiotherapy has been proven to be successful in the

majority of cases of patellofemoral pain. This presentation outlines the evidence base for the rehabilitation strategies for both conditions to be treated successfully

## Invited symposia

### IS-SH09 Football as an Agent of Social Change

#### THE FAMILY AND FOOTBALL: ENABLING POSITIVE HEALTHFUL BEHAVIOURS

RICHARDSON, D., BURGESS, T., NEWLAND, T., WATSON, L., BINGHAM, D., PARNELL, D.

LIVERPOOL JOHN MOORES UNIVERSITY

The family is a significant social group which is regarded as the primary source of a person's social activity (Nam, 2004). The family unit is a key influence in the lifestyle, including health and non health behaviours, of its members. Understanding the complexity of the family unit is critical in order to facilitate appropriate health enhancing behaviours. This presentation offers a series of interactions of a range of practitioners engaged in encouraging positive health behaviours within a Premier League football club based family centre. The Everton Active Family Centre (EAFC) is family health promotion unit located in the grounds of Everton Football Club. The presentation draws on a range of health practitioner experiences working with families at EAFC over a period of 12 months. Practitioners (n=5) engaged in a range of formal and informal interactions with individuals and families. Furthermore semi-structured interviews and focus groups were undertaken with individuals and with collective families. Practitioners adopted the principles of ethnography (Hammersley and Atkinson, 2007) and observational research (Hammersley and Atkinson, 1983) throughout and were encouraged to collate field notes and reflective diaries. The experiences of the practitioners are presented using a series of narrative vignettes and real experiences to capture the complex day-to-day challenges that the family experiences in adopting healthful behaviours. The findings describe the challenges that families face in understanding and engaging in health behaviours such as changes in diet and physical activity. The presentation alludes to the value of targeting the family as a whole unit alongside the targeting of younger family members to influence and sustain behaviour change. Furthermore, the presentation recounts the broad and eclectic practitioner skill base required in order to initiate and sustain behaviour within the family.

#### THE INITIAL FINDINGS FROM THE EVALUATION OF THE PREMIER LEAGUE MEN'S HEALTH PROGRAMME

PRINGLE, A., MCKENNA, J., ROBERTSON, S., SMITH, A., WHITE, A., ZWOLINSKY, S.

LEEDS METROPOLITAN UNIVERSITY

Introduction In the UK, groups of men are at risk from cardio-vascular diseases (CVD), diabetes, fat related cancers and poor mental health (White & Holmes, 2006). Concerns also exist over men's adoption of primary health care and there is a need to reach this group with health interventions using alternative channels (White and Robertson, 2010). One such channel are professional football clubs and offer a rich opportunity to reach male audiences with health promotion interventions. With that in mind, this research examined the pre-intervention health profiles of men adopting Premier League Health (PLH), a national programme of men's health delivered in English Premier League (EPL) football clubs and targeted at men 18-35 years. Methods Interventions were delivered by clubs (N=16) including, educational activities on match days, weekly healthy lifestyle classes and outreach with local communities of men. Interventions were delivered at stadia, club training venues and community facilities. Activities were run by health trainers who received specific training on men's health and behavioral change activities. Following ethical clearance, men completed adapted and validated measures for demographics and lifestyle behaviors, including physical activity, consumption of fruit and vegetables, smoking, weight/height, alcohol intake and perception of health. Data collection by health trainers occurred pre-intervention and was independently analyzed by researchers. Data were used to assess participant adoption and pre-intervention health profiles. Results N=946 adopted PLH, but mode of engagement led to variations in sample size. Demographics showed that 89% (N=783/875) were 18-44 years. 78% (N=685/878) were white British. 43% (N=173/403) were unemployed and 26% (N=157/605) were not fans of the club hosting PLH. The percentage of men failing to meet recommended health guidelines were as follows: physical activity, 79% (N=351/440); daily intake of fruit and vegetables, 83% (N=315/380); smoking, 28% (N=103/373); weight, 68% (N=245/358); and alcohol intake, 40% (N=112/279). 67% (N=208/310), presented with three or more risk factors for CVD, yet 69% (N=242/348) did not consider they had a health problem. Discussion A national programme of men's health promotion interventions delivered in EPL football clubs was effective in reaching target audiences. Interventions were predominantly adopted by men not meeting health guidelines. Men were well placed to receive health promotion advice and support. References White A, Holmes M (2006). Journal of Men's Health and Gender, 3, 2, 139-151. White A, Robertson S (2010). Trends in Urology and Men's Health, 1, 1, 10-12.

#### FOOTBALL AS AN AGENT OF GENERATING SOCIAL CAPITAL

OTTESEN, L.

UNIVERSITY OF COPENHAGEN

Football as an Agent of Generating Social Capital Associate Professor Laila Ottesen, Ph.D, Department of Exercise and Sport Sciences, University of Copenhagen, lottesen@ifi.ku.dk Introduction "Football as health promotion" is a sociological study of several intervention projects with focus on sport and health. The purpose has been partly to provide knowledge about how football as a team sport can generate social capital as well as social and health related changes among the participants, and partly to examine the implementation of football as a health promotion. Methods Several video observations and qualitative (focus group) interviews with the participants are used in connection to the interventions. Results The paper is based on several interdisciplinary studies about football as health promotion carried out at the Department of Exercise and Sport Sciences at the University of Copenhagen under leadership of Associate Professor P. Krstrup and for the sociological part led by the writer of this paper. These interventions have proved that football as an activity offers significant disease prevention and health promoting potentials (Krstrup et al., 2010). Similarly the interventions have shown that the game of football and its community-forming potential contains tremendous social and networking qualities which generate social capital and work health promoting (Ottesen et al., 2010). Discussion Health promoting offers such as "Exercise on prescription" have proved only a limited effect on adherence of new exercise habits. Health interventions have to combine methods and strategies at multiple levels and have to be directed broader than just towards the individual in order to generate social changes (Ottesen et al., 2010). With a background

in the perspectives of social capital and work-life balance (Putnam et al., 2003; Hochschild 2001), the possibilities and resistance which appears among the participants in sport will be analyzed, and furthermore the paper elaborates the possibilities and resistances which appear when the projects are implemented in municipalities, local communities and sports associations. Reference Hochschild AR. (2001) The time bind: when work becomes home and home becomes work. California: Henry Holt. Krstrup P, Dvorak J, Junge A, Bangsbo J. (2010) Executive summary: The health and fitness benefits of regular participation in small-sided football games. Scand J Med Sci Sports (Suppl. 1): 132-135. Offesen L, Jeppesen RS, Krstrup BR. (2010) The development of social capital through football and running: studying an intervention program for inactive women. Scand J Med Sci Sports (Suppl. 1): 118-131. Putnam RD, Feldstein L. (2003) Better together. Restoring the American community. New York: Simon and Schuster.

## Invited symposia

### IS-SH10 Education, Policy and Provider Networks for Physical Activity

#### PHYSICAL ACTIVITY NETWORKS - THE VIEW FROM WITHIN

MARTIN, B.W., KAHLMEIER, S.

UNIVERSITY OF ZURICH

The multiple health effects of physical activity and sports have been well documented and physical inactivity has been recognised as an important threat to public health worldwide. However, physical activity promotion at the population level is a relatively new approach and only few countries have well-established policies and strategies in this field. In this situation, physical activity promotion networks can play an important role in providing possibilities for exchange and facilitating the activities of the different actors. The Netherlands have had one of the first national networks; based on these experiences other countries such as Switzerland have developed their own. With the growing burden of non-communicable diseases worldwide and the growing awareness of the challenges in population-wide physical activity, regional networks have developed. RAFA-PANA, the Red de Actividad Fisica de las Americas/Physical Activity Network of the Americas, HEPA Europe, the European Network for Health-Enhancing Physical Activity and the Asia Pacific Physical Activity Network have been active already for some years, the African Physical Activity Network AFPA has joined them recently. All regional structures are represented in Agita Mundo, the global physical activity promotion network, and all networks collaborate with a whole range of other organisations, including scientific societies. Out of the experiences of the last few years, requirements for the successful functioning of general physical activity promotion networks as well as task-specific structures have been identified. The opportunities offered by this structural solution will be illustrated as well as the challenges and limitations encountered by physical activity networks.

#### EUROPEAN INTEGRATION VIA EUROPEAN NETWORKING? EU-FUNDED NETWORKS HEALTH-ENHANCING PHYSICAL ACTIVITY NETWORKS: A LEGAL AND A POLITICAL SCIENCE PERSPECTIVE COMPARED

KORNBECK, J.

EUROPEAN COMMISSION

The paper will ask the question how to interpret EU funding for health-enhancing physical activity (HEPA) networks made available via sport-specific (as opposed to public health) budget lines. The expectations behind recent policy choices will be explained with reference to the development of the subject area sport and physical activity at EU level, with reference to the specific character of this area and its potential to make a contribution to the prevention of lifestyle-related health conditions caused by physical inactivity. The paper will show how the selection of nine HEPA projects for EU funding in 2009 (in anticipation of a possible future EU Sport Programme) fits into the legal framework defined by Article 165 TFEU and the role of the EU to support, coordinate or supplement the actions of the Member States. As this Treaty-based competence specifically rules out harmonisation and any other binding measures, the choice of network funding is interpreted as a soft yet useful policy making tool, comparing and contrasting a legal with a political science perspective of the role of the EU between regulation and inspiration. Drawing in particular on the Multi-Level Governance (MLG) approach, the paper will make some propositions regarding the benefits of networks as mutual learning communities and the requirements needed in selecting project proposals.

#### PHYSICAL ACTIVITY NETWORKS AND THE ROLE OF GLOBAL ADVOCACY FOR PHYSICAL ACTIVITY

BULL, F.C.

LOUGHBOROUGH UNIVERSITY/UNIVERSITY OF WESTERN AUSTRALIA

There is well established scientific evidence on the health benefits of regular physical activity in promoting health and preventing non communicable disease (NCD). This provides a solid platform for stronger commitment and national programs aimed at increasing levels of participation in most countries. Globally, NCD's account for 63% of all deaths worldwide and 80% of these occur in low and middle income countries (LMIC). There is an urgent need to scale up public health efforts, particularly in LMIC, however evidence alone has yet to translate into increased action and investment in prevention strategies. What appears missing in many countries is sufficient political commitment and high level decision making towards long term investment. For this reason, there is a need for greater advocacy work to promote the importance of physical activity, its central role in NCD prevention along side tobacco control and healthy diets, and the co benefits for other related agenda's such as environmental sustainability. Mobilizing professional networks to address this agenda is critical and recent examples of action will be explored in this presentation. In 2010 Global Advocacy for Physical Activity (GAPA) developed the Toronto Charter for Physical Activity: A global call for action to address an identified gap in suitable advocacy tools. This presentation will briefly outline the stepped approach used to develop the Toronto Charter and the process for global engagement. Progress since its launch in May 2010 as well as the development of the Investment that work for Physical Activity companion document will be shared. There is no better time and there has been no greater need for advocacy on physical activity in the lead up to the forthcoming United Nations High Level Meeting on NCD Prevention and Control in September 2011.

## Oral presentations

### OP-BN07 Sports Biomechanics 2

#### TIME-MOTION ANALYSIS OF AUSTRALIAN A-LEAGUE SOCCER WITH A FOCUS ON ACCELERATION AND DECELERATION CHARACTERISTICS

CLARK, A.C.1,2, JANSE DE JONGE, X.1, DWYER, D.1

1 UNIVERSITY OF NEWCASTLE, AUSTRALIA; 2 CENTRAL COAST MARINERS FOOTBALL CLUB, AUSTRALIA

The A-League is gaining international exposure as a high standard professional soccer league. Time-motion analysis traditionally reports total distance and velocity characteristics. The use of GPS technology allows for the detailed study of important acceleration and deceleration characteristics of elite soccer. The present study sought to complete a thorough time-motion analysis of players during A-league competition using GPS technology. Twelve professional players from one A-League team were analysed using 5Hz GPS technology during official A-League matches over two seasons resulting in 62 full matches. For time-motion analysis each half of the game was divided into three equal periods and analysed for time, distance, velocity and acceleration/deceleration. Repeated measures ANOVA was performed for total distance, distance and time spent in velocity bands and distance in acceleration/deceleration bands (low <1.11 m•s<sup>-2</sup>, moderate 1.11-2.78 m•s<sup>-2</sup>, high >2.78 m•s<sup>-2</sup>). A significant decrease in distance covered per minute was found for both the first half (from 127±18 to 120±16 m•min<sup>-1</sup>) and second half (from 122±17 to 117±18 m•min<sup>-1</sup>) and overall. Over the duration of a match a significant decline was seen in the distance of low intensity running (<3.89 m•s<sup>-1</sup>) (from 1526±179 to 1413±180 m), while an increase was seen in the time spent in low intensity running (from 846±47 to 874±43 s). There was no significant change in the distance travelled and time spent in high intensity (>3.89 m•s<sup>-1</sup>) and very high intensity running (>5.28 m•s<sup>-1</sup>). A significant reduction in the distance covered in low (from 1221±155 to 1146±152 m) and moderate (from 91±22 to 81±22 m) acceleration bands and low (from 487±62 to 451±68 m) and moderate (from 66±16 to 58±15 m) deceleration bands was found. No significant change was found in high acceleration and deceleration bands. The results indicate a progressive decline in average velocity during each half and during the overall match. In addition, a significant decline in distance covered in low intensity running and a concurrent significant increase in time spent in low intensity running, implies that players spend more time stationary and/or moving at lower velocities later in matches. Furthermore, the maintenance of high and very high intensity running throughout the match may indicate that players are implementing an effective pacing strategy in order to preserve high intensity activity. The new findings of the preservation of high acceleration distance combined with the significant decline in moderate and low acceleration distance provide further confirmation of the suggested pacing strategies that allow players to maintain their ability to accelerate maximally during crucial phases of play.

#### BIOMECHANICAL ANALYSIS OF THE BASIC BODY MOVEMENTS IN AIKIDO

FURUTANI, O.

UNIV. OF TOYAMA, FACULTY OF HUMAN DEVELOPMENT

O. Furutani<sup>1</sup>, T. Horita<sup>1</sup>, K. Hashizume<sup>1</sup> Community Sports Course, Faculty of Human Development, University of Toyama, Toyama, Japan. INTRODUCTION Aikido has been developed as a system of physical and mental training, founded by Mr. Morihei Uesiba (1883-1969) called martial arts master in early 20th century (Saito .2010). The main aim of Aikido has been considered to unify the technique, physical and mental aspects of the body, which is translated as "the Way of harmonious spirit". The basic movements in Aikido consists of tenkan (turning) (M.Ueshiba .2005). One moves in circular motion in response to the opponent and while moving spherically, one maintains center of gravity to create the stable axis of movement (K.Ueshiba .1984). The purpose of the present study was to investigate the biomechanical characteristic of the basic body movements in Aikido. METHODS Eight skilled(5-6 grade) male experts (61.4±11.5 y r ; 63.8±6.5 k g ; 169.5±4.2 c m) and 5 unskilled male (19.6±1.5 y r ; 61.3±5.6 k g ; 168.1±2.5 c m) subjects participated in this study. The subjects performed tenkan on the two force plates(KISTLER,Type2986A). The motion of the subjects was recorded by two video cameras (30 f.p.s).Three-dimensional (3D)analysis was performed by a computerized motion analysis system (FRAME DIAS4, DKH, JAPAN). Center of gravity of the body (CG)and lower limb joint kinematic variables were analyzed. RESULTS AND DISCUSSION The differences were found in the path of CG and lower limb joint kinematics between skilled and unskilled subjects in tenkan. The skilled subjects showed small change (2.9±1.4 c m) in vertical position of CG during movement as compared to unskilled subjects (6.0±3.0 c m, P<0.05). The peak velocity of the CG was higher in skilled subjects (1.39m/s) as compared to the unskilled subjects (1.14m/s, P<0.05). Skilled subjects showed shorter movement time (0.55±0.14s) as compared to the unskilled subjects (1.19±0.15s, P<0.01). In addition, force impulse of the skilled subjects were lower (283±51N • S) than the unskilled subjects (525±143N • S, P<0.01). Therefore it has been considered that Aikido experts possess well-coordinated and economical movement. REFERENCES K. Ueshiba, The Spirit of Aikido, 41, 1984, Kodansha, Tokyo, Japan. M. Ueshiba, PROGRESSIVE AIKIDO, 44-45, 2005, Kodansha, Tokyo, Japan. Y. Saito, AIKIDO TANKYU, 84-87, 2010, Shupangeijutusha, Tokyo, Japan.

#### PERFORMANCE AND KINEMATICS OF VARIOUS THROWING TECHNIQUES AND SKILL LEVELS IN TEAM-HANDBALL

WAGNER, H., PFUSTERSCHMIED, J., VON DUVILLARD, S.P., MÜLLER, E.

UNIVERSITY OF SALZBURG

PERFORMANCE AND KINEMATICS OF VARIOUS THROWING TECHNIQUES AND SKILL LEVELS IN TEAM-HANDBALL Wagner, H.1,2, Pfusterschmied, J.1,2, von Duvillard, S.P.3, Müller E.1,2 1: SSK (Salzburg, Austria), 2: CDLBS (Salzburg, Austria), 3: KESB (Idaho, USA) Introduction In team-handball competition, the players utilize various throwing techniques, whereas the standing throw with run-up and jump throw were the most applied (Wagner et al., 2008). In recent studies, it was shown that performance and kinematics in the jump throw differ depending on the skill level (Wagner et al., 2010) and that a transfer of momentum from proximal to distal and dynamic trunk and shoulder joint movements increase ball velocity in team-handball throwing (van den Tillaar and Ettema, 2009; Wagner et al., 2010). However, a study comparing different throwing techniques and skill levels in team-handball throwing is lacking. Consequently, the aim of this study was to analyze differences in performance and kinematics between the team-handball jump and standing throw with run-up in different skill levels. Methods Twenty-four participants of three different skill levels performed 10 valid jump and standing throws with run-up and were instructed to throw the ball with a maximal ball velocity into the center of a target. 3D-kinematics and ball velocity were measured using an 8 camera Vicon MX13 motion capture system, at 250 Hz. Throwing accuracy was determined by the percentage of throws that

missed the target and the mean radial error. A two-way MANOVA with the main factors throwing technique and skill level was used to calculate the differences in performance and kinematics (pelvis, trunk and shoulder rotation). Results Two-way MANOVA yielded significant effects for the factor throwing technique ( $P < 0.001$ ) and skill level ( $P < 0.001$ ). In performance, we found significant differences between throwing techniques ( $P < 0.01$ ) and skill levels ( $P < 0.001$ ) solely in the ball velocity. Additional Post-Hoc tests indicated significant differences in throwing technique ( $n=7$ ) and skill levels ( $n=8$ ) in 15 out of 36 kinematic variables. Discussion Increased ball velocity in the standing throw with run-up could be explained by a better transfer of momentum from proximal to distal. The lead leg braces the body that allows the pelvis, trunk, and throwing arm to accelerate over the braced leg. In the jump throw the missing floor contact of the lead leg demands a different strategy to accelerate the pelvis and trunk that lead to a decrease in ball velocity. However, elite and highly skilled players were able to increase angular velocity in the pelvis, trunk and shoulder rotation in both throwing techniques that lead to higher ball velocity in comparison to the low skilled players. References Van den Tillaar R, Ettema G (2007). *J Appl Biomech*, 23, 12-19. Wagner H, Kainrath S, Müller E (2008). *LS*, 38, 35-41. Wagner H, Buchecker M, van Duvillard SP, Müller E (2010). *J Sports Scie & Med*, 9, 15-23.

## THE EFFECT OF A SIMULATED 18 KM CLASSIC CROSS-COUNTRY SKIING RACE ON MAXIMAL VELOCITY AND FORCE PRODUCTION DURING DIAGONAL SKIING

OHTONEN, O., NIEMINEN, V.M., LINDINGER, S., STÖGGL, T., LINNAMO, V.

UNIVERSITY OF JYVÄSKYLÄ

THE EFFECT OF A SIMULATED 18 KM CLASSIC CROSS-COUNTRY SKIING RACE ON MAXIMAL VELOCITY AND FORCE PRODUCTION DURING DIAGONAL SKIING Ohtonen, O. 1, Nieminen, V-M. 1, Lindinger, S. 2, Stöggel, T. 2, Linnamo, V. 1 1: Neuromuscular Research Center, Department of Biology of Physical Activity, University of Jyväskylä, Finland, 2: Department of Sport Science and Kinesiology, University of Salzburg, Christian Doppler Laboratory "Biomechanics in Skiing", Austria. Introduction Both physiological (e.g. Welde et al. 2003) and biomechanical (e.g. Bilodeau et al. 1996) variables play a role in long distance cross-country skiing races. Lindinger et al. (2009) showed that diagonal roller skiing performance until exhaustion was linked to e.g. longer cycle length and greater force impulses. The aim of the present study was to examine how maximal skiing velocity and force production during diagonal skiing are affected after an 18 km simulated classic ski race on snow. Methods 7 male subjects performed an 18 km (9 x 2 km lap) simulated race in Vuokatti ski tunnel. Before and after the race, skiers performed one maximum velocity trial over a 20 m long force plate row (Vähäsöyrinki et al. 2008) using the diagonal stride. Maximum skiing velocity and differences in vertical and horizontal leg and pole forces related to body weight between pre and post tests were analyzed. Results Maximum skiing velocity decreased by  $8.5 \pm 8.1\%$  ( $P < 0.05$ ). Average vertical and horizontal leg force, and peak horizontal leg force decreased by  $5.3 \pm 3.1\%$ ,  $24.9 \pm 17.3\%$  and  $18.7 \pm 9.4\%$ , respectively (all  $P < 0.05$ ). Peak vertical pole force, impulse of vertical pole force, peak horizontal pole force and impulse of horizontal pole force decreased by  $28.1 \pm 17.6\%$ ,  $24.3 \pm 17.7\%$ ,  $25.1 \pm 23.1\%$  and  $28.6 \pm 29.1\%$ , respectively (all  $P < 0.05$ ). Peak horizontal pole force decreased the most in skiers who also had the most decrease in maximum velocity as indicated by a positive correlation ( $r = 0.93$ ,  $P < 0.05$ ) between the relative change in maximum velocity and the relative change in peak horizontal pole force. Discussion It seems that the skiers are able to maintain vertical leg forces better but the propulsive part of the leg force decreases strongly when the skiers are fatigued. Pole forces, both vertical and horizontal, decreased which emphasizes the role of the upper body in maintaining maximal skiing speed with diagonal stride. Better skiers seem to be able to maintain their skiing speed even when fatigued by maintaining the horizontal pole forces whereas for poorer skiers a decrease in horizontal pole forces may lead to decrease in maximum skiing velocity. References Bilodeau B, et al. *Med Sci Sports Exerc*: 28(1): 128-138 Lindinger S, et al. *Sports Biom*. 8(4) : 318-333 Vähäsöyrinki P, et al. (2008). *Med Sci Sports Exerc* 2008; 40:1111-6 Welde B, et al. (2003). *Med Sci Sports Exerc*: 35(5): 818-825

## THE IMPACT OF POLE PROPULSION ON KINEMATICS AND FATIGUE IN ROLLER SKI SKATING

SANDBAKK, Ø.1, HOLMBERG, H.C.2, LØKKE, T.1, ETTEMA, G.1

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Introduction: The G3 skating technique in cross-country skiing is performed while simultaneously employing skis and poles for propulsion. This technique may therefore be regarded as a compromise between the optimal skating push-off with the legs (comparable to speed skating) and the optimal push-off with the poles (comparable to the double poling technique). In order to understand the effect of using the poles on cycle characteristics and fatigue, the current study compared G3 skating with G3 leg-skating (without using poles for propulsion) while roller skiing on a treadmill. Methods: Seven male elite skiers performed 5-min submaximal stages at low, moderate and high speeds (8, 12 and 16 km•h<sup>-1</sup>) at a 5% incline in both techniques. Kinematics was analyzed 3-dimensionally using the Qualisys Pro Reflex system and the index of fatigue was assessed using heart rate monitoring and the Borg RPE scale. Results: Compared to G3 skating, in leg-skating cycle time and length decreased by 30% at correspondingly increased cycle rates ( $P < 0.01$ ). In association with this, the ski ground contact time and ski gliding phase were shorter in leg-skating ( $P < 0.01$ ) whereas push-off times remained constant across techniques. Ski angles with respect to the forward direction were 40% lower in leg-skating ( $P < 0.01$ ). In addition, the skiers retained constant ski angles from ski plant to ski lift-off when leg-skating, whereas ski angles increased during the push-off when skating using the poles ( $P > 0.05$ ). Maximal angles and the range of movement for the hip, knee and ankle were significantly higher in leg-skating ( $P < 0.01$ ). The legs were fully extended during the push-off phase at all speeds and techniques. When matched for heart rate and the Borg scale, skiers skied at 30% slower speeds when leg-skating ( $P < 0.01$ ). Discussion: A lower total propulsion in leg-skating leads to shorter cycle times and lengths compared to G3 skating. In order to compensate for the loss of propulsion when leg-skating, skiers increase their cycle rate and employ deeper leg positions and greater ski angles during the push-off. In association with this, the skiers kept a constant push-off time, but had shorter gliding time. All together, these aspects were related to the higher rates of fatigue when leg-skating compared to skating with poles at the same speed.



## Oral presentations

### OP-PM22 Cardiovascular: Cardiovascular Training

#### THE EFFECT OF ENDURANCE TRAINING UPON SKELETAL MUSCLE RESISTANCE VESSELS DEPENDS ON THE MUSCLE LOADING AND PLASTICITY

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**Introduction** During aerobic exercise blood flow distribution within skeletal muscles is linked to their fiber-type composition. During sub-maximal exercise blood flow to respiratory muscles may increase to higher extent than to locomotory muscles. Since shear stress is a key stimulus for alterations in muscle feed arteries, these arteries would be non-uniformly affected during endurance training (TR). To test this hypothesis we compared the effects of TR on contraction and relaxation of diaphragm (DA) and gastrocnemius muscle (GA) feed arteries in vitro. **Methods** Male Wistar rats were treadmill trained for 8 wks. The load was gradually increased, so that by the end of the 5th week rats ran 60 minutes per day at a speed 25 m/min and with incline 10 degrees. Expression of MHC isoforms and succinate dehydrogenase (SDH) was studied in single fibers by immunohistochemistry. Isometric contractile responses to noradrenaline (NA) and serotonin and relaxation to acetylcholine (ACh) in segments (2-mm long) of the arteries were studied. **Results** After 8-week endurance training maximal O<sub>2</sub> consumption in experimental animals was significantly greater than in sedentary control, and lactate threshold was shifted to the right, evidencing effectiveness of the employed training protocol. Composition and cross sectional area of either slow or fast muscle fibers in both muscles were not changed after endurance training. On the other hand in red part of gastrocnemius muscle significant increase of SDH activity was observed in both types of muscle fibers. In costal diaphragm no increase of SDH activity was observed. In controls DA as compared to GA had greater density of sympathetic innervation and higher sensitivity to NA, but not to serotonin. After TR sensitivity to NA did not change in GA, but was reduced in DA; decrease of postsynaptic sensitivity must weaken sympathetic constriction of DA during exercise. In controls dilator responses to ACh and nitroprusside in DA were also greater than in GA. After TR reactivity to ACh was not changed in DA, but prominently increased in GA, the effect was abolished by blockade of NO synthesis. Interestingly, reactivity of both arteries to SNP after TR was diminished indicating smaller sensitivity of smooth muscle to NO. **Discussion** We suggest that the training induced improvement of muscle blood supply is connected with reduced capacity for constriction in DA and with increased capacity for relaxation in GA. Differential effects of TR on DA and GA are related to basic characteristics of these arteries and their host muscles. Supported by the RFBR (grant 09-04-01701-a) and by the Program "Mechanisms of physiological functions: from molecule to behavior" of Biological Science Department, RAS.

#### BLUNTED CARDIOVASCULAR ADAPTATIONS TO INTENSE-INTERVAL COMPARED WITH ENDURANCE TRAINING

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**Introduction** Much of the recent focus on adaptations to maximal-intensity interval exercise has been on energy metabolism, yet cardiovascular adaptations are also important for performance capabilities and health. The purpose of this study was to examine several cardiovascular and endurance-related functional adaptations to endurance (END) versus 30-s repeat high-intensity interval training (RHIE). We hypothesised that resting blood volume and pressure would respond similarly between regimes and sexes, and that the volume responses would relate to improvements in aerobic power and capacity. **Methods** Participants were 12 healthy but untrained adults (5 males, 7 females; age  $23 \pm 4$  y;  $VO_{2max}$   $38 \pm 5$  mL/min/kg). They were ranked within sex for  $VO_{2max}$  and assigned in randomised then alternating order to 8-wk supervised RHIE or endurance cycle ergometer training using established protocols, before a 7-wk washout and crossover. RHIE progressed from four to six 30-s intervals 3 d/wk, while END progressed from 40 to 60 min at 65%HR<sub>max</sub> 5 d/wk. Measures taken before and <3 d after training were  $VO_{2max}$ , resting blood volume (CO dilution) and arterial pressure (Finapres), and cardiovascular responses to 50-min standardised exercise (65% pretraining  $VO_{2max}$ ) and a 10-min work trial. Females were tested on d 4-10 of the menstrual cycle. Inferential analysis was via spreadsheets at [www.newstats.org](http://www.newstats.org). **Results** Increases in red cell volume were larger in END (10±9%) than in RHIE (95%CI for diff: 7±6), whereas differences for blood and plasma volumes were unclear. A 4% smaller increase in red cell volume for females was also unclear (CI: ±13%). Reductions in resting systolic, mean and diastolic pressures were clearly larger in END than RHIE. Reductions in HR at rest (END: -5; RHIE: +2 b/min) were unclear between regimes (CI: -7±8), but reductions during exercise were clearly larger in END (-21 vs -4 b/min; CI: -17±8), with unclear sex differences. Cardiac Troponin concentration responses to fixed-load and work-trial exercise were negligible. Increases in work-trial distance were larger in END (16 vs 5%; CI: 11±7), whereas increases in aerobic power were not (11 vs 16%; CI: -5±8). Changes in blood volume were moderately related to changes in exercising HR ( $r=-.50$ ,  $p=.10$ ) and aerobic power ( $r=.54$ ,  $p=.06$ ) in END, but not in RHIE. **Discussion** Whereas endurance and intense interval training seem to confer similar metabolic adaptations, the present data indicate that endurance training (for 8 weeks) is more effective in raising red cell volume, reducing resting blood pressure and exercising HR, and improving work capacity in previously untrained adults. Similar gains in aerobic power may reflect different myocardial effects.

#### PRE-PARTICIPATION SCREENING IN ELITE RUGBY UNION PLAYERS: ECG PATTERNS AND LOW FALSE POSITIVE RATES

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**Purpose:** ECG changes in athletes are common and usually reflect structural and electrical remodelling of the heart to intensive physical training. However, abnormalities of athlete's ECG may be an expression of underlying heart disease. Recent experience of pre-participation screening (PPS) in Italian athletes demonstrates a reduction in mortality from cardiomyopathies and conduction disorders; however such practice attracts criticism due to high false positive rates. In 2010 the Premiership Rugby Union in England introduced formal PPS. **Methods:** All Premiership Rugby Union players underwent PPS with a clinical questionnaire and 12-lead ECG. ECG changes were characterised into training-related (group 1) and those not commonly related to training (group 2). Trans-thoracic echocardiogram (TTE) and other investigations were performed if questionnaire was positive or group 2 ECG changes seen. **Results:** A total of 606 players were assessed (mean age 22.9 years; range 15-37). Group 1 ECG changes included sinus bradycardia in 269 (44.4%), prolonged PR interval in 52 (8.6%), partial RBBB in 53 (8.7%), voltage criteria for LVH in 130 (21.5%) and early repolarisation in 323 (53.3%). Group 2 ECG changes included left axis deviation in 17 (2.8%), right axis deviation in 4 (0.6%), RBBB in 5 (0.8%), voltage criteria for RVH in 1 (0.2%), pro-

longed QT interval in 1 (0.2%), short PR without WPW pattern in 9 (1.5%) and abnormal T wave inversions in 15 (2.5%). Of the 606 players, 45 (7.4%) required TTE [35 (5.7%) due to ECG abnormalities; 5 (0.8%) due to family history of sudden death or cardiomyopathy; 5 (0.8%) due to symptoms]. After TTE, 34 of the 45 players were reassured. Six had abnormal changes on TTE [markedly dilated LV cavity in 3 (0.5%), mitral regurgitation in 1 (0.2%), pulmonary stenosis in 1 (0.2%), dilated aortic root in 1 (0.2%)] requiring serial surveillance. Five (0.8%) had abnormalities on TTE and/or ECG warranting further evaluation [possible ARVC in 3 (0.5%), possible in HCM 1 (0.2%), prolonged QT in 1 (0.2%)]. Further tests included exercise stress test in 5 (0.8%), 24-hour ECG in 5 (0.8%) and cardiac MRI in 3 (0.5%). None of the players exhibited a cardiac disorder warranting disqualification from sport. Conclusion: Cardiovascular evaluation of elite rugby players with a questionnaire and ECG raised no concern in 92.6% players and further 5.6% were reassured after TTE. Only 1.8% players required further tests or serial surveillance TTE. No players were disqualified. ECG patterns seen in rugby players were similar to those described in other sporting disciplines. The false positive rate on PPS with a questionnaire and ECG in an expert setting was low at 5.6% compared to 7% in the Italian experience.

## STRENGTH AND POWER TRAINING DID NOT MODIFY CARDIOVASCULAR RESPONSES TO AEROBIC EXERCISE IN ELDERLY SUBJECTS

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Introduction: Resistance training increases muscle strength in older adults, which has been suggested to diminish the effort necessary for the execution of physical tasks, and consequently, to reduce the cardiovascular load during exercise. This hypothesis has been proven for strength but not for aerobic stress. Therefore, this study was designed to verify if different resistance training regimens can blunt the cardiovascular load increase in response to an aerobic stimulus. Methods: Thirty-nine older adults were randomly allocated into three groups: Control (C: n=11, 63±1years), Strength Training (ST: n=13, 63±1years, 2x/week, 70-90% of 1RM), and Power Training (PT: n=15, 65±1years, 2x/week, 30-50% of 1RM, concentric phase performed as fast as possible). Before and after 16 weeks, oxygen uptake (VO<sub>2</sub>), systolic blood pressure (SBP), heart rate (HR), and rate pressure product (RPP) were evaluated during a progressive treadmill maximal cardiopulmonary exercise test. Results: Resting SBP and RPP reduced significantly and similarly from pre to post-intervention in all the groups (-7.4±1.5mmHg, -0.52±0.16 mmHg.beat/min.103, respectively, P<0.05). Maximal SBP, HR and RPP did not change throughout the study in either one of the groups. After the interventions, the slopes of the linear regressions calculated for measured VO<sub>2</sub>, HR and RPP in regard to the estimated VO<sub>2</sub> (absolute load) decreased significantly and similarly in all the experimental groups (-0.08±0.02, -10.1±2.5, -1.91±0.42, respectively, P<0.05), while the slope for the linear regression calculated between SBP and estimated VO<sub>2</sub> did not change. The slopes of the linear regressions calculated between all the cardiovascular parameters in regard to the measured VO<sub>2</sub> also did not change after the interventions. Discussion: Oppositely to what is commonly assumed, ST and PT did not reduce the metabolic cost during aerobic exercise in elderly subjects. Thus, they did not blunt submaximal and maximal increases in HR, SBP and RPP during aerobic exercise. Therefore, ST and PT did not reduce cardiovascular stress during aerobic tasks that are part of the daily activities of elderly subjects, such as sweeping the house, washing dishes, walking and so on. Financial support: FAPESP, CNPQ, CAPES and Head of the Psychopharmacology Incentive Fund Association.

## RELATIONSHIPS BETWEEN CARDIAC CHARACTERISTICS AND THE RELATIVE AEROBIC POWER IN MALE AND FEMALE ATHLETES

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Introduction. As endurance performance markedly depends on the cardiac functions, relationships between some cardiac indices and spiroergometric parameters have been reported in our previous paper (Kneffel et al. Echocardiography, 24 901 2007) and in the papers of several other authors. In the present study relationships between the relative aerobic power, and some morphologic (left ventricular (LV) hypertrophy indicated by the LV wall thickness, internal diameter and muscle mass), functional (diastolic function indicated by the E/A ratio) and regulative (heart rate (HR), cardiac output, circumferential shortening velocity) characteristics of the athlete's heart were investigated in a large number (N=912) of young adult (age: 19-35 yr.) male and female subjects. Methods. Subjects were enrolled to four sub-groups according to their sports activity as follows: endurance athletes – ball-game-players – sprint-and-power athletes – non-athletes. Relative aerobic power was investigated on treadmill or bicycle spiroergometry, cardiac characteristics were measured by two-dimensionally guided M-mode and Doppler-echocardiography. Results. In the whole material, highly significant correlations were between the rel. aerobic power and the LV hypertrophy, E/A and the HR. In the endurance athletes and in the ball-game-players most of the cardiac parameters (rel.LV muscle mass and internal diameter in both genders, wall thickness in males, E/A and HR in females) displayed significant correlations. In the group of sprint-and-power athletes and in non-athletes a few of significant correlations (E/A and HR in sprint-and-power athletes, rel.LV muscle mass and wall thickness in non-athletes) were found only in the males. Conclusion. Endurance trained athletes (endurance athletes and ball-game-players) are supposed to have a high oxidative capacity in their muscles (slow twitch muscle fibres and an improved oxidative metabolism); the limit of the aerobic capacity and performance is the oxygen supply of the muscles which is determined by the cardiac function. The proportion of slow twitch fibres and the oxidative capacity in sprint-and-power athletes is lower; performance is already limited in the periphery.

## Oral presentations

### OP-PM27 Molecular 2

#### RPS6 PHOSPHORYLATION MIMICS BLOOD INSULIN PROFILE WITH DIFFERENT PROTEIN INGESTION REGIMENS FOLLOWING RESISTANCE EXERCISE

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mRNA translation is a key step in the regulation of muscle protein synthesis (MPS). Resistance exercise and nutrients both stimulate MPS, with the two having an synergistic effect on anabolic signals important for muscle hypertrophy. To date, no study has determined the interaction of manipulating nutrient availability after exercise during prolonged (12 h) recovery. Purpose: To determine the time-course of anabolic signaling during prolonged recovery from resistance exercise. Methods: 24 resistance trained men were randomly assigned to one of three groups, reporting to the laboratory after a 10-12 hr overnight fast. Immediately following leg extension exercise (4 sets × 10 reps @ 80% 1-RM, 3 min recovery) each group received whey protein in a different dosing regimen over 12h of recovery: 1) PULSE: 8 × 10 g (125 mL) every 1.5h; 2) INT: 4 × 20 g (250 mL) every 3h; and 3) BOLUS: 2 × 40 g (500 mL) every 6h. Biopsies from vastus lateralis were taken at rest and 1, 4, 6, 7 and 12 h post-exercise. Blood insulin profile and rpS6 Ser235/6 phosphorylation was measured as a marker of the nutrient response and translation initiation for MPS. Results: BOLUS increased phosphorylation of rpS6 Ser235/236 at 1h (~7 fold,  $P < .001$  compared to baseline) which with a trend to a change after 7h ( $P = .08$  compared to baseline). In contrast there were no differences in rpS6 Ser 235/236 phosphorylation with either INT or PULSE feeding protocols at any time-point compared to baseline. Blood insulin concentrations followed a similar pattern to that of the phosphorylation status of rpS6 showing two peaks at ~1h and ~7 h post exercise. Conclusion: BOLUS whey protein ingestion was associated with the greatest anabolic signal compared to the other feeding regimens. If rpS6 activity is a good predictor of muscle protein synthesis we expect that these results will correlate with FSR. Specifically, our results indicate that feeding doses of 20 and 10 g of protein fail to exert a noticeable change in this marker of translational machinery activation. This project was funded by ARC project linkage grant LP100100010.

#### EXERCISE-SPECIFIC MTOR, BUT NOT AMPK SIGNALING IN TRAINING-ACCUSTOMED INDIVIDUALS

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Exercise-specific mTOR, but not AMPK signaling in training-accustomed individuals Vissing, K.1, McGee, S.L.2, Farup, J.1, Kjølhed, T.1, Vendelbo, M.H.3, Jessen, N.3. 1. Dept. of Sport Science, Aarhus University, DK-8000 Aarhus, Denmark, 2. Metabolic Research Unit, School of Medicine, Deakin University, Geelong, Australia, 3. Department of Internal Medicine and Endocrinology, Aarhus University Hospital, DK-8000 Aarhus, Denmark. Introduction An AMPK-Akt "switch" signaling mechanism has previously been suggested to explain adaptations to frequency-dependant electrical stimulation in rat muscle (1), while similar exercise-induced signaling selectivity in humans seem more equivocal (2-3). We hypothesized, that in human individuals accustomed to exercise through prior training, Akt-mTOR signaling is selectively activated by strength exercise, while AMPK signaling responses are less specific for exercise type. Methods 24 untrained individuals were divided in endurance, strength or non-exercise control groups. Exercise groups completed extended progressive training programs. Single-bout exercise trials were then conducted in the fasted state including comparison to a non-exercising control group, with blood and muscle samples collected prior to and at 0, 2.5, 5 and 22 hours post-exercise recovery to be analyzed for selected plasma substrates and hormones and for protein phosphorylation of muscle markers of AMPK and Akt-mTOR signaling. Results: endurance training (ET) producing an increase in  $\dot{V}O_{2\max}$  (~11%;  $p < 0.01$ ) and a decrease in submaximal exercise heart rate (~13%;  $p < 0.001$ ) and with strength training (ST) producing increases in knee extensor (~9%;  $p < 0.01$ ) and mean fiber cross-sectional area (~18%;  $p < 0.05$ ), respectively, and increases in peak torque (~19%;  $p < 0.001$ ) and maximal dynamic strength (~39%;  $p < 0.001$ ) of knee extensor muscle. Increased plasma levels of glucose, insulin, GH and IGF-1 and increased phosphorylated levels of muscle PAS AS160, mTOR, P70S6K and GSK-3 $\alpha$ , were observed exclusively after strength exercise ( $p < 0.05$ ). Increased phosphorylation of AMPK, HDAC5, CREB and ACC was observed after endurance exercise ( $p < 0.05$ ), but with similar trends observed after strength exercise and with no difference between exercise groups. No changes in these measures were observed in non-exercising controls. Discussion The results support that in trained individuals, downstream mTOR-signalling is selectively activated by strength exercise during late post exercise recovery, while homogeneity exists for AMPK-signaling for differentiated exercise. References 1. Atherton PJ, Babraj J, Smith K, Singh J, Rennie MJ, Wackerhage H. (2005) FASEB J. 19,786-788. 2. Wilkinson SB, Phillips SM, Atherton PJ, Patel R, Yarasheski KE, Tarnopolsky MA, Rennie MJ. (2008). J Physiol. 586,3701-3717. 3. Camera DM, Edge J, Short MJ, Hawley JA, Coffey VG. (2010) Med Sci Sports Exerc. 42,1843-1852.

#### THE SUPERVILLIN POLYMORPHISM RS6481619 IS NOT ASSOCIATED WITH MAXIMAL OXYGEN UPTAKE OR ITS TRAINING RESPONSE

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THE SUPERVILLIN (SVIL) POLYMORPHISM RS6481619 IS NOT ASSOCIATED WITH MAXIMAL OXYGEN UPTAKE OR ITS TRAINING RESPONSE 1Williams A.G., 1Day S.H., 1Johnson D., 2McPhee J.S. 1Institute for Performance Research and 2Institute for Biomedical Research into Human Movement and Health, Manchester Metropolitan University, UK Introduction Understanding interindividual variability in response to aerobic training holds the potential for a more individualised approach to exercise prescription. Recently, Timmons et al. (2010) identified 11 single nucleotide polymorphisms (SNPs) that collectively accounted for 23% of the variance in the gains in maximal oxygen uptake in the HERITAGE Family study (Bouchard et al. 1999). Most of these polymorphisms have not previously been associated with exercise responses and thus replication is needed. Here we analyse the potential association between one of those polymorphisms, the supervillin (SVIL) SNP rs6481619, and data derived from McPhee et al. (2009). Method McPhee et al. (2009) obtained one-leg cycling peak oxygen uptake and two-leg cycling maximal oxygen uptake in 61 previously sedentary women before and after a six-week aerobic cycle training programme. DNA was extracted from 200  $\mu$ L whole blood using spin columns (Qiagen, Crawley, UK). Genotyping was performed via

real-time PCR using a Chromo4 machine (BioRad, Hemel Hempstead, UK) and a custom Taqman® SNP genotyping assay (Applied Biosystems, Warrington, UK). Data were analysed using ANCOVA, with body mass and physical activity as covariates. Results One-leg cycling peak oxygen uptake increased from 1.9 L/min to 2.1 L/min and two-leg cycling maximal oxygen uptake increased from 2.4 L/min to 2.7 L/min (both  $P < 0.0005$ ). No significant associations were observed between the SVIL rs6481619 SNP (AA=32, AC=25, CC=4) and any oxygen uptake data ( $0.15 \leq P \leq 0.99$ ). In particular, whether treated as 3 separate genotype groups ( $P = 0.808$ ) or as A-allele homozygotes vs. C-allele carriers ( $P = 0.536$ ), there was clearly no association between genotype and the response of maximal oxygen uptake to training – i.e. the phenotype used by Timmons et al. Discussion The SVIL rs6481619 SNP accounts for 4% of the observed variance in the Timmons et al. study. Very recent work by Bouchard et al., using precisely the same phenotype data as Timmons et al. (but different methods to identify candidate genes), also fails to replicate the SVIL data. In that context, it is less surprising that we fail to replicate the Timmons et al. observation in an independent cohort with different training intensity and volume. References Bouchard C, An P, Rice T, Skinner JS, Wilmore JH, et al. (1999). *J Appl Physiol*, 87, 1003-8. Bouchard C, Sarzynski MA, Rice TK, Kraus WE, Church TS, et al. (2010). *J Appl Physiol*, DOI:10.1152/jappphysiol.00973.2010. McPhee JS, Williams AG, Degens H, Jones DA. (2010). *Eur J Appl Physiol*, 109, 1111-8. Timmons JA, Knudsen S, Rankinen T, Koch LG, Sarzynski M, et al. (2010). *J Appl Physiol*, 108, 1487–96.

### IS THERE A DOSE-RESPONSE EFFECT OF A DUAL DA/NA REUPTAKE INHIBITOR ON PERFORMANCE AND THERMOREGULATION IN THE HEAT?

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Introduction Bupropion, a dopamine/noradrenaline (DA/NA) reuptake inhibitor has previously shown to possess both ergogenic and thermogenic properties (Watson et al, 2005). It appears that bupropion (2x300mg) enabled subjects to maintain a higher power output with the same perception of effort and thermal stress while obtaining significantly higher core temperatures. Despite this ergogenic effect and the potentially high risk for developing heat illness, bupropion is not a prohibited substance. Furthermore, it is not known if lower doses (50 and 75% of the maximal daily dose of 300mg) exert the same effects during exercise in high ambient temperature. Methods Ten healthy trained male cyclists (age  $25 \pm 4$  y;  $W_{max}$   $351 \pm 27$  W;  $VO_{2max}$   $63.5 \pm 6$  ml/min/kg) completed four experimental trials in  $30^{\circ}\text{C}$  in a double blind-randomized crossover design. Subjects ingested either placebo (pla; 300 mg) or bupropion (300 mg =bup100; 225 mg = bup75 or 150 mg = bup50) on the evening before and the morning of the trials. Subjects cycled for 60min at 55% $W_{max}$ , immediately followed by a time trial (approx. 30min) to measure performance. Statistical analysis was performed with a 2-factor (drugxtime) repeated measures ANOVA, paired samples t-tests were used to identify pair-wise differences. The significance level was set at  $p < 0.05$ . Results In the placebo trial subjects took  $35.7 \pm 6.7$  min to complete the time trial while in the bup50 trial this was  $33.7 \pm 3.4$  min ( $p = 0.375$ ); in the bup75 trial  $33.4 \pm 3.4$  min ( $p = 0.247$ ); bup100:  $33.1 \pm 3.7$  min ( $p = 0.316$ ). No differences between the bupropion trials were observed ( $p > 0.05$ ). Core temperature was significantly higher in the bup100 trial at the end of exercise ( $p = 0.035$ ) compared to the placebo trial. No differences in ratings of perceived exertion and thermal sensation were detected ( $p > 0.05$ ). Discussion In contrast to the previous study, no statistical significance could be shown for performance, despite a 2 to 2.6 min or 5 to 7% better performance in the bupropion trials. Furthermore, no difference between the doses of bupropion were observed, indicating that even the lowest dose (2x150 mg) resulted in the same effects on performance. Core temperature rose significantly after administration of the highest bupropion dose. This is an effect that was also observed in our previous study and that is caused by the increased metabolic heat production resulting from the maintenance of a higher power output. References Watson P, et al. *J Physiol* 565.3: 873-883, 2005.

### SKELETAL MUSCLE SIGNALLING IN RESPONSE TO SPRINT EXERCISE: SEX DIFFERENCES?

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Introduction. Sprint exercise leads to the activation of several signalling cascades, particularly those involved in the regulation of metabolism and the response to cellular stress in the skeletal muscle. Despite differences between men and women in both the metabolic response to endurance and sprint exercise no single study has determined whether a sex dimorphism in skeletal muscle signalling response to sprint exercise exists in humans. Purpose. To determine if there a sex dimorphism in the AMPK, MAPK/ERK and STAT3 muscle signalling pathways in response to 30s all-out sprint test (Wingate test). Methods. Seventeen men and ten women performed a 30-s Wingate test. Muscle biopsies were taken before, immediately after the exercise and at 30 and 120 minutes during the recovery period. Results. Thr172-AMPK $\alpha$ , ACC $\beta$  Ser221, Thy705-STAT3, Thy202/Thy204-ERK1/2 and Thy180/Thy182-p38MAPK phosphorylation responses to sprint exercise were similar in men and women. Thr172-AMPK $\alpha$  phosphorylation was enhanced fourfold 30 min after the sprint exercise in males and females ( $P < 0.01$ ). The ACC $\beta$  Ser221 phosphorylation was enhanced by about threefold just after the sprint test exercise and 30 min into the recovery period in males and females ( $P < 0.01$ ). Thy705-STAT3 phosphorylation was increased two hours after the Wingate test compared to the value observed right after the end of the exercise ( $P < 0.05$ ) and 30 min after the Wingate test there was a 2.5-fold increase in Thy202/Thy204-ERK1/2 phosphorylation, compared to both the pre-exercise and to the value observed right after the Wingate test (both,  $P < 0.05$ ). Conclusion. The muscle signalling response to a single bout of sprint exercise mediated by AMPK, ACC, STAT3, ERK and p38MAPK is essentially similar in men and women. Marked increases in AMPK, ACC, STAT3, and ERK phosphorylation were observed after a single 30s all-out sprint (Wingate test) in the vastus lateralis. Supported by grants from FUNCIS 10/07 and Ministerio de Educación y Ciencia, Spain (DEP2010-21866).

## Oral presentations

### OP-PM53 Muscle Physiology

#### CROSSTALK BETWEEN THE EXERCISE-INDUCED MECHANICAL HYPOALGESIA AND ISOKINETIC MUSCLE STRENGTH

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**CROSSTALK BETWEEN THE EXERCISE-INDUCED MECHANICAL HYPOALGESIA AND ISOKINETIC MUSCLE STRENGTH** Pencheva, N.I., Stoilov, A. 2, Grancharska, K. 1: Department of Sports and Kinesiotherapy and 2: Department of Physics of SOUTH-WEST UNIVERSITY (Blagoevgrad, Bulgaria) **Introduction** The exercise-induced hypoalgesia (EIH) is a controversial issue and further research is warranted. The aim of this study was: - to compare pain-pressure threshold (PTT) at rest of gastrocnemius-soleus muscle (GS) between dominant and non-dominant lower leg or between lateral and medial part of GS belly; - to assess the degree of EIH in loaded (GS) and unloaded (b. brachii; BB) limb; and - to correlate PPT or EIH with muscle strength. **Methods** The study included 19 right-handed, right-legged, male volunteers (median age: 21 years, range 18-23). Hand-held pressure algometer (Somedic AB) was used to evaluate the PTT (kPa/cm<sup>2</sup>). The pressure (increase rate of 50 kPa/s) was applied to left and right lower leg on both lateral or medial part of the GS belly and to left and right BB, before and 15 min after treadmill test to exhaustion. The elevation of the PTT after exercise was a measure for the degree of EIH. To define subject's maximal ankle (plantar/dorsal flexion; speed: 30 o/s) or knee (flexion/extension; speed: 60 o/s) muscle strength, an isokinetic dynamometer (Biodex System 4 Pro) was used. **Results** The medial part of the GS muscle was more sensitive to pressure (PTT, kPa/cm<sup>2</sup>: 350±25-right side; 350±24-left side) as compared with the lateral (430±18 and 390±19, respectively), but only the right lateral part was less sensitive as compared to the left one. The EIH (kPa/cm<sup>2</sup>) was maximal for the lateral part of right GS (150.2±17.39) and was more pronounced in comparison with unloaded limb (right BB: 63.5±15.8). The EIH correlated ( $p<0.05$ ) to ankle muscle strength (plantar flexion, 117.8±8.7 NM;  $r=0.77$ ) and knee muscle strength (flexion, 121.3±6.7 NM,  $r=0.69$ ; extension, 239.5±11.8 NM,  $r=0.54$ ). **Discussion** The differences in PPT's between lateral and medial part of GS found in the present study, correspond to suggestions (Polianskis et al., 2001) for different nociceptor density in functionally diverse locations of a muscle. The EIH is not localized to the exercising body part. Central pain inhibitory mechanisms probably mediate the EIH (Koltyn, 2000; Drury et al., 2004; Pencheva and Petrova, 2005), but the greatest decrease in PPT occurs in the exercising limb. The correlation between the EIH with isokinetic muscle strength found in this study suggests that the endogenous modulation of pain perception following exercise improves muscle strength. **References** Drury DG, Stuempfle K, Shannon R, Miller J (2004). JEPonline, 7(4), 1-5. Koltyn KF (2000). Sports Med, 29(2), 85-98. Pencheva N, Grancharska K, Nikolova E, Kotcev Ch (2008). SRJSWU, 1(1), 57-61. Polianskis R, Graven-Nielsen Th, Arendt-Nielsen L (2001). Eur J Pain, 5, 267-277. **Acknowledgements.** The study was supported by Grant "DOO2-54/08" of NS Fund.

#### GREATER PERIPHERAL FORCE PRODUCTION ABILITIES AND NOT GREATER CENTRAL DRIVE EXPLAIN SUPERIOR CYCLE TIME TRIAL PERFORMANCE

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*UNIVERSITY OF WORCESTER*

**Introduction** Compensatory neuromuscular activity has been demonstrated to occur in response to impaired muscular force production during fatiguing exercise (Bundle et al 2006). However, to our knowledge no study has compared neuromuscular activity during self paced exercise tasks of differing levels of performance. This study therefore compares power output and neuromuscular activity during the fastest and slowest of two 20km cycle time trials. **Methods** One female and six male well trained participants ( $31 \pm 11$  years) who were currently active in competitive road cycling performed two 20km time trials using their own bicycles mounted on the Kingcycle ergometer rig. Instantaneous power output and surface iEMG measured from the vastus lateralis, biceps femoris, and tibialis anterior over a 10s period were recorded at 0.5km intervals. iEMG data was subsequently normalised against MVC for each muscle group. Mean power and iEMG data were calculated for each 5km segment of the fastest and slowest trials performed, and a Two Way ANOVA for repeated measures was used to assess differences between trials. **Results** Three participants achieved their fastest time in the first trial performed, and four in the second. Mean time to complete fastest and slowest trials was  $1796 \pm 154$ s and  $1872 \pm 208$ s respectively. Power output was significantly higher ( $P<0.01$ ) in every individual 5km segment of the fastest overall trials, whilst iEMG activity was greater ( $P<0.05$ ) in every individual segment of the slowest overall trials. **Discussion** The similar shape of the power profiles during fastest and slowest trials suggest a high degree of regulation of pacing and that differences in performance were not the result of premature onset of fatigue during the slowest trials. However, the greater neuromuscular activity in conjunction with the lower muscular power output indicates that peripheral force production abilities were somehow compromised during the slower trials. Although the exact nature of this impairment is unknown, the results of this study indicate that differences in performance between two self paced time trials result from variation in peripheral physiological status and not from variation in central motor drive. **References** Bundle, M.W., Ernst, C.L., Bellizzi, M.J., Wright, S., Weyand, P.G. (2006). American Journal of Physiology – Regulatory, Integrative and Comparative Physiology, 291(5), 1457-1464.

#### LARGER BILATERAL FORCE DEFICIT IN PROXIMAL THAN DISTAL JOINTS MIGHT BE LINKED TO DIFFERENCES IN INTER-HEMISPHERIC COMMUNICATION

AUNE, T.K., AUNE, M.A., ETTEMA, G., VEREIJEN, B.

*NORD TRONDELAG UNIVERSITY COLLEGE*

**Introduction** The term bilateral force deficit (BFD) is used to describe that maximal muscle force is lower during simultaneous contraction of muscles bilaterally compared to the sum of forces generated unilaterally. The physiological explanations of BFD are mainly based on theory of neural inhibition, and there is mounting evidence for a higher order of inhibition related to the interaction of the primary motor cortex (M1) of the two hemispheres when performing concurrently bilateral contractions. These interhemispheric inhibitory interactions might decrease neural drive to the activated muscles. Based on the morphological and functional differences between proximal and distal joints the purpose of this study was to explore eventually differences in BFD in proximal and distal joints in the upper extremities/arms. **Method** Ten volunteer male ( $n=5$ ) and female ( $n=5$ ) sport science students participated in the experiment. The subjects underwent two days of testing. The subjects were tested in two unilateral conditions and the bilateral condition in constrained single-joint maximal voluntary contraction (MVC) in isometric flexion of the shoulder and index finger. **Results** The results showed a significant BFD for

shoulder flexion (20.51%), while there was a relatively small and non significant BFD for index finger flexion (5.22%). Discussion These results indicate that the commissural fibers in corpus callosum preserving interhemispheric communication have an inhibitory effect for proximal muscles, while distal muscles are less inhibited. The significant difference in BFD between proximal and distal muscles might be explained by the high number of commissural fibers connecting the motor cortex areas for proximal joints compared to distal joints. It is concluded that the commissural fibers in corpus callosum preserving interhemispheric communication in general might have an inhibiting effect on bimanual motor tasks. References Brodal, P. (2004). The central nervous system: structure and function. Oxford: Oxford University Press Daffertshofer, A., Peper, C.E. & Beek, P.J. (2005). Stabilization of bimanual coordination due to active inter-hemispheric inhibition: A dynamical account. *Biological Cybernetics*. 92: 101-109. Khodiguian, N., Cornwell, A., Lares, E., DiCaprio, P.A., & Hawkins, S.A. (2003). Expression of the bilateral deficit during reflexively evoked contractions. *Journal of Applied Physiology*. 94: 171-178. Kuruganti, U. & Seaman, K. (2006). The bilateral strength deficit is present in old, young, and adolescent females during isokinetic knee extension and flexion. *European Journal of Applied Physiology*. 94: 322-326.

## 10:15 - 11:45

### Invited symposia

#### IS-BN03 Musculoskeletal Modelling for Assessing Loading and Risk of Injury

##### THE ROLE OF MUSCLE FORCES IN JOINT LOADING AND INTRA-ARTICULAR LOAD DISTRIBUTION: EXPERIMENTAL RESULTS AND IMPACT ON MODELLING

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In human movement studies it is common to calculate the net joint moments of the proximal joint of a body segment using an inverse dynamic approach. More detailed models distribute the net moments and net forces acting on a given joint to muscle forces, bone-to-bone forces and ligament forces. Such models use a number of assumptions e.g. the muscle moment arm, muscles' line of action, take additional information into account (e.g. muscle activation) and quite often use static optimization with a more or less randomly chosen cost function to solve the mathematically underdetermined problem. Finite element models can probably estimate the intra-articular stress and stress distribution but such models are strongly depend on information on the material properties of the elements and the force applied to the joint through muscle forces, inertial forces, axial and shear forces. Direct pressure distribution measurements have been applied in ex-vivo studies to joints of the human leg and especially to the talocrural joint, the patello-femoral joint and the tibio-femoral joint. Potthast et al. (2008) showed in a systematic approach using a pneumatic loading simulator on fresh frozen cadaveric legs the strong effect of the application of muscle forces to the talocrural joint. The muscle forces and their distribution have been shown to build the dominant determinants of intra-articular joint and biological tissue loading. The data demonstrated extreme individual results. Recent data demonstrated the role the muscles play in the tibio-femoral joint. The study used a pneumatically driven knee simulator in an ex-vivo experiment and allowed an inside view into changes in intra-articular loading patterns related to joint alignment (varus, valgus) and muscle forces of thigh and shank. Depending on the muscle forces applied the centre of intra-articular pressure moved up to 12 mm in medio-lateral and 5 mm in anterior-posterior directions. The effect of different quadriceps loading patterns on the patello-femoral contact pressure during simulated weight bearing knee flexion was recently reported by Wünschel et al. (2011). The impact of more medial or lateral applied quadriceps loading to the pressure distribution between patella and trochlea and especially the centre of contact pressure was clearly demonstrated. The ex-vivo data explore the dominant role the muscle forces play for intra-articular joint loading and therefore joint tissue loading. A more detailed inspection of the results allows a significant inside view into the variability of intra-articular loading patterns in different subjects and the high individuality of results. These finding should have a major impact on modelling especially if individualized estimates of intra-articular or tissue loading are the purpose of research. References: Potthast, W., Lersch, C., Segesser, B., Koebke, J., Brüggemann, G.-P. (2008). *Clin. Biomech.* 23, 632-639. Wünschel, M., Leichte, U., Obloh, C., Wülker, N., Müller, O. (2011). *Knee Surg. Traumatol Arthrosc.* DOI 10.1007/s00167-010-1359-y.

##### KNEE MODELLING AND IN-VIVO CHANGES WITH CONTRACTION: IMPLICATIONS FOR ESTIMATING JOINT FORCES AND LOADING

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Human movement is the result of muscle moments (muscle force x moment arm) applied around the joint axes of rotation. Since the muscle and tendon operate in series, the mechanical properties of tendons and any changes in moment arms will affect muscle length, velocity and, therefore, force output and the muscle moment applied to the joint. In addition to muscle length and force changes during dynamic activities, moment arms and lines of action of muscles and tendons also change with contraction (Tsaopoulos et al., 2007a). Although moment arms cannot be easily predicted from anthropometric characteristics in adults (Tsaopoulos et al., 2007b; O'Brien et al. 2009) and there are significant differences in the estimates of moment arm length when using different joint rotation centre definitions, in the knee for example (Tsaopoulos et al., 2009), it is well recognized that contraction-specific parameters are required for the realistic estimation of muscle and joint forces in musculoskeletal modelling and simulation applications. We have recently calculated tibiofemoral knee joint forces during dynamic isokinetic concentric knee extension and the differences between resting-state and contracting-state measurements of moments arms and lines of tendon action lead to overestimated compressive and shear forces when using the resting-state parameters throughout the joint range of motion. The overestimation of the maximum compressive force when using resting-state mechanical parameter values was ~418 N (5.8%) or ~0.6 times body weight (BW) with a shift of the average maximum force joint position from 45 to 30 deg of knee flexion. The maximum shear force was overestimated by ~1120 N (158%) or 1.6 BW when using resting-state parameters. Inflated tibiofemoral forces would over-estimate loading of the knee joint and risk of injury during dynamic activities involving knee extension. This review of our work on muscle-tendon and joint function shows that there are important in-vivo interactions, which have significant implications for performance, measurement of dynamic strength, and estimation of loading in the musculoskeletal system using modern modelling and simulation techniques. References Tsaopoulos D, Baltzopoulos V, Richards P, Maganaris C. (2007a).

J Biomech, 40, 3325-3332. Tsaopoulos D, Maganaris C, Baltzopoulos V. (2007b). J Biomech, 40, 645-651. O'Brien T, Reeves N, Baltzopoulos V, Jones D, Maganaris C. (2009). J Anat, 215, 198-205. Tsaopoulos D, Baltzopoulos V, Richards P, Maganaris C. (2009). Eur J App Phys, 105, 809-814.

## RELATIVE INFLUENCE OF REALISTIC SEGMENTAL MOTION AND JOINT MODELLING ON

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RELATIVE INFLUENCE OF REALISTIC SEGMENTAL MOTION AND JOINT MODELLING ON LOWER LIMB LOADING DURING RUNNING AND SPRINTING Lake, M. John Moores University, Liverpool, U.K. Background The contribution of segmental accelerations to joint kinetic calculations during locomotion has often been underestimated and there are several data collection issues to address before utilising the inverse dynamics technique to determine joint kinetics for movements that have some high frequency characteristics. We have previously explored non-invasive methods to adequately track and then capture lower limb segmental movement transients (Digby et al., 2005) and more recently have examined their influence on joint kinetic calculations (e.g. Smith and Lake, 2007). This review summarises some of the important methodological factors to consider when attempting to record joint motion and loading during running and sprinting. Realistic lower limb motion transients and joint axis modelling Information regarding the typical frequency content of segmental motions during running and sprinting is limited in the literature, but there are indications from bone pin studies that tibial motion has frequencies up to 30-40 Hz. By maintaining those frequencies in the data we have been successful in matching our non-invasive estimates of movement transients to similar measures using bone pins. There is a dual consideration for the measurement of the transients non-invasively: 1) that the marker or accelerometry mounting system on the skin is likely to track fast underlying bone motion; 2) that the transient motion is captured adequately using appropriate sampling rates and filter cut-off frequencies. Using those precautions we have measured peak movement transients that are more than double those previously documented (e.g. peak internal rotation velocity of the tibia). The modelling of lower limb joint axes and the accuracy of moment arm lengths typically has a larger influence on joint kinetic calculations than accurate segmental accelerations. However, we have found that for some joints during sprinting the movement transients can have a similar and opposite influence on joint moments and powers to those observed when manipulating joint axis definitions. Conclusion Few studies have attempted to justify their non-invasive approaches to measure fast lower limb movements during running and, in some cases, it is likely that there may be a substantial underestimation of movement transients. A more realistic consideration of both movement transients and joint axes are required before interpreting joint kinetic data during the stance phase of running and sprinting. References Digby, C., Lake M., Lees A. (2005) Ergonomics 48, 1623-1637. Smith, G. and Lake, M. (2007) Journal Sports Sci, 25, S73-74.

## MODELLING INDIVIDUAL-SPECIFIC NEUROMUSCULAR AND MORPHOLOGIC CONTRIBUTIONS TO KNEE INJURY: MOVING BEYOND HOMOGENEOUS PREVENTION

MCLEAN, S.

UNIVERSITY OF MICHIGAN

In spite of knee joint and particularly ACL injury mechanisms increasingly viewed as multi-factorial, few injury prevention efforts extend beyond an isolated neuromuscular focus. This limited approach has stemmed primarily from the fact that neuromuscular factors can be readily modified through common training principles. Being largely viewed as non-modifiable, knee joint morphologies have typically been ignored within the prevention model. With such factors directly impacting knee joint mechanics and resultant ACL loading, however, we contend that their neglect drastically compromises prevention success. A precise understanding of the integrative contributions of individual-specific neuromuscular and morphologic factors to knee joint injury risk thus seems critical. The inherent complexities associated with assessing combined neuromuscular and morphologic contributions to knee injury render in vivo experimental-based methods virtually impossible. Our own work has been driven by the notion that the application of innovative modeling techniques may circumvent this issue. We have previously utilized valid subject-specific model landing simulations to examine the effects of realistic neuromuscular perturbations on 3D knee loading (McLean et al., 2003). With these models, we have identified high-risk individual-specific landing neuromechanical profiles (McLean et al., 2004) and subsequently elucidated explicit training adaptations that may act to reduce this risk (McLean et al., 2009). The finite element (FE) modeling method is a powerful and versatile modeling tool capable of reproducing highly complex joint tissue geometries and the mechanical behavior of constituent materials at discrete points throughout a system. With this in mind, we have developed finite element modeling techniques that reliably simulate knee joint and resultant ACL load states during high-impact landings as a function of explicit specimen specific morphologies (e.g., posterior tibial slope angle and ACL laxity) (McLean et al., 2010). We now initiate innovative surrogate modeling methods that couple forward dynamic and structurally relevant FE models to successfully predict the knee joint and ligamentous response. Through these novel efforts, we aim to establish a non-invasive clinical risk screening tool that targets and ultimately counters knee injuries based on individual-specific neuromechanical and joint factors. We agree developing models of this type represents a substantial and perhaps currently insurmountable computational challenge. The potential for reducing catastrophic knee injuries and their long-term sequelae, however, suggests such efforts are both warranted and vital. References 1. McLean SG, Su, A, van den Bogert, AJ. (2003). J Biomech Eng, 125, 864-74. 2. McLean SG, Huang, X, Su, A, Van Den Bogert, AJ. (2004). Clin Biomech, 19, 828-38. 3. McLean SG, Huang, X, van den Bogert, AJ. (2008) Clin Biomech, 23, 926-36. 4. McLean SG, Oh, Y, Ashton-Miller JA, Wojtyls, EW. (2011) J Bone Jt Surg Am, In press

## Oral presentations

### OP-PM30 Stress, Damage, Inflammation 3

#### DIFFERENT CHANGES IN OXIDATIVE STRESS AND NO BIODISPONIBILITY DURING 24 HOURS IN HYPOBARIC VS NORMOBARIC HYPOXIA

FAISS, R.1,2, JAGDEEP, S.2, PIALOUX, V.3, SARTORI, C.4, FAES, C.3, PRAZ, M.2, DÉRIAZ, O.2, MILLET, G.P.1

1: ISSUL, FBM (LAUSANNE, SWITZERLAND), 2: IRR (SION, SWITZERLAND), 3: CRIS (LYON 1, FRANCE), 4: CHUV (LAUSANNE, SWITZERLAND)

**Introduction** Slight differences in physiological responses at rest have been reported between hypobaric hypoxia (HH) and normobaric hypoxia (NH) during short exposure (4). It has been also suggested that hypobaria per se might influence the nitric oxide (NO) regulation (1) and that NO influences the physiological differences between HH and NH (2). In addition, oxidative stress is known to decrease the NO bioavailability in the vasculature (5). To date, comparison of HH vs NH physiological responses during moderate exercise, NO end-products and oxidative stress markers over a long period (24 h) was not reported yet. **Methods** Ten male subjects were randomly exposed for 24 h to actual (HH) or simulated (NH) high-altitude (3000m). Pre- and every 8h, plasma levels of oxidative stress (i.e. MDA, AOPP), antioxidant power (FRAP) and peroxynitrite activity (nitrotyrosine), exhaled NO [exNO] and blood nitrate and nitrite [NOx] were measured at rest and oxygen arterial saturation (SpO<sub>2</sub>), heart rate (HR) and gas exchanges during a 6-min cycling exercise at 50% of peak power output. Results exNO decreased ( $p < 0.05$ ) in HH (-10%, -35% and -21% after 1h, 16h and 24h) but remained stable in NH. Similarly, NOx decreased over 24h in HH (-36%,  $p < 0.05$ ) but was stable in NH. In opposition, AOPP increased more ( $p < 0.05$ ) in HH (+120%, +116% and +260% after 1h, 16h and 24h) than in NH (+13%, +23% and +88%). The other oxidative stress markers did not change either in HH or in NH. During exercise, minute ventilation and tidal volume were lower in HH compared to NH after 8h and 16h ( $p < 0.05$ ). SpO<sub>2</sub>, HR, oxygen consumption, breathing frequency, end tidal O<sub>2</sub> pressure and heart rate showed similar adaptations in HH and NH. **Discussion** This study reports the time course of adaptations in oxidative stress and physiological responses to moderate exercise throughout a 24h period in HH compared to NH. The exercise-induced increase in ventilation was lesser in HH than NH and was associated with a decrease in NO biodisponibility in HH as already observed (1). Furthermore, the concomitant increase in AOPP in HH suggests that oxidative stress might inhibit NO as it was previously demonstrated (3). However it remains unclear if the decreased NO bioavailability and the increased oxidative stress are involved in the lower ventilatory adaptations to hypoxia observed in HH. **References** Hemmingsson T, Linnarsson D (2009) *Respir Physiol Neurobiol* 169:74-77. Kayser B (2009) *Respir Physiol Neurobiol* 169:338-339. Pialoux V et al. (2009) *Hypertension* 54:1014-1020. Savourey G et al. (2003) *Eur J Appl Physiol* 89:122-126 Thomas SR et al. (2008) *Antioxid Redox Signal* 10:1713-1765.

#### ASTAXANTHIN SUPPLEMENTATION PREVENTS MUSCLE AND OXIDATIVE DAMAGE INDUCED BY TRAINING IN ELITE YOUNG SOCCER PLAYERS

BARALIC, I.1, DJORDJEVIC, B.1, KOTUR-STEVULJEVIC, J.2, STEFANOVIC, A.2, IVANISEVIC, J.2, DIKIC, N.3, RADIVOJEVIC, N.3, ANDJELKOVIC, M.3, VUJIC, S.3

1:INSTITUTE FOR BROMATOLOGY,FACULTY OF PHARMACY,BELGRADE,2:INSTITUTE FOR MEDICALBIOCHEMISTRY,FACULTY OF PHARMACY,BELGRADE,3:SPORTS MEDICINE ASSOCIATION OF SERBIA(OUTPATIENT CLINIC VITAMAXIMA),BELGRADE

**Introduction** Intensive physical activity is closely related to the production of free radicals, which play an important role as mediators of skeletal muscle damage. This study examined the effects of Astaxanthin (Asx) supplementation on oxidative and enzymatic exercise stress markers in elite young soccer players. Evaluations were made after 90 days of regular training activity and supplementation. **Methods** 32 male soccer players (age  $17.72 \pm 0.76$  years) participated in this study. Subjects were randomly assigned in a double-blind fashion to astaxanthin (Asx) and placebo (P) group. Asx group was supplemented with 4 mg of Asx. Blood was obtained before and after 2 hours training, at the end of observational period. The biomarkers of oxidative stress taken in consideration were total antioxidative status (TAS), superoxide-dismutase (SOD), superoxide anion (O<sub>2</sub><sup>-</sup>) and advanced oxidation protein products (AOPP). Serum activity of creatine-kinase (CK), lactate-dehydrogenase (LDH) and aspartate-aminotransferase (AST) were also measured. Results TAS decreased after the training in both groups, but this change reached statistical significance only in P group ( $p < 0.01$ ), which indicates that Asx supplementation could support antioxidant defense mechanism. A trend for increased serum SOD was observed in both groups following training, with higher SOD activity in Asx group compared to P group. As a result of training, AOPP and O<sub>2</sub><sup>-</sup> concentrations increased in P group, while there was a decrease in these parameters in Asx group. These changes did not reach statistical significance. Post-exercise elevations above resting values was observed for CK and AST in the P group ( $p < 0.01$ ), while remained practically unchanged in Asx group. We observed significant increase in LDH activity in both groups after the training ( $p < 0.01$  for both groups). **Discussion** Antioxidant activity of Asx can have potential benefits in protection of non-enzymatic (TAS) defense mechanism from free radical production. Asx supplementation may help in neutralizing O<sub>2</sub><sup>-</sup> and reducing protein oxidation during exercise. Asx reduced post-training increment of CK and AST, which may suggest that the muscular damage was reduced. Based on our findings, supplementation with astaxanthin might be beneficial strategy in improving sport recovery and performance. Tsakiris S, Parthimos T, Tsakiris T, Parthimos N, Schulps K. (2006). *Clin Chem Lab Med*, 44(8), 1004-1008. Finaud J, Lac G, Filaire E. (2006). *Sports Med*, 36(4), 327-358.

#### LEAD ACETATE, AND OXIDANT/ANTIOXIDANT, INFLAMMATORY AND NEUROTHROPHIC-MARKERS: NEURO AND CARDIO-PROTECTIVE EFFECTS OF EXERCISE TRAINING AND CURCUMIN

HOSSEINZADEH, M., DABIDI-ROSHAN, V., HOSEINZADEH, S., JOLAZADEH, T., MAHJOB, S.

UNI. OF MAZANDARAN

**Introduction** Lead is one of the most important metals that pollute the natural environment due to man's impact. The toxicity of many heavy metals is due to their ability to cause oxidative damage to tissues. Health effects of exposure to air pollution have been indicated by previous studies (Bharat et al. 2009, Boris et al. 2008, Chuang et al. 2007). We investigated the neuro and cardio-protective effects of exercise training and/or curcumin on lead acetate induced damage in rats homogenized tissues. **Methods** Forty rats were randomly divided into 5 groups: (1) lead acetate (Pb), (2) curcumin+Pb, (3) endurance training+Pb, (4) training+curcumin+Pb, (5) sham-operated groups. The rats in the 3 and 4 groups experienced the treadmill running of 15 to 22 m/min for 25 to 64 minutes, 5 times a week for 8 weeks. The 1 to 4 groups received lead acetate (20 mg/kg), the sham-operated group received curcumin solvent (ethyl oleat), and the 2



and 4 groups received curcumin solution (30 mg/kg) intraperitoneally, 3 times a week for 8 weeks. Results The two-way ANOVA analyses indicated, Lead administration resulted in significant increases in Metallothionein-3 (MT-III), high-sensitive C-reactive protein (hs-CRP), creatine kinase-MB (CK-MB), malondialdehyde (MDA), and low-density lipoprotein (LDL), but significantly decreased brain-derived neurotrophic factor (BDNF), glutathione peroxidase (GPx), Total Antioxidant Capacity (TAC), and high-density lipoprotein (HDL) levels. However, treadmill running and/or curcumin supplementation resulted in a significant decrease in hs-CRP, CK-MB, MDA, and LDL levels and significantly increased BDNF, GPx, TAC, and HDL levels. Moreover, there was an inhibitory effect of training+curcumin on chronically lead acetate administration in the hippocampus MT-III levels, as compared to other groups. Discussion The present study demonstrates the restorative potential of curcumin and exercise training by reversing lead-induced oxidative damage in brain and heart. Treatment by curcumin and exercise training restored these damages and tended to normalize biomarkers, suggesting a reversal of lead-induced toxicity, and confirming the free radical scavenging property of curcumin (Bharat et al. 2009). This result provides a rationale for an inhibitory role of herbaceous antioxidant supplementation and aerobic regular exercise in the attenuation of lead-induced neuro and cardiotoxicity. References Bharat B.A, Kuzhuvelil B.H. (2009): Potential therapeutic effects of curcumin, the anti-inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases, *Int J Biochem Cell Biol* 41, 40–59 Boris Z, Simkhovich M, Robert A.K. (2008): Air pollution and cardiovascular injury: Epidemiology, Toxicology, and Mechanisms: *J. Am. Coll. Cardiol.* 52; 719-726 Chuang K-J, Chan C-C, Su T-C, Lee C-T, Tang C-S. (2007): the effect of urban air pollution on inflammation, oxidative stress, coagulation, and autonomic dysfunction in young adults. *Am J Respir Crit Care Med* 370-376

## EFFECTS OF ASTAXANTHIN SUPPLEMENTATION ON SPORTS PERFORMANCE IN YOUNG ELITE SOCCER PLAYERS

RADIOJEVIC, N.1, DIKIC, N.1, BARALIC, I.2, DJORDJEVIC, B.2, ANDJELKOVIC, M.1, VUJIC, S.1, TOTIC, S.3

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Introduction Oxidative stress is a condition in which the delicate balance existing between pro-oxidant (free radicals) production and antioxidant defense system is changed in favor of free radical expression. Astaxanthin (Asx), a red carotenoid pigment, is a biological antioxidant that occurs naturally in a wide variety of living organisms. The aim of this study was to determine the effects of Asx supplementation on sports performance in young elite soccer players. Methods Sixty healthy young (age 17.7±0.7) soccer players have participated in this double blind placebo controlled study during three months. The intervention group received 4 mg Asx capsules daily. We monitored ergospirometry parameters (VO<sub>2</sub>max, RQ, VE, HRmax, HRrecovery, time to exhaustion, maximal speed). Also, we have analyzed blood biochemical (ALT, AST, CK, LDH, Iron, Ferritin, Cho, HDL, LDL, Tg, Gly, Tp, TBIL, urea, creatinine) and hematological (WBC, RBC, PLT, Hgb, Hct, MCV) parameters before and after training session. Before starting the dietary supplementation, baseline values for each of the subjects were obtained. All tests were repeated after 90 days of supplementation. Results Any significant changes in ergospirometry parameters between groups were not observed among the values before and after 90 days of administration period. In Asx group, however, there were significant improvement in maximal speed (18/18.5 km/h) and time to exhaustion (9.7/10 min) before and after 90 days of supplementation period (p<0.05). Significant elevation of CK level registered in P group after training session 90 days after supplementation (p<0.05), was not observed in Asx group. There were no significant effects of Asx supplementation on the biochemical and hematological parameters between groups. Discussion The present study suggests that Astaxanthin may stabilize muscle cells membranes and reduce muscular fatigue. Based on our findings, supplementation of Astaxanthin could improve endurance that may lead to better sports performance. Further studies need to evaluate mechanisms behind the increased endurance. References Malmsten C.L, Lignell A. (2008). Carotenoid Science, Vol. 13. Sawaki K et al. Sports performance benefits from taking natural astaxanthin characterized by visual acuity and muscle fatigue improvements in humans. *Journal of Clinical Therapeutics & Medicines* 2002; 18 (9): 1085-1100.

## REDOX STATUS REGULATION OF INTRACELLULAR SIGNALING PATHWAYS FOLLOWING EXERCISE-INDUCED MUSCLE DAMAGE

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Introduction Exercise-induced muscle damage (EIMD) generates reactive oxygen species (ROS) thereby inducing oxidative stress in skeletal muscle which in turn elevates muscle's antioxidant defense systems (Margonis et al., 2007). Although several oxidative-stress-sensitive signal transduction pathways, such as those of NF-κB, MAPK, and Akt/mTOR, have been shown to activate gene expression of numerous enzymes and proteins that are essential for cellular redox homeostasis, there is limited information regarding the effects of redox status on the regulation of these pathways following EIMD (Ji, 2008). Therefore, the aim of this study was to determine the responses of redox-sensitive pathways in human skeletal muscle during the inflammatory and healing phases associated with EIMD. Methods Ten healthy men received either placebo or N-acetylcysteine (NAC, 20 mg/kg/d) following a strenuous eccentric exercise protocol (20 sets, 15 repetitions/set) on an isokinetic dynamometer in a counterbalanced, double-blind design. In each trial, blood was collected and muscle strength was measured at baseline, immediately post-exercise as well as 2h post-exercise and daily for the next 8 days. In each trial, muscle biopsies from vastus lateralis were collected at baseline, 2h post-exercise as well as 2 and 8 days within recovery. Results Eccentric exercise induced marked muscle damage (determined microscopically and biochemically), muscle soreness (increased DOMS), intense inflammatory response (increased creatine kinase, CRP, cytokines, adhesion molecules), performance deterioration (at 60 and 180 o/sec), and an upregulation of AKT, mTOR, p70S6K, rpS6, and NF-κB phosphorylation for 3 days within recovery. Inflammation subsided, performance improved and muscle healing was evident 8 days post-exercise. NAC administration attenuated muscle damage, inflammatory response and strength losses within 2 days post-exercise but resulted in lower satellite cell activation and strength gains 8 days within recovery compared to placebo. NAC ingestion resulted in an attenuation of AKT, mTOR, p70S6K, rpS6, and NF-κB phosphorylation 8d post-exercise. Discussion The results of the present study suggest that redox status regulation may be essential for muscle's adaptive response during the inflammatory and healing phases associated with EIMD as previously shown (Aoi et al., 2004). It appears that although antioxidant supplementation may limit muscle damage and inflammation, it may also hamper muscle's regenerative capability. References Aoi, W., Naito, Y., Takanami, Y., Kawai, Y., Sakuma, K., Ichikawa, H., Yoshida, N., Yoshikawa, T. (2004). *Free Radic Biol Med*, 37, 480–487. Ji LL. (2007). *Exp Gerontol*, 42, 582–593. Margonis K, et al. (2007). *Free Radic Biol Med*, 43, 901-910.

## THE COMBINED INTAKE OF ALPHA -KETOGLUTARIC ACID AND 5-HYDROXYMETHYLFURFURAL DOES NOT PREVENT THE HYPOXIA ASSOCIATED PERFORMANCE DECREMENT

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UNIVERSITY INNSBRUCK

**Introduction** Hypoxia is known to decrease aerobic exercise performance. The main cause is the reduced oxygen availability at altitude (1) but also the oxidative stress induced by hypoxia has been suggested to decrease performance (2). Accordingly, Subudhi et al. found improved power output at the ventilatory threshold during acute exercise in hypoxia when the oxidative stress was reduced by antioxidant (AO) supplementation (3). It could be speculated that also the combined intake of alpha -ketoglutaric acid (alpha-KG) and 5-hydroxymethylfurfural (5-HMF) which was shown to reduce oxidative stress and to increase VO<sub>2</sub>max and Wattmax in patients admitted for lung resection (4) could prevent the hypoxia associated performance decrement. **Methods** 12 healthy, regularly active men performed two incremental cycle ergometer tests to exhaustion (the first under normoxia and the second under hypoxia at a simulated altitude of 4300m). Maximal oxygen uptake (VO<sub>2</sub>max), maximal power output (Wattmax), the power output at the ventilatory threshold (VT) (first systematic increase of the VE/VO<sub>2</sub>) and the lactate threshold (LT) (4mmol/L) were determined. The VO<sub>2</sub>max values of the test in normoxia were used to randomly assign participants to either a placebo group (PG, n=6) or an alpha-KG and 5-HMF supplementation (SG, n=6) group in a double-blind fashion. **Results** Compared to normoxia a significant reduced VO<sub>2</sub>max (PG -12.0±3.6, SG -10.6±3.1 ml/min/kg), Wattmax (PG -50.7±16.9, SG -61.0±26.3 W) and power output at the VT (PG -57.3±38.6, SG -62.8±33.0 W) and LT (PG -45.0±18.4, SG -35.0±27.9 W) was found under hypoxia in both groups (p<0.05). No differences were found for these decrements between groups. **Discussion** Although we used a comparable "dose" of AO as Subudhi et al. did, the present results do not support their outcomes. Subudhi et al. found a reduction in the hypoxia associated performance decrement (power output at VT) after AO ingestion (3). An explanation may be that in the present investigation the AO supplementation did not increase the antioxidative capacity of the subjects. Supplementation in the present investigation started only 48h before the hypoxia test, whereas Subudhi et al. supplemented for 3 weeks (3). The present results indicate that short term ingestion of AO before going to high altitude has no effect on the hypoxia associated performance decrement. **References** (1) Burtcher et al. (2006). *Int J Sports Med* 27:629-35 (2) Askew EW (2002). *Toxicology* 180:107-119 (3) Subudhi AW et al. (2006). *Med Sci Sports Exerc* 38:1425-1431 (4) Matzi V et al. (2007). *Eur J Cardiothorac Surg* 32(5): 776-782 Supported by the ÖSV

## Oral presentations

### OP-PM39 Balance

## THE IMPACT OF OBESITY ON DEVELOPMENTAL COORDINATION DISORDERS IN ADOLESCENCE

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**Introduction:** Developmental Coordination Disorders (DCD) as well as overweight and obesity are of increasing importance in the study of human growth as both indications are associated with a number of comorbidities and increasing prevalence rates. This study sought to determine the impact of obesity on DCD in adolescence. Therefore, we assumed: (i) there is an impact of obesity on DCD in adolescence as we expect obese adolescents to show a higher DCD-risk in comparison to normal-weight adolescents; (ii) the impact of obesity on DCD is task specific as we expect the higher DCD-risk of obese adolescents in comparison to normal-weight adolescents to be more pronounced in gross than in fine motor tasks; (iii) the impact of obesity on gross motor DCD is gender-specific as we expect the higher risk of obese adolescents for gross motor DCD in comparison to their normal-weight peers to be more pronounced in male than in female adolescents. **Methods:** At the beginning of a stationary rehabilitation, 43 boys and 36 girls aged 11 to 16 years (mean: 14.02; SD: 1.29) were assessed with the Movement Assessment Battery for Children 2. The results were compared with 92 normal-weight controls. Logistic regressions were used to test hypotheses. **Results:** Results made it clear that (i) obese adolescents do have a 8.73 (CI(95%) 2.46-30.95) higher DCD-risk in comparison to their normal-weight peers; (ii) the impact of obesity on DCD is more pronounced in gross than in fine motor tasks as obese adolescents show a 4.77 (CI(95%) 1.69-13.51) higher gross motor DCD-risk whereas the increased risk of fine motor DCD is 3.68 (CI(95%) 1.47-9.21); (iii) the impact of obesity on gross-motor DCD is only significant in boys (OR: 15.82; CI(95%) 1.94-128.82). **Conclusion:** Our results suggest that obesity could be a detrimental factor in the consolidation of gross motor DCD especially in boys. However, due to the cross-sectional design of the study, final empirical evidence is still lacking. **References:** Wagner, M., Kastner, J., Petermann, F., Jekauc, D., Worth, A. & BöS, K. (in prep.). The impact of obesity on Developmental Coordination Disorders in adolescence.

## EFFECTS OF TRAINING ON BALANCE PERFORMANCE UNDER DT-CONDITIONS

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**Introduction** Most daily activities require the management of sensori-motor tasks while simultaneously processing external information: for example, holding a conversation while opening a container or crossing a street while observing traffic flow (dual-task performance). A review has shown, that older adults perform more poorly than younger adults when simultaneously engaged in cognitive and sensori-motor tasks (Wollacott & Shumway-Cook, 2002). In daily life situations this is associated with reduced balance performance and an increased fall risk. This systematic review investigated if older adults benefit from training interventions in dual-task (DT) situations. Training effects were analysed with regard to the training programme and task conditions (e.g. standing, walking, complexity of secondary cognitive task). **Methods** Literature was systematically searched via OVIDsp (Medline, EMBASE, PsycINFO). DT studies were included by the following criteria: (1) investigation of at least one motor task, (2) assessment of DT performance outcomes, (3) conduction of an intervention, and (4) investigation of older adults in an experimental-control group designs or an old-young comparisons. Results Eleven studies met all inclusion criteria. Studies differed in sample size, training duration, investigated motor and cognitive tasks. Four types of interventions were identified: (1) general single task (ST) motor training, (2) specific ST motor training, (3) general DT training, and (4) task-related (specific) DT training. Nearly all types of training improved motor performance under DT- conditions for standing and walking tasks. The secondary tasks differed in complexity and examined cognitive functions e.g. processing speed, controlled or visuospatial processes and executive functions (following Colcombe & Kramer, 2003). A Meta- Analysis of the training effects could not be processed because of the

differences in methodological quality. Most benefits seem to be reached by a specific DT training in comparison to a general ST training. Conclusions Motor and cognitive DT performance can be improved by performance related exercises. To reach beneficial effects, the training intervention should include a certain level of exercise load such as rising difficulties, appropriate intensity and duration, a certain level of task specificity, and variable task prioritisation. To provide transfer into everyday situations we suppose that the intervention needs to build up rather general task managing strategies. Future research should focus on transfer of training effects into everyday situations and dose-response-relationships. References Colcombe SJ & Kramer AF. Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychol Sci* 2003,14(2):125-130. Woollacott M & Shumway-Cook A. Attention and the control of posture and gait: a review of an emerging area of research. *Gait and Posture* 2002,16:1-14.

## **FATIGUE INDUCED CHANGES IN STATIC AND DYNAMIC POSTURAL CONTROL IN ATHLETES WITH PREVIOUS ANKLE INJURY**

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**Introduction:** Neuromuscular impairments, such as proprioceptive deficits and decreased balance performance (static and dynamic postural control) have been demonstrated following ankle injury (Wikstrom et al., 2009). This may contribute to an increased re-injury risk in team athletes after return to competition. Although most (re)injuries occur in the last minutes of a game (Hawkins & Fuller, 1999), little is known about fatigue-induced changes of sensorimotor control in athletes who suffered from an ankle sprain in the past. The aim of this study was to investigate bilateral, fatigue-induced alterations of static and dynamic balance in athletes with a history of ankle injury. **Methods:** 31 athletes, 15 with a previous ankle sprain (9 males, 6 females, age:  $22.67 \pm 2.72$  years, height:  $176.27 \pm 8.88$  cm, mass:  $70.93 \pm 8.10$  kg) and 16 healthy control subjects (11 males, 5 females, age:  $25.88 \pm 2.66$  years, height:  $176.13 \pm 8.65$  cm, mass:  $69.38 \pm 10.17$  kg) were tested in two experimental sessions: (1) Center of pressure sway velocity (vCOP) in single-leg-stance, 'time to stabilisation' (TTS) after a unilateral jump-landing task and (2) mean reach distance in the 'star excursion balance test' (SEBT) were assessed for both legs before and immediately after a fatiguing treadmill exercise (TRF). To compare fatigue induced performance of injured with non-injured legs a two factorial linear mixed model was specified for each of the main outcomes. 'Fatigue' and 'injury' were included as fixed factors nested in the random individual's factor. **Results:** In non-fatigued condition, athletes with a history of ankle injury showed significant impairments in vCOP and SEBT ( $p < 0.05$ ) whereas TTS was similar between both groups. Significant fatigue effects were found in both legs of injured and non-injured athletes for SEBT, vCOP and TTS ( $p < 0.05$ ). There was a significant fatigue-by-injury interaction for TTS ( $p < 0.001$ ). Post hoc analysis revealed a significantly greater increase of TTS in athletes with a history of ankle injuries. **Discussion:** Both groups showed significant changes in static and dynamic postural control following a fatiguing running exercise. In the jump stabilizing task, fatigue-effects were most prominent on the injured leg. To our knowledge, this is the first study showing that dynamic postural control of subjects with a history of ankle injury is more affected by fatigue compared to healthy athletes. Further studies with larger sample size are needed to confirm these results. **References:** Wikstrom EA, Naik S, Lodha N, Cauraugh JH (2009). *Med Sci Sports Exerc.* 41(6), 1287-1295. Hawkins RD, Fuller CW (1999). *Br J Sports Med* 1999, 33(3), 196-203.

## **EFFECTS OF A PROPRIOCEPTIVE TRAINING PROGRAM WITH CROSSOVER ON BALANCE CONTROL IN POSTMENOPAUSAL SUBJECTS**

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**Introduction** Ageing is associated with a progressive loss of balance control and an increased risk of falling. This is a relevant problem especially in postmenopausal osteoporotic women due to the major risk of fractures. Physical training has been indicated to attenuate the natural decay of postural control. However, most of the machines used for training are designed for enhancing muscle force, but not specifically for increasing proprioceptive function and balance control. In this study, balance control was examined by using a new machine "CROSSOVER Technogym" (CO), with which body balance is continuously challenged by working out in multilateral planes as skating movement. **Methods** To evidence the effects of CO on balance, we recruited two groups (10 subjects each) of postmenopausal voluntary healthy women (aged 55-69) assigned to train with a stationary bike (SB) and CO, respectively. Test sessions were performed 7 days and 1 day before training onset, as well as 5 and 12 weeks after training onset. Balance was assessed as center of foot pressure velocity (CFPv) in stance tests with eyes open (EO) and closed (EC). Explosive force was also evaluated as jump height in standardized squat jumps. Heart rate (HR) and mechanical power during the training sessions were recorded. ANOVA and post-hoc analysis were performed for statistical significance. **Results** Both CFPv in EC and "Romberg quotients" (RQ) between EC and EO CFPv were significantly reduced in CO subjects, while this was not observed in SB subjects. The effect lasted several weeks after the end of training. In CO group CFPv decreased from  $1.67 \pm 0.39$  cm/sec to  $1.46 \pm 0.22$  cm/sec in EC condition, and RQ from  $1.22 \pm 0.14$  to  $1.06 \pm 0.1$ . Conversely no differences between the groups were observed concerning explosive power enhancement and HR reduction. **Discussion** The reduction of CFPv and RQ clearly indicates an improvement of balance in the elder subjects who underwent the CO training program. This was not observed in the group trained with stationary bike, although the effects on force and heart rate were similar in SB and CO groups. Therefore, we suggest that CO training specifically improves balance, possibly increasing the efficacy of the motor control through the enhancement of the proprioceptive input.

## **THE EFFECT OF FUNCTIONAL CIRCUIT TRAINING ON FUNCTION, SELF-REPORTED BALANCE AND HEALTH STATUS**

GINÉ-GARRIGA, M., GUERRA, M., MARTIN-BORRÀS, C., UNNITHAN, V.B.

FPCEE BLANQUERNA. UNIVERSITAT RAMON LLULL

**INTRODUCTION.** The concept of frailty has long been associated with advancing age but only recently has it been specifically defined as a medical syndrome. Physical frailty has been regarded as a precursor state to disability and dependence on others for daily activities. Frail individuals are considered to be the group of patients that presents the most complex and challenging problems to health care professionals. The purpose of this study was to evaluate whether a 12-week functional circuit training program (FCT) could reduce functional decline, and improve self-reported balance and health status in a group of physically frail community-dwelling older individuals. **METHODS.** Fifty-one individuals, 83.98 (2.89) years old, were considered frail and tested at week 0 and randomly assigned into two groups (intervention group, IG = 26, control group, CG = 25); forty-one were assessed at week 12 (IG = 22, CG = 19). IG underwent a structured 12-week FCT program, which focused on a combination of functional balance and lower body strength-based exercises. Measures of

function (Barthel Index), and self-reported balance (Activities-specific Balance Confidence scale) and health status (SF-12) were assessed at week 0 and 12. An ANCOVA was performed and week 12 measures were covaried for week 0 measures. RESULTS. Function measures in IG participants showed significant ( $p<0.05$ ) improvements relative to those in the CG. The mean score (SD) in Barthel index assessment of participants in the IG and CG groups were 78.23 (.88) and 69.15 (.95), respectively in week 12 measures. Significant ( $p<0.05$ ) improvements were also demonstrated for the other outcome measures. The mean units (SD) in physical function assessed with the SF-12 questionnaire in the IG and CG groups were 40.86 (1.05) and 31.59 (1.13), respectively in week 12 measures ( $p=0.001$ ). DISCUSSION. In summary, our findings indicate that our intervention improves function, and self-reported balance and health status, leading to a reduction in functional limitations.

### PROMOTING BALANCE AND STRENGTH IN THE MIDDLE-AGED WORKFORCE

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**Introduction** The prevalence of sustaining fall-related injuries is high in the middle-aged workforce (Kemmlert and Lundholm, 2001). Deficits in postural control (i.e., increased postural sway, reduced gait velocity) and muscle strength (i.e., decreased strength and especially power) represent important fall-risk factors (Onambele et al., 2006). The objective of this study was to examine the impact of balance and strength training conducted at the worksite followed by detraining on measures of postural control and muscle strength/power in the middle-aged workforce. **Methods** Thirty-two adults (9 females, 23 males) with sedentary office work participated in this study and were assigned to an intervention ( $n=17$ , age:  $56\pm 4$  years, mass:  $75\pm 8$  kg, height:  $174\pm 9$  cm) or a control group ( $n=15$ , age:  $56\pm 3$  years, mass:  $82\pm 12$  kg, height:  $175\pm 8$  cm). The intervention group participated in 8 weeks of progressive balance and strength training conducted at the worksite (three times per day for 8 minutes each, 5 days per week), followed by 8 weeks of detraining. Pre, post, and follow-up testings included the measurement of (a) total centre of pressure (CoP) displacements during one-legged standing on a balance platform, (b) gait velocity during a 12-m-walk at preferred speed, (c) peak isometric/isokinetic torque and rate of torque development (RTD) of the plantar flexors on an isokinetic device, and (d) counter-movement jumping height on a force platform. **Results** A 2 (group: intervention, control)  $\times$  3 (test: pre, post, follow-up) analysis of variance with repeated measures on test revealed significant improvements in CoP displacements ( $p<0.01$ , +11% from pre to post testing), gait velocity ( $p<0.05$ , +3%), peak isometric ( $p<0.05$ , +19%) and isokinetic ( $p<0.05$ , +17%) torque, RTD ( $p<0.01$ , +37%), and jumping height ( $p<0.05$ , +4%). During detraining, balance variables further improved (+4-7% from post to follow-up testing), whereas strength variables deteriorated (-4-24%). **Discussion** Results of the study illustrate that a short-term balance and strength training conducted at the worksite on a daily basis represents a feasible and safe training modality that produced marked improvements in variables of static and dynamic balance as well as maximal and explosive strength in the middle-aged workforce. Given that the training regimen was able to counter important intrinsic fall-risk factors (i.e., deficits in postural control and strength), it seems plausible to argue that this worksite training program could have a fall-preventive effect. **References** Kemmlert K, Lundholm L. (2001). *Appl Ergon*, 32(2), 149-53 Onambele GL, Narici MV, Maganaris CN. (2006). *J Appl Physiol*, 100(6), 2048-2056

## Oral presentations

### OP-PM45 Muscle Activity 2

#### DYNAMIC MUSCLE CONTRACTIONS INDUCED BY HIGH FREQUENCY STIMULATION ARE INFLUENCED BY K<sup>+</sup> AND LACTIC ACID IN ISOLATED RAT SOLEUS MUSCLES

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**Introduction** During intense activation muscles may receive input of very high frequency from the nervous system (Christie & Kamen, 2006). The ability of the muscles to react functionally to these high frequencies is crucial for the rate of force development (RFD) and for maximal power (Pmax) development. Under intense activation muscle excitability and contractility may also be influenced by increased extracellular K<sup>+</sup> ([K<sup>+</sup>]<sub>o</sub>) and accumulation of lactic acid (LA). Here we investigated the influence of [K<sup>+</sup>]<sub>o</sub> and LA on the RFD and Pmax in muscles stimulated at high frequency. **Methods** Soleus muscles isolated from 4 wk old Wistar rats were incubated in standard K.R. buffer at 30°C initially containing 4 mM K<sup>+</sup> and equilibrated with 95% O<sub>2</sub>/5% CO<sub>2</sub> (pH 7.4). For measurement of power muscles were mounted on a force/length controlled dynamometer (305B, Aurora inc., Canada) at Lo. Muscles were stimulated every 10 min with 0.5-1.5 sec pulse trains at 60 Hz or 300 Hz to obtain tetanic activation. Contraction velocities were recorded at a number of different force levels from 5-90% of isometric force. Force-velocity curves were constructed by fitting to the Hill equation and Pmax was calculated. For measurements of isometric tetanic force and RFD muscles were mounted isometrically and stimulated as described above, RFD was defined as the force developed during the first 30 ms of contraction. During the experiments [K<sup>+</sup>]<sub>o</sub> was increased from 4 to 8 mM and subsequently 10 mM LA was added. N was 8-10 in all experiments. **Results** Tetanic force was equal at 300 and 60 Hz ( $42\pm 2$  vs  $43\pm 2$  g,  $p>0.05$ ). However both Pmax and RFD were larger at 300 Hz than at 60 Hz ( $231\pm 19$  vs  $189\pm 15$  g $\times$ mm/s and  $16.0\pm 0.4$  vs  $10.1\pm 0.7$  g/30 ms, respectively (both  $p<0.05$ ). At 60 Hz, incubation at 8 mM K<sup>+</sup> significantly reduced force and Pmax by 11 and 13 % respectively, whereas RFD was increased by 15 %. Subsequent addition of 10 mM LA at 8 mM K<sup>+</sup> had no significant effect on any of the contractile parameters. At 300 Hz, however, incubation at 8 mM K<sup>+</sup> led to larger reductions in force, Pmax and RFD (31, 32 and 26 % respectively), and significant recoveries of 16, 7 and 19 %, respectively, were seen when 10 mM LA was added. **Discussion** The results illustrate that optimal dynamic muscle function is achieved at higher stimulation frequencies than those needed to achieve maximal isometric force. Furthermore, the depressing effects of K<sup>+</sup> and protective effects of LA on force, power and RFD are more pronounced at high frequencies indicating that regulation of muscle excitability is very important for muscle function during high frequency input. **References** Christie A & Kamen G. (2006). *J. Neurophysiol*, 95, 2787-2795.

## COMPARISON BETWEEN ALTERNATING AND PULSED CURRENT ELECTRICAL MUSCLE STIMULATION FOR ACUTE PHYSIOLOGICAL RESPONSES

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KING SAUD UNIVERSITY

**Introduction** Several types of electrical muscle stimulation (EMS) are used in rehabilitation and sport training, and one of the factors to determine the types is waveform. The most commonly used EMS waveforms are alternating current (AC) and pulsed current (PC). Some studies showed that alternating current EMS induced more muscle fatigue than pulsed current (1,2). However, physiological differences between AC and PC EMS are not necessarily clear. This study compared AC and PC EMS for torque output, muscle oxygenation, skin temperature, blood lactate, hormonal responses, and skeletal muscle damage markers. **Methods** Twelve healthy men (23-48 y) received AC EMS (2.5 kHz delivered at 75 Hz, 400  $\mu$ s) for the knee extensors of one leg and PC EMS (75 Hz, 400  $\mu$ s) for the other leg to induce 40 isometric contractions (on-off ratio 5-15 s) at the knee joint angle of 100° (0°: full extension) separated by 2 weeks in a randomised, counterbalanced order. The current amplitude was consistently increased to maximally tolerable level, and the torque and perceived intensity were recorded. Changes in tissue oxygenation index ( $\Delta$ TOI) and total hemoglobin volume of vastus lateralis and medialis muscles were assessed by a near-infrared spectroscopy. Skin temperature (Tsk) of the stimulated knee extensors were measured before, during and for 30 min after EMS. Blood lactate, growth hormone, testosterone, insulin-like growth factor 1, testosterone, and cortisol were measured before, during, immediately after, and 15, 30, 45 and 60 min after EMS. Maximal voluntary isometric contraction torque, muscle soreness with a 100-mm visual analogue scale and plasma creatine kinase activity were measured before and 1, 24, 48, 72 and 96 h after EMS. Changes in these variables were compared between AC and PC by a two-way repeated measures ANOVA. **Results** No significant differences between AC and PC were evident for changes in the peak torque induced during EMS, but the torque during each isometric contraction was less stable for AC than PC. The changes in Tsk, lactate, hormones, muscle damage markers were not significantly different between AC and PC. The decreases in  $\Delta$ TOI amplitude during contraction phases were significantly ( $P < 0.05$ ) greater for PC than AC. **Discussion** These results suggest that the acute effects of AC and PC EMS on the stimulated muscle and systemic responses are similar; however, muscle oxygenation was more affected in AC, which was likely due to greater muscle fatigue in the AC compared with the PC. **References** 1. Laufer Y, Elboim M (2008) *Phys Ther*, 88: 1167-76 2. Laufer et al. (2001) *Phys Ther* 81: 1307-1

## BICEPS BRACHII MUSCLE OXYGEN DEMAND DURING ELECTRICALLY EVOKED AND VOLUNTARY SUSTAINED ISOMETRIC CONTRACTIONS

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**Introduction** We have shown that decreases in biceps brachii (BB) oxygenation (measured by near-infrared spectroscopy, NIRS), during intermittent (1s contraction/1s rest) isometric contractions (ISO) of the elbow flexors induced by electrical muscle stimulation (EMS) were greater to those during voluntary contractions (VOL) when both were performed at the same force level, but similar when both were performed at the respective maximal intensity (I). Considering that sustained ISO (e.g., 10s) is more metabolically demanding than intermittent 1s contractions, this study compared changes in BB oxygenation and total haemoglobin volume (tHb) during and after a 10s sustained ISO of the elbow flexors evoked by EMS generating 30% of maximal voluntary ISO (MVC) and VOL at the same torque level (30%MVC) as well as MVC level. **Methods** Eight healthy men (23-33 y) undertook EMS and VOL with the same arm on an isokinetic dynamometer with an elbow joint angle of 90°. The BB and brachioradialis muscles were stimulated via surface electrodes at 30 Hz to induce a 10s ISO targeting 30% of pre-determined MVC. After a 100s rest, the subjects performed a 10s VOL ISO at the same torque level as that of EMS followed 90s later by a 10s MVC. Torque and changes in BB oxygenation (tissue oxygenation index, TOI) and tHb (measured by Hamamatsu NIRO-200) during and after each contraction were compared between EMS and VOL. **Results** When EMS was compared to VOL at the same torque level, decreases in TOI and tHb from baseline were greater ( $P < 0.05$ ) and recovery of TOI to baseline was slower ( $P < 0.05$ ) for EMS than VOL. However, when EMS was compared with VOL at MVC level, changes in TOI and tHb parameters during and after the contraction were similar, despite the 65% lower torque for EMS than VOL. **Discussion** At the same torque level, the greater TOI and tHb changes in EMS than VOL suggest that BB O<sub>2</sub> demand in the investigated muscle volume was greater for EMS than VOL; this was likely due to lower activation of muscle fibres during submaximal VOL. The similar TOI and tHb changes between EMS and VOL at MVC level indicate that the BB O<sub>2</sub> demand was similar between the two conditions. Thus, it seems likely that muscle fibres at least under the NIRS probe were similarly activated during EMS and VOL at MVC, despite the spatially fixed and temporally synchronous activation manner in EMS (2). The difference in the torque output between EMS and VOL at MVC seems to be due to the greater involvement of all elbow flexor and stabilizer muscles to force production in VOL than EMS. **References** 1. Muthalib M, et al. *Eur J Appl Physiol* 107:235-41, 2009 2. Gregory C, Bickel C. *Phys Ther* 85:358-64, 2005

## EFFECTS OF DYNAMIC ELECTROMYOSTIMULATION OF THE LEG MUSCLE CHAIN ON ISOMETRIC AND ISOINERTIAL STRENGTH PARAMETERS AND SPRINT PERFORMANCE

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**Introduction:** Linear and nonlinear sprints are basic abilities in many sports. Electromyostimulation (EMS) is known as a potential training method on strength and power. Although two studies reveal an improvement of sprint performance by static EMS (Billot et al. 2010; Brocherie et al. 2005), there are no data for possible effects of dynamic EMS training. This method seems advantageous because it integrates neuromuscular coordination comparable to motor tasks. The aim of this study was to investigate the effects of EMS supported dynamic training forms on strength, power and sprint performance. **Methods:** 14 strength trained subjects ( $21.3 \pm 2.6$  yrs;  $178.0 \pm 9.9$  cm;  $70.5 \pm 10.6$  kg) were randomized in an EMS (EMS-G) and a free weight group (FW-G). The training period lasted 4 weeks (2x/week). Squats and lunges were the exercises for both groups (3 sets, 10 rep., 1 min rest). The computer given speed (DigiMax) for a single repetition was 2s con, 1s iso and 2s ecc at a range of motion of 90-170°. The difference between the groups was given in the application of an additional weight (10-repetition maximum) in contrast to EMS (individually 70% intensity; impulse: frequency 85Hz, width 350 $\mu$ s, type bipolar/rectangle; duty cycle 6/4) during the exercises. The EMS surface electrodes (miha bodytec) were placed around the muscle belly of the calves, thighs and at the buttocks. The pre- and post-test were conducted before and after the training period. The re-test followed 2 weeks of regeneration. The strength diagnostics were carried out with a Leg-Extension, a Leg-Curl and a Leg-Press (gym80; 3 isometric

and 6 isoinertial tests with 40% and 60% additional load). Sprint abilities were tested by a 30m sprint (standing + flying start) and a t-run measured by light barriers (Sportronic). Results: Sign. increases of maximal isometric force ( $F_{max}$ ) and isoinertial power ( $P_{max}$ ) for both training groups were shown at Leg-Press:  $F_{max}$  improved by 30% for the FW-G and by 22% for the EMS-G (re-test).  $P_{max}$  with 60% additional load increased for both groups in the post-test (12% FW-G; 12% EMS-G) and in the re-test (17% FW-G; 11% EMS-G) ( $p < 0.05$ ). The 10m sprint time decreased significantly for the EMS-G (-3%) during the 30m sprint (standing start). No sign. results were given for the FW-G. Both groups showed a significantly higher performance for the t-run (15% FW-G; 18% EMS-G). There were no sign. differences between the groups ( $p < 0.05$ ). Conclusion: Dynamic EMS as well as free weight training both enhance strength and power of the leg muscle chain and sprint performance. There are no specific effects between the groups. Thus dynamic EMS (individually 70% intensity) offers comparable effects without using additional loads in technically challenging exercises such as the squat. Brocherie et al. (2005). *Med Sci Sports Exerc*, 37, 455-460. Billot et al. (2010). *J Strength Cond Res*, 24, 1407-1413.

## NEUROMUSCULAR ADAPTATIONS INDUCED BY CONSTANT AND VARIABLE FREQUENCY STIMULATION

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Rapid fatigue development is one of the major limitations of Electrical Stimulation (ES) clinical applications. Research has been focused on identifying the ES protocol that would minimise this rapid fatigue onset. Constant and variable frequency trains (CFTs, VFTs) have been compared in terms of fatigue entailment. Results are equivocal, since some authors report greater muscle fatigue following VFTs (Binder-Macleod and Russ, 1999) while others demonstrate no differences (Thomas et al, 2003) or even decreased muscle fatigue compared with CFTs (Bickel et al, 2003). No study has been focused on the nature of the fatigue developed under these two stimulation paradigms. The aim of the present study was to compare the fatigue developed by these two patterns of stimulation both quantitatively and qualitatively. Ten healthy males received the two ES regimes, which were randomly assigned to the lower limbs. ES was applied over the triceps surae and protocols consisted of 450 trains (167ms on/500ms off, 30Hz) at an intensity evoking 30% of Maximal Voluntary Contraction (MVC). A doublet (100Hz) was used in the beginning of each train for the VFTs protocol. Torque and electromyographic activity of the soleus muscle were continuously recorded. Neuromuscular tests were performed before and immediately after each ES protocol. Changes in muscle characteristics (excitability and contractile properties) were evaluated by analysis of the muscle compound action potential (Mwave) and associated twitch torque (PI), while the RMS/M was used to assess neural drive to the exercising muscle. All parameters were obtained during rest, maximal and submaximal (30% MVC) contractions. MVC significantly decreased after the two protocols ( $P < 0.05$ ), giving evidence of similar neuromuscular fatigue development. M-wave (at rest and superimposed to maximal and submaximal contractions) significantly decreased after both ES protocols ( $P < 0.01$ ), demonstrating alterations in muscle excitability, while the associated mechanical response showed no significant changes. The twitch mechanical response elicited at the intensity evoking 30% MVC significantly decreased after both protocols ( $P < 0.001$ ), giving evidence of altered contractile properties of the motor units solicited during the ES protocols. RMS/M values obtained at submaximal contraction tended to increase compared to pre values ( $P = 0.08$ ), suggesting enhanced neural drive to the exercising muscle. The two ES patterns gave rise to equivalent neuromuscular fatigue development. This fatigue was the result of adaptations taking place at a peripheral level while neural command was increased to cope with the peripheral alterations of the muscle capacity to generate force. The present results do not give evidence of an advantage of one ES pattern over the other in terms of neuromuscular fatigue development. Bickel et al. *Phys Ther* 2003; 83: 366-73 Binder-Macleod and Russ. *J Appl Physiol* 1999; 86; 1337-46 Thomas CK et al. *J Neurophysiol* 2003; 89: 2055-64

## THE PHYSIOLOGICAL EFFECTS OF LOW-INTENSITY NEUROMUSCULAR ELECTRICAL STIMULATION ON SHORT-TERM RECOVERY FROM SUPRA-MAXIMAL EXERCISE BOUTS IN TRI-ATHLETES.

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The physiological effects of low-intensity neuromuscular electrical stimulation (NMES) on short-term recovery from supra-maximal exercise bouts in tri-athletes. 1Malone JK, 1Coughlan GF, 1Crowe L, 2Gissane GC, 1Caulfield B. 1Stim XDP Research Group, Institute for Sport & Health, University College Dublin, Dublin 4, Ireland. 2St Mary's University College, Strawberry Hill, Twickenham, Middlesex, England. Introduction Inadequate recovery from high-intensity exercise bouts can limit sporting performance [1]. Previous research using various recovery intervention protocols have generally found positive results compared to passive recovery [2,3]. A recent study showed that NMES during recovery lowered blood lactate (Bla) compared to passive recovery [4]. The aim of this study was to determine the acute effects of NMES on Bla and performance parameters in trained male tri-athletes. Methods On three separate days, 13 trained male tri-athletes ( $31 \pm 5$  yrs;  $182.8 \pm 6.9$  cm;  $78.1 \pm 8.4$  kg) performed six 30 sec Wingate tests (30WanT) on a cycle ergometer. Each session consisted of 3 x 30WanT (bouts 1-3) interspersed by 4 min recovery (80 Watts @ 80 rev.min<sup>-1</sup>), followed by a randomly assigned 30 min recovery intervention of either: i) passive (seated), ii) active (cycling @ 30% V02max) or iii) NMES (1 Hz / 500  $\mu$ s - ON:OFF 2:6 s). The 3 x 30WanT bouts were then repeated (bouts 4-6) and compared to bouts 1-3 for peak power (PP), mean power (MP) and fatigue index (FI). Bla and heart rate (HR) were recorded at designated time points throughout. Data were analysed using repeated measures ANOVA with Tukey's HSD post hoc test. Results Bla decreased significantly faster during the active recovery intervention compared to both the NMES and passive interventions ( $P < 0.05$ ). There were no significant differences between interventions for PP ( $P = 0.710$ ), MP ( $P = 0.928$ ) and FI ( $P = 0.814$ ) when the post intervention bouts (4-6) were compared to the pre intervention bouts (1-3). Discussion NMES during recovery was not more effective than active, or surprisingly, passive recovery for improving subsequent performance. Despite Bla clearing at a significantly faster rate for the active recovery intervention, PP, MP or FI did not improve significantly compared to NMES and passive. This supports the belief that lactate is not a major cause of muscle fatigue [1]. In conclusion, NMES does not appear to be more effective than traditional methods for enhancing recovery. References 1. Williams C & Ratel S, (2009). *Human Muscle Fatigue*. Routledge. 2. Gill ND et al., (2006). Effectiveness of post match recovery strategies in rugby players. *Br J Sports Med*, 42, 260-263. 3. Lane KN & Wenger HA. (2004). Effect of selected recovery conditions on performance of repeated bouts of intermittent cycling separated by 24 hours. *J Stren Cond Res*, 18, 855-860. 4. Neric FB et al., (2009). Comparison of swim recovery and muscle stimulation on lactate removal after swimming. *J Stren Cond Res*, 23, 2560-2567.

## Oral presentations

### OP-PM23 Cardiovascular: Heart Rate Dynamics

#### HEART RATE AND PERCEIVED EXERTION RESPONSES TO THREE TYPES OF LOW-VOLUME, HIGH-INTENSITY EXERCISE: PILOT DATA FROM PROJECT FFAB

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HEART RATE AND PERCEIVED EXERTION RESPONSES TO THREE TYPES OF LOW-VOLUME, HIGH-INTENSITY EXERCISE: PILOT DATA FROM PROJECT FFAB (FUN FAST ACTIVITY BLASTS) Taylor, K. L. 1, Azevedo, L.1, Bock, S. 2, Batterham, A. M. 1. 1Teesside University (Middlesbrough, UK). 2Durham University, UK. Introduction Project FFAB (Fun Fast Activity Blasts) is a controlled before and after study of the effects of low-volume, high-intensity exercise on a variety of health outcomes in adolescents (13-15 yrs). Notwithstanding the substantial benefits reported, the exercise modes utilised in recent work (e.g., stationary cycling and running; Burgomaster et al., 2005 and Tjønnå et al., 2009) might not form engaging and sustainable interventions in an adolescent population. A preliminary in-depth qualitative study within Project FFAB indicated a preference for exercise challenges related to boxing, dance, and soccer. The aim of this pilot study was to assess heart rate and perceived exertion responses to three prototype prescriptions of low-volume high-intensity exercise based on these activities. Methods Participants (24 females, 13.6 ± 0.5 years; mean ± SD) took part in three sessions (one boxing-based, one dance-based, and one soccer-related) and were encouraged to perform 45 s of maximal effort exercise followed by 90 s rest. This was repeated four times per session. Heart rate (HR) was measured using Polar RS400 monitors and the Polar Team2 system (Polar Electro, Kempele, Finland). Participants recorded their overall rating of perceived exertion (RPE) using a pictorial OMNI scale (Robertson, 2004). Results The participants' average maximum HR values were 200 ± 19bpm, 200 ± 16 bpm and 200 ± 11 bpm (mean ± SD) for boxing-, dance-, and soccer-related activities, respectively. These equate to ~96% of the participants' age-predicted maximum heart rate. The overall RPE average was 5.4 ± 1.8. Discussion The observed maximum HR values and % maximum heart rate confirm that each exercise challenge was high-intensity. It is plausible that if such activities were to be integrated within an intervention, health benefits might accrue similar to those reported in previous work (e.g., Whyte et al., 2010; Tjønnå et al., 2009). The average RPE value of 5.4 indicates the participants described the sessions as between "somewhat easy" and "somewhat hard". This was unexpected and, given the high maximum HR values, warrants further investigation. The findings from this pilot work inform the design of a 10-week school-based high-intensity training intervention for adolescents in Project FFAB. References Burgomaster K, Hughes S, Heigenhauser G, Bradwell S, & Gibala M (2005). J Appl Physiol, 98, 1985-1990. Robertson RJ (2004). Perceived Exertion for Practitioners: Rating Effort with the OMNI picture system. Champaign, Illinois: Human Kinetics. Tjønnå AE, Stølen TO, Bye A, et al. (2009). Clin Sci, 116, 317-326. Whyte LJ, Gill JM, & Cathcart AJ (2010). Metabolism, 59, 1421-1428.

#### EFFECTS OF CARDIOLOCOMOTOR INTERACTIONS ON THE SPECTRUM OF HEART RATE VARIABILITY DURING RUNNING

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EFFECTS OF CARDIOLOCOMOTOR INTERACTIONS ON THE SPECTRUM OF HEART RATE VARIABILITY DURING RUNNING Di Michele, R.1, Merni, F.1 1: Department of Histology, Embryology, and Applied Biology, University of Bologna (Italy) Introduction During cycling and running, the locomotor rhythm can modulate the heart rate (HR), although the characteristics of cardiocomotor coupling are different in the two exercise modes (Nomura et al., 2003). Furthermore, it was recently demonstrated that in cycling the interactions between the locomotor and heart rhythms result in a new heart rate variability (HRV) spectral component corresponding to pedalling frequency (Blain et al., 2009). This study aimed to analyse the spectrum of the RR signal collected during an incremental running test, in order to individuate the frequency and magnitude of spectral components originating from cardiocomotor interactions. Methods On a grass field, nineteen male soccer players performed an exhaustive running test, with speed starting at 8.5 km/h and increasing by 0.5 km/h every minute. During the test, self-selected stride rate (SR) and RR periods were measured. A Short-time Fourier transform was applied to the RR series to estimate the power spectra. Results In all the subjects, the analysis of time-varying spectra allowed to detect two spectral frequency components related to SR. The first component (F1) was at a frequency of one half the SR (1.2 to 1.6 Hz), whereas the frequency of the second component (F2) equalled the absolute value of the SR-HR difference (0 to 0.8 Hz). At 80, 90, and 100% of maximum HR, the magnitude of F1 was 19.2 ± 10.2, 17.8 ± 9.3, and 15.0 ± 8.2 % of total high-frequency power (HF, >0.15 Hz). At the same intensities, F2 represented 19.6 ± 13.4, 16.6 ± 9.5, and 13.2 ± 7.4 % of HF. Discussion The presence of F1 confirmed what observed in cycling (Blain et al., 2009), i.e. a spectral component corresponding to the main locomotor rhythm that represents a significant portion of HF power and appears even when the cardiac and locomotor rates are not synchronous. The mechanism underlying F1 is probably the modulation of venous return by limb muscles contraction. The main finding of this study is however the appearance of the F2 component. F2 could have links with the relationship between the instantaneous RR variation and the phase of the cardiac cycle in which the vastus lateralis contraction occurs (Nomura et al., 2006). Finally, the presence of F2 in the same frequency ranges of the low frequency and the respiratory components could lead to overestimate the spectral power relative to those components, requiring caution when interpreting the frequency analysis of HRV collected during running. References Blain G, Meste O, Blain A, Bermon S (2009). Am J Physiol Heart Circ Physiol, 296(5), H1651-H1659. Nomura K, Takei Y, Yanagida Y (2003). Eur J Appl Physiol, 89,221-229. Nomura K, Takei Y, Yoshida M, Yanagida Y (2006). Eur J Appl Physiol, 97, 240-247.

#### ADAPTING WORKLOAD IMPROVES THE USE OF HEART RATE RECOVERY AS A MONITORING TOOL

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Introduction Heart rate after a standardized exercise test varies with a change in training status (Borresen and Lambert, 2007; Buchheit et al., 2008; Lamberts et al., 2009) possibly compromising the accuracy of measuring changes in heart rate recovery (HRR). Therefore the aim of this study was to determine if a change in exercise intensity would result in a change in HRR and its associated typical error of measurement. The practical aim of this study was to determine the range of exercise intensity following which HRR is relatively stable and can therefore be used as an accurate monitoring tool Methods Thirty-one subjects were recruited for this study and asked to perform four

submaximal running tests (HIMS). Based on the heart rate after the first HIMS, and with the aim to achieve heart rates in between 85-90% of heart rate maximum (HRmax), subjects were allocated to either group SAME (85-90% of HRmax (n=9)) - completing four identical HIMS (starting speed 7.2 km•h<sup>-1</sup>), group FASTER (< 85% HRmax (n=10)) completing two standard and two faster HIMS (starting speed 8.6 km•h<sup>-1</sup>) or to group SLOWER (> 90% HRmax (n=12)) completing two standard and two slower HIMS (starting speed 6.0 km•h<sup>-1</sup>) on alternating days. Results Adapting the HIMS resulted in the HRmax of SLOWER at the end of the HIMS decreasing from 94% HRmax to 89% HRmax (p = 0.000136), while HRmax increased from 82% HRmax to 88% HRmax in the FASTER group (p = 0.000136). There were no changes in absolute HRR at the end of the HIMS in either of these groups. However, improved coefficient of variation (CV) and lower typical errors of measurement (TEM) were found in both the SLOWER and FASTER group (SLOWER: CV 11 ± 7 to 5 ± 3% (p = 0.025), TEM 6 to 3 beats; FASTER: CV 11 ± 7 to 4 ± 3% (p = 0.048), TEM 7 to 3 beats) when the HIMS protocol was adapted. Discussion This study shows that although no changes in absolute HRR occurred with a change in exercise intensity, the capacity to detect meaningful changes improved significantly when the exercise intensity of the HIMS protocol was adapted. The highest sensitivity to detect meaningful changes on a day-to-day basis occurred at exercise intensities ranging from 86 to 93% of HRmax. To ensure the highest level of sensitivity in detecting meaningful changes in HRR, submaximal testing protocol should be adapted when ≤ 85% or ≥ 94% of HRmax is reached. References Borresen J, Lambert MI. (2007). Sports Med. 28, 633-646. Buchheit M, Millet GP, Parisy A, Pourchez S, Laursen PB, Ahmaidi S. (2008). Med. Sci Sports Exerc. 40, 362-371. Lamberts RP, Lambert MI. (2009). J. Strength. Cond. Res. 23, 1005-1010. Lamberts RP, Swart J, Noakes TD, Lambert MI. (2009). Eur. J Appl. Physiol 105, 705-713.

## IS THE ESTIMATING MAXIMUM HEART RATE EQUATION VALID TO PRESCRIBE EXERCISE SPORT TRAINING IN CHILDREN AND YOUTH?

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IS THE ESTIMATING MAXIMUM HEART RATE EQUATION VALID TO PRESCRIBE EXERCISE SPORT TRAINING IN CHILDREN AND YOUTH? Colantonio, E.I, Lima, J.R.P.2, Kiss, M.A.P.D.M.3 1: Universidade Federal de São Paulo (São Paulo, Brazil), 2: Universidade Federal de Juiz de Fora (Juiz de Fora, Brazil), 3: Universidade de São Paulo (São Paulo, Brazil) Introduction Estimation of HRmax has been largely based on formula HRmax= 220-age (Eq n°1). This equation is used in textbooks without citation of original research, even so formula and related concepts are included in Sports Medicine examinations, Exercise Physiology, and Fitness. Therefore, the aim of this study was to compare the HRmax predicted by formula and HRmax measured during exercise test, performed to exhaustion, in a large range of age group, according to gender and training level. Methods Sample was composed by 145 subjects (74 female and 69 male), ranging from 7 to 17 yr, divided into pupils (non-trained) and swimmers (trained). VO2peak values were obtained by VO2000 – Medgraphics® gas analysis system, Inbrasport® ATL treadmill using an incremental adapted Bruce protocol. Rest and exercise HR was monitored by the Ergo PC 13 Micromed® electrocardiograph. HRmax was also estimated by formula Eq n° 1. Data were analysed with general linear model. Results Mean and standard deviation of difference between predicted HRmax and measured HRmax, according to gender and training level were: female non trained 23.85 ± 13.61; female trained 25.76 ± 13.87; male non trained 27.94 ± 15.80; male trained 24.06 ± 15.23; total non trained 26.23 ± 14.95; total trained 24.90 ± 14.49 bpm. Linear normal model agreement results were: age: p=0.001, coefficient (-1.76), confidence interval [-2.54 ; -0.98]; gender: p=0.969, coefficient (-), confidence interval [-], training level: p=0.342, coefficient (-), confidence interval [-]; gender and training level interaction: p=0.454, coefficient (-), confidence interval [-], respectively. Discussion Both gender cross-sectional (Tanaka et al, 2001) or longitudinal data (Gellish et al, 2007) provide statistical evidence that the commonly accepted prediction of HRmax by Eq n°1 is biased for adults; HRmax is overestimated, both gender, under 40 yr and underestimated HRmax for those older 40 yr. In present study difference between HRmax predicted and HRmax measured decreased 1.76 units by year, in total 7-17 yr age-group. Conclusion It can be concluded that prediction of HRmax based on Eq n°1 overestimated measured HRmax during a lab maximal incremental test in children and youths. In addition, the gender and training level were not related with the HRmax, independently if HRmax was predicted or measured. Thus, the HRmax=220-age is not recommended for exercise training prescription, in special for children and youths. References Gellish RL., et al. (2007) Med Sci Sports Exerc, 39:822-9. Tanaka H., et al. (2001) J Am Coll Cardiol, 37:153-6.

## DOES HEART RATE FEEDBACK INFLUENCE RATINGS OF PERCEIVED EFFORT AND PERFORMANCE TIME DURING COMPETITIVE CYCLING?

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Introduction It has been shown that for cycling time trials lasting longer than 10 minutes, an even pacing strategy is fastest. This is despite the fact that even experienced cyclists start at a high work rate and then taper off despite similar, or even increased, perceived effort. Further, many athletes use heart rate monitors to gauge their pace even though their use has been questioned. Thus, the aim of this study was to establish whether constant heart rate feedback would result in an altered pacing strategy during cycling TT performance. Methods Seven trained cyclists were required to complete two 40 km Time Trials. During each of these, heart rate was continuously measured although with one condition, heart rate feedback (HRF) was provided while during the other condition, no heart rate feedback (NHRF) was given. Cycling speed, 'central' and 'local' perceived effort were measured at 10 km intervals. Results Although cyclists maintained the same average speed during both conditions (mean of 44 km/h), they were initially more cautious during the HRF condition with pace remaining relatively constant during the first 30 km. In contrast, during the NHRF condition speed gradually increased in the first 10 km and then stabilised until the 30 km mark. After 30 km, in both conditions, speed increased exponentially and significantly to a final speed of 47 km/h and 46 km/h for the HRF condition and the NHRF condition respectively. The cyclists completed the HRF condition 20 s faster than the NHRF condition; a finding which was not significant. There were no difference in heart rates; a mean heart rate of 158 b/min (NHRF) and 160 b/min (HRF). However, the cyclists perceived less effort during the NHRF condition but only at the 10 km mark; a finding which was significant. After this, perceptions of effort were similar. Discussion Overall, heart rate, perceptual and performance responses were similar during both conditions. Further, athletes were able to accurately perceive work effort despite receiving no heart rate feedback. However, the 20 s faster TT when heart rate feedback was given, is an important finding. This may have been due to the fact that during the NHRF condition, heart rate did not dictate pace and the cyclists thus started out at a faster pace and then realised that this could not be maintained. They then used their internal feed forward control mechanism to reduce speed in order to ensure adequate provision for the end spurt. This more variable pacing strategy during the NHRF condition may have resulted in the 20 s slower total time.



This is supported by previous findings which have shown that a more even distribution of work rate is the fastest even though most athletes don't follow this.

## Oral presentations

### OP-BN10 Biomechanics Methods

#### CHANGES IN RECURRENT INHIBITION DURING MAXIMAL VOLUNTARY ANISOMETRIC CONTRACTION

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**Introduction** As recently reported by Duchateau and Enoka (2008), the specific modulation of the activation signal during lengthening contractions could involve both supraspinal and spinal mechanisms. Different researchers have highlighted that this specific neural drive, observed for lengthening contractions, mostly acts at the spinal level (Duclay et al. 2005; Gruber et al. 2009). Both pre and post-synaptic inhibitory mechanisms appear to be involved in the modulation of the activation signal during lengthening compared with shortening maximal voluntary contraction (MVC). This study was designed to investigate the relative contribution of post synaptic inhibitory mechanisms to the neural modulations observed for lengthening contraction by evaluating changes in recurrent inhibition during anisometric MVC. **Methods** Experiments were performed on 9 healthy men. Maximal H-reflexes (Hmax) and M-waves (Mmax) were evoked in Soleus (SOL) at an ankle angle of 90° during shortening and lengthening MVC. During MVC, maximal H-reflex with no direct M-wave response was also recorded as reference H-reflex (H1). The paired H reflex technique proposed by Hultborn and Pierrot Deseilligny (1979) was used to record test H reflex (H') to assess recurrent inhibition. The Hmax/Mmax and H'/H1 ratios were computed to investigate changes in spinal excitability and in recurrent inhibition respectively. SOL electromyographic (EMG) activity were quantified with root mean square (RMS) values of the EMG signal and normalized to the corresponding maximal M-wave (Mmax). **Results** The results indicate that the amplitudes of H' and H1 were by 34,4% and 19,5% lower during lengthening than during shortening MVC, respectively. Both SOL Hmax/Mmax and H'/H1 ratios were smaller ( $P < 0.05$ ) during lengthening MVCs ( $0.46 \pm 0.07$  and  $0.49 \pm 0.10$ , respectively) compared with shortening MVCs ( $0.59 \pm 0.05$  and  $0.64 \pm 0.10$ , respectively), despite similar RMS values of SOL EMG for all contraction types ( $P > 0.05$ ). **Discussion** Although the test reflex may be less sensitive to inhibitory mechanisms than the reference H-reflex (Hultborn and Pierrot-Deseilligny, 1979), the larger decrease in H' than in H1 during lengthening compared with shortening MVCs indicates a change in post synaptic inhibition. At comparable levels of SOL EMG activity, the decrease found in both Hmax/Mmax and H'/H1 ratios suggests that the reduction of the spinal excitability during lengthening MVC can, at least partly, be linked to an increase in recurrent inhibition. **References** Duclay J, Martin A (2005). J Neurophysiol 94: 3555-3562 Hultborn H, Pierrot-Deseilligny E (1979). J Physiol 297:229-251 Duchateau J, Enoka R (2008). J Physiol 586:5853-5864. Gruber M, Linnamo V, Strojnik V, Rantalainen T and Avela J (2009). J Neurophysiol 101: 2030-2040

#### RANGE OF MOTION, MOMENTS OF FORCE, JOINT AND GROUND REACTION FORCES OF GAIT DURING PREGNANCY

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**Introduction** The quantification of the mechanical load on internal biological structures during physical activity in daily life and recreational activity is a prerequisite for understanding injury and overload mechanisms and for controlling that physical activity. The purpose of this study is the quantification of mechanical load acting on the lower limb of the pregnant woman. **Methods** Biomechanical data were collected in laboratory, using 2 force-platforms (Kistler AG, Winterthur, Switzerland) and a high resolution optoelectronic system with 10 cameras of high speed (Oqus3 Qualisys AB) at 200Hz, providing three-dimensional data. Kinematic and kinetic analysis by inverse-dynamics, were obtained with Visual3D software. The task consisted of walking at a comfortable speed. Three measures were collected at the beginning of the 2nd trimester-B2T ( $13.0 \pm 1.8$  weeks), at the beginning of the 3rd trimester-B3T ( $27.0 \pm 1.3$  weeks), and at the end of the 3rd trimester-E3T ( $37.1 \pm 1.2$  weeks). 4 pregnant women participated in B2T, 5 in B3T and 6 in E3T, in a crossover longitudinal study. **Results** Comfortable speed decreased from 1.22m/s in B2T through 1.17m/s in B3T, until 1.11m/s in E3T. Stride width increased from 0.108m in B2T through 0.117m in B3T, until 0.124m in E3T. Stride length decreased from 1.29m in B2T through 1.26m in B3T, until 1.22m in E3T. Duration of the gait cycle increased from 1.06s in B2T through 1.08s in B3T, until 1.10s in E3T. Ground reaction forces (GRF) tend to decrease maximum peak in vertical component and have higher anterior and medial forces. Ankle moment of forces tends to decrease through pregnancy and, knee and hip moment of forces tend to increase from B2T to E3T. Power seems to decrease in all lower joints during pregnancy. **Discussion** On average, throughout pregnancy, temporal and spatial parameters have changed (Falola et al., 2009; Wu et al., 2002; Wu et al., 2004; Wu et al., 2008), allowing the pregnant women fit to morphological and physiological changes (Guyton & Hall, 1997). The sagittal range of motion, GRF and joint reaction forces on both lower limb joints shows small but significant differences among trimesters (Foti, et al., 2000; Lymbery and Gilleard, 2005). The results of the present work in progress will be useful to develop recommendations for pregnancy specific exercise programs, for pain prevention and to improve the biomechanical models. **References** Falola, J. M., et al. (2009). Science & Sports, 24(1), 49-51. Foti, T., Davids, J. R., & Bagley, A. (2000). Journal of Bone and Joint Surgery-American Volume, 82A(5), 625-632. Guyton, A. C., & Hall, J. E. (1997). Tratado de Fisiologia Médica (9th ed.). Rio de Janeiro, Brasil: Guanabara Koogan S.A. Lymbery, J. K., & Gilleard, W. (2005). Journal of the American Podiatric Medical Association, 95(3), 247-253. Wu, W. H., et al. (2002). Clinical Biomechanics, 17(9-10), 678-686. Wu, W. H., et al. (2004). Clinical Biomechanics, 19(5), 480-488. Wu, W. H., et al. (2008). European Spine Journal, 17(9), 1160-1169.

#### MUSCLE COORDINATION AND OVERALL EFFICIENCY IN CYCLING

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**MUSCLE COORDINATION AND OVERALL EFFICIENCY IN CYCLING** Blake, OM.1; Champoux, Y.2; Wakeling, JM.1 1: Simon Fraser University, Canada 2: VelUS, University of Sherbrooke, Canada **INTRODUCTION** Cycling utilizes muscle coordination to apply force to the pedals. Some coordination patterns produce maximal power while some are more efficient. Variations in muscle coordination are reflected in the metabolic costs (Bigland-Ritchie et al., 1976) and mechanical power output and therefore should be apparent in the overall mechanical

efficiency ( $nO$ ). The purpose of this study was to identify relationships between muscle coordination patterns and factors affecting muscle coordination to explain changes in  $nO$ . METHODS Surface electromyography (EMG) was measured from 10 leg muscles in 9 competitive cyclists at a range of workloads. The EMG was resolved into intensities (IEMG) (von Tscharnner, 2000). Total EMG intensity (Itot) was given by the sum of IEMG across all muscles for each pedal cycle and was used as a proxy for metabolic power (Wakeling et al., 2011). The ratio of mechanical power output to Itot was therefore used to estimate  $nO$ . Kinematics, pedal forces and power output were also measured and principal component (PC) analysis was used to establish muscle coordination (IPC), kinematic and pedal force patterns (Wakeling et al., 2009). Relationships between the IPCs and the pedal forces, kinematics, power output and  $nO$  were determined. RESULTS AND DISCUSSION The rectus femoris and tibialis anterior were keys to power production early in the pedal cycle and the soleus was critical in the bottom of the cycle. The gluteus maximus had the largest IEMG range supporting its role as a major contributor to high power output (Ryan et al., 1992). The  $nO$  was maximized at 55-60%  $VO_{2max}$  and was strongly related to the muscle coordination patterns. High  $nO$  had an even distribution of IEMG across all muscles with equally dispersed timing among the key power producers. Pedal forces were consistent among cyclists and  $nO$  was independent of the direction of applied force. The ankle angles changed with power output, Itot and  $nO$ . The hip angles varied with power output and Itot but not with  $nO$ . The knee angles were similar throughout. This study demonstrates that  $nO$  in cycling is achieved through coordinated contraction of muscles crossing the same joint, sequential peak muscle activation from knee to hip to ankle and a reliance on multiple muscles to produce large joint torques. The results may have implications on training for cycling as training at 55-60%  $VO_{2max}$  may maximize the rider's exposure to high-efficiency coordination patterns and kinematics. REFERENCES 1. Bigland-Ritchie B, et al. (1976). J Physiol. 260(2):267-277. 2. von Tscharnner V. (2000). J Electromyogr Kinesiol. 10(6):433-445. 3. Wakeling JM, et al. (2011) Phil Trans R Soc B. 366(1570) (in press) 4. Wakeling JM, et al. (2009). J Neurophysiol. 101(2):843-854. 5. Ryan MM, et al. (1992). J Electromyogr Kinesiol. 2(2):69-80.

### **PATELLAR TENDON CROSS SECTIONAL AREA AND MOMENT ARM USING THREE-DIMENSIONAL MRI IN PATIENTS WITH ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION.**

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ARISTOTLE UNIVERSITY OF THESSALONIKI

Introduction Surgical reconstruction of a torn anterior cruciate ligament (ACL) is performed using various types of grafts. One of the most commonly used autografts is the bone-patellar tendon-bone (BPTB) graft, which has lead to very successful clinical outcomes in ACL reconstruction (Busam et al., 2008). Most studies have shown that the thickness of the patellar tendon after harvesting increases, at least up to 2 years postoperatively (Bernicker, 1998, Kartus, 1999). However, whether this structural change in PT properties affects muscle moment-arms is unknown. The purpose of this study was to examine whether 3-D anatomical cross-sectional area (aCSA) of the patellar tendon (PT) and moment arm in individuals who had ACL reconstruction differs compared with controls. Methods Eight males and two females ( $n=10$ ) with a mean age of 42 years (SD 5.5 yr), height 1.74 (SD 3.14 cm), tibial length 39.2 (SD1.84 cm) and femur length 41 (SD 1.13 cm) participated in the study. The knee joint was scanned using MRI, the Femur (FM), Tibia (TB), PT and PT tendon were identified in each MRI plane and reconstructed in 3-D using 3-D Doctor. An adopted form of tibiofemoral contact point (TFCP) was used in order to measure PT moment arm in 3-D images. Tendon CSA was measured at 10% 25%, 50% and 75% of the tendon length by the use of MRI axial planes. Variables were correlated for ACL reconstructed and controls. Results The PT tendon moment arm evaluated to 49.63 mm (SD 5.30) for controls and 49.67mm (SD 4.7) for ACL reconstructed patients. T-tests showed non-statistical significant differences between healthy and ACL-reconstructed values in both PT moment-arm and a CSAs ( $t= .010$   $p= .992$ ) Discussion The present study showed that PT tendon moment arm is not affected by harvesting for ACL reconstruction, despite evidence from other studies that tendon is hypertrophic for some period after surgery. These findings must be taken into account on future 3-D biomechanical research with reconstructed models and in more precise measurement on knee biomechanics. References Busam, M. L., Provencher, M. T., & Bach, B. R., Jr. (2008). Complications of anterior cruciate ligament reconstruction with bone-patellar tendon-bone constructs: care and prevention. Am J Sports Med, 36(2), 379-394. Bernicker, J. P., Haddad, J. L., Lintner, D. M., DiLiberti, T. C., & Bocell, J. R. (1998). Patellar tendon defect during the first year after anterior cruciate ligament reconstruction: appearance on serial magnetic resonance imaging. Arthroscopy, 14(8), 804-809. Kartus, J., Lindahl, S., Kohler, K., Sernert, N., Eriksson, B. I., & Karlsson, J. (1999). Serial magnetic resonance imaging of the donor site after harvesting the central third of the patellar tendon. A prospective study of 37 patients after arthroscopic anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc, 7(1), 20-24.

### **EFFECTS OF ISOMETRIC TRAINING ON THE MOMENT-ANGLE RELATIONSHIP AND MUSCLE ARCHITECTURE OF KNEE EXTENSORS**

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UNIVERSITY OF CASTILLA-LA MANCHA

Introduction The force-length relationship of the skeletal muscle can be modified by resistance training (2,4), and has been related to decreased risk of muscle injury when the peak torque is shifted to longer muscle lengths (3). However, the mechanisms that underpin these processes are not still clear. The aim of this study was to analyse the muscle adaptations produced by two protocols of isometric training: one at long muscle lengths and another at short muscle lengths. Methods Twenty-nine men and women were divided into three groups: one performed isometric training of the knee extensors at long muscle lengths during 8 weeks (80% of MVC, 90° knee angle, G90, 0° = full extension), and the second one performed the same training protocol at short muscle lengths (50°, G50). The subjects of the third group acted as controls. Before and after the training programme muscle isokinetic dynamometry (60°•s<sup>-1</sup>) was utilised to analyse the moment-angle relationship, and isometric (90° knee flexion) strength was tested. Besides, we also measured vastus lateralis (VL) muscle architecture with ultrasonography. Results There was a shift in the angle of peak torque of the G90 to longer muscle lengths (80.9° pre-training and 90.3° post-training,  $P=0.002$ ), while the G50 angle shifted to shorter muscle lengths (from 76.6° to 70.3°,  $P=0.039$ ). There were also increases in isometric strength in both training groups, (33%,  $P=0.000$  vs 14%,  $P=0.017$ ; G90 and G50, respectively). Both training groups showed significant increases in muscle thickness, (14%,  $P=0.001$  vs. 5%,  $P=0.027$ ; G90 and G50, respectively) but only G90 significantly increased their pennation angles. Besides, the G90 showed a tendency to increase their fascicle length (3%, ns), while the G50 fascicle lengths remained unchanged (-1%, ns). Discussion The results of the present study show changes in muscle architecture along with shifts in the angle-torque relationship of knee extensor muscles after isometric training at long and short muscle lengths. VL muscle fascicles tended to increase in the group that trained at long muscle lengths, while showed no changes with the isometric training at short muscle lengths. We think that the greater strength gains and the architectural changes showed with training at long muscle lengths were related to the greater stress and strain imposed on the muscle fascicles at this joint configuration (1,2). References 1. Ichi-

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## JOINT POWER CONTRIBUTIONS TO EXTERNAL POWER OUTPUT ON DIFFERENT ERGOMETER CONFIGURATIONS IN ELITE MALE ROWING

GREENE, A., SMITH, R., SINCLAIR, P., DICKSON, M., COLLOD, F.

UNIVERSITY OF SYDNEY

JOINT POWER CONTRIBUTIONS TO EXTERNAL POWER OUTPUT ON DIFFERENT ERGOMETER CONFIGURATIONS IN ELITE MALE ROWING  
Greene, A.I, Smith, R.I, Sinclair, P.I, Dickson, M.I and Colloud, F.Z. 1: University of Sydney (Sydney, Australia), 2: University of Poitiers (Poitiers, France) Introduction Rowing ergometers form an integral part of the training regime of all rowers, regardless of experience or performance level. However, owing to the differing designs of rowing ergometers there exists some dispute as to how different ergometers compare in regard to the technical and force parameters of the rowing stroke. Whether the foot stretcher is fixed or free to move in the anterior posterior direction may dictate the rower's movement patterns and effect power production and joint coordination through the stroke. This may ultimately affect the potential of the ergometer to best replicate on-water rowing. Method Rowers (14) were tested at 32 strokes/minute on three ergometer conditions: the fixed stretcher Concept2 ergometer, the Concept2 ergometer mounted on sliding rails and the sliding stretcher RowPerfect ergometer. Ergometers were instrumented identically to measure the external force generated at the handle and the foot stretcher, and reflective markers (52) were attached to specific anatomical landmarks on the subject to record the 3D kinematics of the rowing stroke. A nine segment inverse dynamics model was used to calculate joint and overall power delivery. Results Peak power generation and absorption at the knee joint was significantly greater on the fixed stretcher when compared to the sliding stretcher ergometers ( $p = 0.01$ ). Joint energy production at the knee and hip joints was significantly greater for the fixed stretcher ergometer condition ( $p = 0.044$ ;  $p = 0.025$ ), however no differences were found between ergometer conditions for the external energy delivered to the ergometer by the rower. Discussion Whilst rowing at the same stroke rate and intensity, the fixed stretcher ergometer increases the flexor and extensor moments, and subsequently the power generation and absorption at the knee joint. Greater power is generated at the knee joint to enable sufficient power to be delivered to the ergometer in order to accelerate the entire rowers mass relative to a fixed point. The fixed stretcher also acts to change the coordination pattern of the rower during the recovery phase by changing the timing and increasing periods of knee power generation and absorption. Joint energy requirements at the knee and hip joints increased on the fixed stretcher ergometer, however this increased joint energy production was not delivered directly to the to the ergometer, suggesting reduced mechanical efficiency when rowing the fixed stretcher ergometer. The presence of the sliding foot stretcher may provide a more accurate portrayal of on-water rowing stroke mechanics than the fixed stretcher ergometer, which increases the workload and demands of the joints of the lower limb.

## Invited symposia

### IS-SH11 Emotion in Sport

#### EMOTIONS IN SPORT: CURRENT ISSUES & PERSPECTIVES

HANIN, Y.

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Introduction This presentation reviews the selected issues in research on emotion-performance relationships in high-achievement sport. An individualized and evidence-based approach (termed the Individual Zones of Optimal Functioning: IZOF model) was used to examine state-like performance-related emotional experiences & meta-experience with a special emphasis on their defining characteristics (Hanin, 2000, 2007, 2009, 2010). Methods In the IZOF-based assessments, it is assumed that athletes are able to generate their own words to describe their unique emotional experiences (Hanin, 2000, 2007). Emotion profiling involves recalled, current, anticipatory, optimal/dysfunctional, interpersonal and intra-group measures. We also used an aggregated 40 items Emotional State Profile (ESP-40, Hanin, 2010) to identify interaction patterns of optimal and dysfunctional emotions (positively-toned and negatively-toned). The Identification-Control-Correction (ICC) procedure (Hanin & Hanina, 2009) creates an action-profile (a movement sequence) by assessing an athlete's self-generated components of the task execution process. Results and discussion The findings provide empirical support for the benefits of idiographic approach to emotions in high-achievement sport. Several developments include the issues of multidimensionality for the system description of idiosyncratic emotional experiences, the categorization of emotion content, the in-out of the zone concept in prediction of individually successful and poor performances, and optimal and dysfunctional emotion intensity. The biggest barrier in research on performance-related emotions is a lack of performance process measures usually limited to normative performance outcomes. Thus similar to assessments of idiosyncratic emotions, the ICC programme is proposed as individualized self-referenced action profiling. Conclusion Future research may focus on interaction patterns of athletes' emotional experiences and on the development of action-profiling and performance process measures. This would enable to identify individually optimal and dysfunctional movement sequences and to combine emotion-centered and action-centered coping strategies in regulation of performance-related psychobiosocial states. References Hanin Y. (2007). Emotions in Sport: Current issues and perspectives. In G. Tenenbaum & R.C. Eklund (Eds.). Handbook of Sport Psychology 3rd ed. (pp. 31-58). Hoboken, NJ: John Wiley. Hanin, Y.L. (2010). Coping with Anxiety in Sport. In: Adam Nicholls (Ed.) Coping in Sport: Theory, Methods, and Related Constructs. Nova Science Publishers, (pp. 159-175). Hanin, Y. & Hanina, M., with the Commentators (2009). Optimization of performance in top-level athletes: An Action-Focused Coping. Int. J. of Sport Sci. & Coaching, 4 (1), pp. 47-91.

#### EMOTION AND PERFORMANCE IN SPORT AND PHYSICAL ACTIVITY: A HOLISTIC APPROACH

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Introduction The multifaceted relationships among emotional states and performance in sport and physical activity have been studied in light of the holistic conceptualisation of the Individual Zones of Optimal Functioning (IZOF) (Hanin, 2007). According to the IZOF model, each performer experiences a specific content and intensity range of positively and negatively toned psychobiosocial (PSB) states that can

have either a functional or dysfunctional impact on performance. The interaction between emotional states and performance is dynamic and bidirectional; namely, emotions tend to influence performance, while on-going performance outcomes influence the content and intensity of emotions. Methods Several IZOF-based studies recently have been conducted to examine the emotion-performance link (e.g., Pellizzari et al., in press), the effects of an action-oriented IZOF-based intervention on performance (Bortoli et al., 2011b), and the effects of a motivational climate on youngsters in the context of physical education and sport (e.g., Bortoli et al., 2011a). Results and discussion Performance findings showed that an individual's optimal pattern of emotional level was associated with optimal performance and, conversely, a dysfunctional pattern was related to poor performance; athletes also experienced optimal-pleasant emotions after good performances, and dysfunctional-unpleasant emotions after poor performances (Pellizzari et al., in press). In a further study, an action-oriented individualised intervention has been effectively applied to the Italian shooting team to help shooters improve, stabilise, and optimise their performances (Bortoli et al., 2011b). Physical activity findings showed task orientation and a perceived mastery-involving climate to be related to positively-toned PBS states, whereas performance climate to be related to negatively-toned PBS states (e.g., Bortoli et al., 2009). Moreover, perceived competence, actual competence, and task orientation were strong predictors of positively-toned PBS states (Bortoli et al., 2011a). Finally, performance climate and an antisocial moral atmosphere in sport were shown to be related to antisocial behaviour and a range of negatively-toned PBS states (Bortoli et al., 2011c). Conclusion Overall findings showed the advantages of adopting the IZOF-based holistic approach to the study of emotion-related states in sport and physical activity. References Bortoli L, Bertollo M, Robazza C (2009). *Pers Indiv Differ*, 47, 18-24. Bortoli L, Bertollo M, Comani S, Robazza C (2011a). *J Sport Sci*, 29, 171-180. Bortoli L, Bertollo M, Hanin Y, Robazza C (2011b). Submitted. Bortoli L, Messina G, Zorba M, Robazza C (2011c). Submitted. Hanin YL (2007). In G Tenenbaum & R Eklund (Eds.), *Handbook of sport psychology* (3rd ed., 31-58). Wiley, Hoboken, NJ. Pellizzari M, Bertollo M, Robazza C (In press). *Int J Sport Psychol*.

## ENHANCING EMOTION REGULATION OF OTHERS AND SELF IN SPORT

LANE, A.M.

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Introduction Emotions are proposed to be energy giving and if people can harness their energy, then they can be helpful for performance (Hanin, 2000). Evidence shows that individuals develop meta-beliefs on which emotions help performance (Hanin, 2003). Emotion regulation activities are proposed to be driven by a discrepancy between current and ideal states (Carver, 2004). The aim of this presentation is to report on a series of studies designed to assess emotions associated with best and worst performance and the use and effectiveness of emotion regulation strategies used by athletes in a number of different sports. Methods Current and ideal emotions were assessed using both standardised and ideographic measures. Emotion regulation strategies were assessed using cognitive and behavioural strategies identified in the recently developed Emotion Regulation of Others and Self Scale (EROS). We also assessed emotional self-efficacy and trait emotional intelligence. Data are presented from over 2000 athletes using cross-sectional and longitudinal design from a range of sports. The results presented are a summary of these studies. Results Results show that athletes are motivated to increase emotions associated with high action-tendencies regardless of whether these are pleasantly-toned (i.e., excitement) or unpleasantly-toned (i.e., anger and/or anxiety). Athletes tend to seek to reduce the intensity of emotions such as depression and dejection. However, it should be noted that there are large intra-individual differences in the intensity of emotions associated with best performance. To increase unpleasant high-activation emotions, athletes use a range of cognitive and behavioural strategies. Examples include using negative self-talk or imagining feeling frustrated after being passed/defeated by a fellow competitor. However, athletes motivated to increase unpleasant emotions also use strategies to increase pleasant emotions, suggesting a dual process of increasing emotions with high action tendencies. We found that emotional intelligence self-efficacy is a predictor of the discrepancy between current and ideal emotions whereby the higher the self-efficacy, the smaller the discrepancy. This result suggests that emotionally intelligent athletes are capable of regulating emotions to optimal levels. Discussion We suggest that findings offer support for the notion that athletes hold beliefs that emotions such as anxiety and anger can be motivational (Hanin, 2000, 2003) and that athletes actively engage in strategies to increase these emotions. Findings also show that ideal emotional states comprise a mix of pleasant and unpleasant emotions typically associated with high action-tendencies. Trait emotional intelligence and emotional self-efficacy both offer an individual difference variable that predicts emotion regulation usage. Future research should look at the effectiveness of training packages designed enhance emotion regulation skills. References Carver, C. S. (2004). *Self-regulation of action and affect*: Guilford Press.

## Invited symposia

### IS-BN10 Biomechanics of Non-steady state Locomotion

#### SIDE CUTTING MANOEUVRES IN SPORT: WHERE BALANCE AND INJURY RISK CONFRONT PERFORMANCE

VANRENTERGHEM, J.

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Sudden accelerations, decelerations, and changes of direction are key components of performance in field games. These manoeuvres induce large and often fatal stresses to the musculoskeletal system, in particular structures at the knee joint such as the anterior cruciate ligament and hamstring muscle (Hawkins et al, 2001). The last two decades has seen a substantial amount of work teasing out the interwoven roles of internal, environmental, and biomechanical risk factors of such injuries (Renstrom et al, 2008). Insight into the biomechanical risk factors has seen dramatic progress due to technological advances, looking in the detailed function of the knee joint in particular. Few authors have however focused on the role of whole-body balance in these contexts. In an attempt to better understand the role of balance, appropriate methods needed to be developed to evaluate balance in dynamic movements. The key requirement of these methods was that sufficiently accurate data for lower limb joint kinematics and kinetics needed to be available, while at the same time collecting whole body centre of mass (CoM) motion. The solution was found in measuring a lower limb and trunk (LLT) segmental model, including functional hip and knee joints. It was shown that without the need to model arms and head an accurate CoM could be estimated (Vanrenterghem et al, 2010). The acquired methodology has allowed us to revisit popular hypotheses concerning key risk factors of ACL and hamstring injury in a series of studies. In all of these studies we have looked at a 45 degree cutting manoeuvre from straight running. Amongst other questions, we addressed the roles of first half fatigue and half time recovery in football on ACL injury risk factors, and how this may interact with changed balancing abilities. We explored the role of balance in determining whole body motion

trajectories at different speeds of execution to revisit the role of approach speed on risk factors. We also revisited the proposed causal factors of increased joint stresses in unanticipated compared to anticipated side cutting manoeuvres. The advancement of work in this area is expected to benefit not only the understanding of injury risk in side cutting, but also hopefully aid to further the fundamental understanding of balance mechanisms in dynamic sports activities. References Hawkins et al (2001) Br J Sports Med, 35, 43-47 Renstrom et al (2008) Br J Sports Med, 42, 394-412 Vanrenterghem et al (2010) Gait & Posture, 31, 517-521

## NEUROMECHANICS OF WALK-TO-RUN TRANSITIONS

SEGERS, V., VAN CAEKENBERGHE, I., MALCOLM, P., AERTS, P., DE CLERCQ, D.

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Walking and running are two stable cyclic locomotion patterns with a different range of speeds. When increasing speed, the walk-to-run transition (WRT) spontaneously takes place. For the last decade we examined this type of unsteady locomotion from a biomechanical perspective. By studying the collective output of the system during WRT (e.g. kinematics, kinetics, EMG), insights in the control and execution of human unsteady locomotion can be gained. When humans spontaneously accelerate from standing still, the WRT-speed is 2.66 m/s and is very stable within and between individuals (De Smet et al., 2009a). The stability of the WRT-speed was also shown during accelerations on treadmill. Next we focused on how the actual WRT is realized. Based on kinesiology and mechanics of transitions during accelerations, we conclude that the WRT is a sudden event, accomplished during one step. This step starts from a double stance and ends with a flight phase. After a small preparation in the swing of the last walking step prior to WRT, during the transition step active power is generated by muscular input of the stance limb to initiate the first flight phase. It is uncertain how and at what level this energy input is controlled. We also examined why humans prefer this specific WRT-speed. Since the WRT-speed is likely not directly related to metabolic efficiency nor to the limits of the inverted pendulum mechanism, other proximate causes must trigger the transition. Dorsi- and plantar flexors were found to act at maximal or adverse conditions at WRT (Hreljac, 1995; Neptune & Sasaki, 2005). Indeed, resisting dorsi- and plantar flexors by means of a powered exoskeleton led to a lower WRT-speed (Malcolm et al., 2009a; 2009b). By manipulations of the weakest link, WRT-speed decreases. However, assisting the dorsi- and/or plantar flexors does not influence WRT-speed due to other weakest links. Furthermore, inducing a visual flow that is higher or lower than the actual speed (leading to an erroneous visual input in the perception-action cycle) also had an effect on WRT-speed (De Smet et al., 2009b). This unconscious influence of a misleading optic flow can probably be related to the coupling of visual flow to previous experience. We have to conclude that the full picture of the hierarchy and interplay between determinants of the WRT is not yet known. Moreover, conscious cognitive input (e.g. reaction on external stimulus) can overrule the signals of the peripheral neuromuscular triggers and the perception-action coupling. References De Smet K, Segers V, Lenoir M, De Clercq D. (2009a). Gait Posture, 29, 54-58 De Smet K, Malcolm P, Lenoir M, Segers V, De Clercq D. (2009b). Exp Brain Res, 193, 501-508 Hreljac A. (1995). J Biomech, 28, 669-677 Malcolm P, Fiers P, Segers V, Van Caekenberghe I, Lenoir M, De Clercq D. (2009a). Gait Posture, 30, 322-327 Malcolm P, Segers V, Van Caekenberghe I, De Clercq D. (2009b). Gait Posture, 29, 6-10 Neptune R, Sasaki K. (2005). J Exp Biol, 208, 799-808

## STABILITY IN WALKING AND RUNNING - BIOMECHANICAL CONCEPTS AND CHALLENGES

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In human walking and running, typical patterns of the ground reaction force with two humps in walking and a single hump in running are found. This behavior is widely found in nature and can be well described by assuming spring-like leg function (spring-mass model, Blickhan, 1989, extended to bipedal gaits, Geyer et al., 2006). However, systematic deviations from such a perfectly elastic leg behavior like a telescopic linear spring can be found. One reason for this is that the leg has non-elastic properties (e.g. in materials and muscles Haeufle et al., 2010). Also, the leg is landing at the ground with non-zero contact velocities leading to impact losses (De Wit et al., 2000). The segmental design of legs with a distal foot segment and almost straight knee configurations could also contribute to deviations in the spring-like leg function (Seyfarth et al., 2001, Maykranz, 2009). In fact, elastic properties at joint level are related to spring-like leg function in a nonlinear fashion (Rummel and Seyfarth, 2008). Furthermore, hip torques joint can redirect the leg force with respect to the center of mass (Maus et al., 2008). By this, the upper body can stay in an upright position guaranteeing postural trunk stability during locomotion. Another example of extending the spring-mass model is to include lateral body movements (Seipel and Holmes, 2005, Peuker and Seyfarth, 2010). In fact, even extensions to quadrupedal (Gross, 2009) and hexapod (Schmitt and Holmes, 2000) gait models can be considered. Interestingly, all these structural extensions of the model did preserve the previously observed self-stabilizing leg function found in the spring mass model (Seyfarth et al, 2001). With this repertoire of conceptual models it becomes possible to design models of desired complexity, which could inherit features of the underlying template models (Full & Koditschek, 1999). In order to compare the model predictions with experimental data it is important to make sure that the key characteristics of human gait are sufficiently represented in the biomechanical models. So far there are fundamental differences between the predicted gait pattern and experimental data on human locomotion. For instance, it is not clear which mechanisms cause the observed step-to-step variability in kinematic and kinetic parameters. This is important as concepts on gait and gait stability often rely on the assumption of a periodic gait pattern, which exhibits a fixed point. References Blickhan, 1989, J. Biomechanics. De Wit et al., 2000, J. Biomechanics. Full and Koditschek, 1999, J Exp. Biol. Geyer et al., 2006, Proc. Roy. Soc. Lond. B. Gross et al., 2009, Dynamic Walking. Haeufle et al., 2010, Bioinspiration & Biomimetics. Maus et al., 2008, CLAWAR. Maykranz et al., 2009, Autonome Mobile Systeme. Peuker and Seyfarth, 2010, WCB. Rummel and Seyfarth, 2008, IJRR. Schmitt and Holmes, 2000, Biol. Cybernetics. Seipel and Holmes, 2005, IJRR. Seyfarth et al., 2001, Biol. Cybernetics.

## Invited symposia

## IS-PM15 Stem Cells and Tissue Regeneration in Muscle Physiology and Disease

## QUIESCENT AND ACTIVATED MUSCLE SATELLITE CELLS: TRANSCRIPTOME ANALYSIS AND MI-RNA REGULATION

BUCKINGHAM, M., CRIST, C., PALLAFACCHINA, G., MONTARRAS, D.

PASTEUR INSTITUTE, CNRS URA2578

The satellite cells of many muscles transcribe Pax3 as well as Pax7 and we have therefore used a Pax3GFP/+ mouse line to isolate these cells by FACS. When cultured, satellite cells undergo activation, however they repair damaged skeletal muscle less efficiently than freshly isolated cells. In vivo activated satellite cells are abundant in growing postnatal muscles and in regenerating adult mdx muscle. A transcriptome analysis was carried out in which satellite cells from adult muscle, which are mainly quiescent, were compared with cells from these sources of in vivo activated cells, where sequences common to both that undergo changes in level are probably associated with the activated state per se. Cultured cells had a strikingly different transcriptome profile. Aspects of this analysis will be discussed, that provide insight into the satellite cell niche. Many satellite cells already transcribe the myogenic determination gene, Myf5, and we detect no up-regulation of Myf5, nor indeed of MyoD on activation, although the proteins become detectable. We have shown miRNA-31 regulation of Myf5 mRNA through specific sites in the 3' UTR. We now report on the role of miRNA-31 in muscle satellite cells where it prevents premature differentiation, thus maintaining the quiescent satellite cell population required for regeneration. The rapid down-regulation of Pax3, required at the onset of differentiation, is also orchestrated by miRNA, in this case miRNA-27, that accumulates after satellite cell activation, prior to differentiation. Again interference with the activity of this microRNA interferes with differentiation and with regeneration in vivo.

## ADULT STEM CELLS IN MYOCARDIAL AGING AND REGENERATION

NADAL-GINARD, B.

LIVERPOOL JOHN MOORES UNIVERSITY

Cardiomyocyte death and renewal are the two sides of the proverbial coin of cardiac homeostasis in which the resident Cardiac Stem Cells (CSCs) play a central role (Ellison et al. 2007 Nature CPCM Suppl 1, S52). Although the generation of new cardiomyocytes predominates cell death in the young, contributing significantly to the normal growth of the heart into adulthood, cardiomyocyte death predominates the formation of new cardiomyocytes in late adulthood and old age (Anversa and Nadal-Ginard, 2002 Nature 415: 240). As the organism ages, the rate of cardiomyocyte death progressively rises, correlating with increases in the average size of the cardiomyocytes and the degree of cellular senescence. Myocardial aging results from senescence of cardiomyocytes due to attenuation in their turnover dictated by CSC aging and the inevitable accumulation of older cells, participating in the occurrence of ventricular dysfunction and failure in the 'old' heart (Torella et al. 2004 Circ Res 94:514). A goal of cardiovascular research for the past decade has been to find a method of replacing the cardiomyocytes lost through ageing and/or one or more myocardial infarctions, so as to prevent, or reverse, the pathological remodelling of the myocardium that is responsible for the development of late cardiac failure. Stem cell therapy is fast becoming an attractive and highly promising treatment for heart disease and failure. Current clinical trials are mainly using bone marrow cells of different origins as the therapeutic agent (Nadal-Ginard & Vuster, 2007, Nature CPCM 4:1) and have produced at best, modest results. Scientifically the race is still on to find the 'best' type and source of cell to reconstitute the myocardium and improve function following myocardial damage. We are developing strategies that are able to specifically activate the resident CSC pool by using growth factors/cytokines, without the need for cell transplantation. We show that the growth factor IGF-1 enhances cell replication and attenuates CSC and cardiomyocyte senescence delaying the appearance of a cardiomyopathic old heart. Furthermore, using a clinically relevant experimental infarct animal model in hearts the size of human's, we show intracoronary injection of the growth factors IGF-1 and HGF after myocardial infarction in pigs has a protective effect on myocardial tissue organization and structure and produces significant CSC activation and ensuing regeneration. These results provide the proof-of-concept needed to justify further experimental development and refinement of this approach, which could ultimately lead to an effective, simple, clinically applicable and widely available protocol of myocardial regeneration, having significant impact on public health.

## ADULT STEM CELLS IN SKELETAL MUSCLE AGEING AND REGENERATION

HARRIDGE, S.

KING'S COLLEGE LONDON

The mechanisms underlying the age related loss of muscle mass (sarcopenia) are not fully understood. One view is that older muscles exhibit a deterioration in their ability to adequately maintain and repair themselves following damage. Mammalian skeletal muscle is a post-mitotic tissue relying on mechanisms of maintenance and repair. Satellite cells are the muscle stem cells which provide the source of muscle precursor cells for this purpose. They are activated from their quiescent state in the niche between the basal lamina and sarcolemma (where they express the marker Pax7) by exercise or damage. Once activated these cells, often referred to as "myoblasts" when they fall outside their anatomical location, can proliferate, fuse and differentiate (expressing myogenic differentiation markers such as myogenin and ultimately myosin heavy chain) and form new contractile muscle proteins and in culture fibre-like structures (myotubes). Evidence for an age-related impairment to repair following damage has come primarily from studies on rodents where some studies have shown older muscles exhibit a poorer recovery in terms of function (force) and / or markers of regeneration. Two main possibilities exist for such impairment in regenerative potential. Either the satellite cells themselves are intrinsically impaired by the ageing process, or there are factors in the aged milieu which negatively influence their behaviour. Data from early graft experiments on rodents, or more recently from conjoined circulation models, suggest that it is the age of the host and not the age of the damaged or grafted muscle that is responsible for this impairment. This points to factors in the local environment which are responsible for impaired regeneration. Impaired Notch signaling and increased TGF-beta expression in the satellite cell niche (Conboy et al. 2005) have been implicated in this process. However, there are also data which suggest less of a problem in this regard. For example, recent graft experiments on mice show that aside from a short delay there is an excellent myogenic stem cell response from older mouse muscles (Shavlakadze et al. 2010). Furthermore, whilst it is not possible to replicate the severity of the damage models used in rodents on human beings, that fact that the muscles of even very elderly people are able to adapt to strength training (increase muscle size and strength) and increase satellite cell number suggests that satellite cell function / the local environment is not limiting. Likewise, our experiments where primary human myoblasts are

cultured in sera from either young or elderly people, show no age-related impairment to proliferation or differentiation (George et al. 2010). In addition, whilst myoblasts obtained from both older and younger individuals show heterogeneity in their behaviour, there appear to be no obvious differences due to age. References Conboy I. et al. (2005) *Nature*. 433(7027):760-4 George T. et al. (2010) *Exp. Gerontol.* 45:875-81 Shavlakadze T. et al. (2010) *Biogerontology*. 11:363-76

## Invited symposia

### IS-SH01 Managing Talent in Professional Sport

#### MANAGING TALENT

RICHARDSON, D., NESTI, M., LITTLEWOOD, M., BENSTEAD, L.

LIVERPOOL JOHN MOORES UNIVERSITY

The aim of the presentation is to explore the notion of managing the development of talent within and through top-level professional football. Issues associated with player identity (i.e., through youth and professional environments), associated personal meaning that emerges from the 'real' and 'lived' experiences of talented players will be addressed. Furthermore the presentation includes more recent issues associated with the management of the migratory transition of young players. The presentation explores organisational structure and culture with respect to the strategic and operational working mechanisms that impact player development and progression. The symposium encourages participants to reflect on their own practice and/or experiences of managing young talent. Furthermore, the presentation will seek to provide examples of practices from across Europe in the strategic and/or operational approaches that may better facilitate the successful progression of talented players.

#### TOP FOOTBALL PLAYERS PERFORMANCE: THE IMPORTANCE OF RIGHT MANAGEMENT

DI SALVO, V.

ASPIRE/UNIVERSITY OF ROME

"Top football players performance: the importance of right management" V. Di Salvo <sup>1,2</sup> 1 Department of Health Science, University of Rome "Foro Italico", Rome, Italy. 2 Director of Performance Qatar Football Association, Qatar. There is a consensus in sport science that the most effective training is that which most closely replicate competitive performance condition. The growing interest for match analysis helped the understanding of physiological load imposed to football players (Di Salvo 2009, Rampinini 2009). The success of football performance is based on the functional adaptation between physical-psychological and the technical-tactical development. This optimal combination in the pursuit of a competitive advantage needs to start in the early stages of the elite football player's career and continue during the peak and post-peak years of the professional phase. In this context, fundamental will be the introduction of new philosophy based on the right management of the different areas in which sport science aspects, supported by new technologies, are combined with the specific football needs. The new tools and methodology have to be seen as additional help to be integrated with the actual know-how. Following the criteria of integration of new technologies, a strategic priority is the development of a training and performance centre with the goal of developing new approaches in the training methodologies area. This advance will produce a modern concept in the control of training with individualized programmes that will develop the performance and the longevity career of all athletes. The new philosophy is based on the interconnectivity of different areas and the integration of the results produced by them. The performance centre should be designed around different operating labs that through cross-platform activity and interchangeable data analysis optimize performance in the field by committing to the following: -Submission of functional evaluation monitoring the physiological characteristics of each athlete. -Development of individual training programmes. -Monitoring of training sessions and the evaluation of match analysis. -Conduct scientific research and apply to on-field practical application for improving the training methodologies. Objective data collected by the different labs should be combined from specific software and analyzed in an integrated way taking into consideration the correlation between the different parameters evaluated. Individual training programs must be designed with an overview on the different areas and considering and other important parameters as playing position, age, career level, physiological profile, games load (minutes played). References 1. Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P. & Drust, B. (2009) *J of Sports Medicine*, 30, 205-212. 2. Rampinini, E., Impellizzeri, F.M., Castagna, C., Coutts, A.J. & Wisłóff, U. (2009) *J of Sci and Medicine in Sport*, 12, 227-233.

#### YOUTH DEVELOPMENT: BEST PRACTICE IN EUROPEAN PROFESSIONAL FOOTBALL

SULLEY, C.

LEEDS UNITED FOOTBALL CLUB

Talent is regarded by many as the highest valued piece in the equation to deliver success. The talent pool in professional football that ultimately reaches its potential is small and very difficult to predict at the outset. The costs of identifying and developing talent are increasing as the implications of the FIFA rules on home grown quotas begin to take hold. Therefore, the search for, and development of, the best football talent in Europe is going to become more and more competitive. The average player cost spent in 2010 by the teams reaching the quarter finals of the Champions League was £16.2m up from £11.1m in 2009. This presentation is based on the findings of a 10 month research project that included over 10 field visits to some of Europe's best known professional football club Academy's and national associations for developing elite professional footballers. The presentation covers aspects of best practice in areas including; governance, investment, talent ID, coaching and development. Governance: Football governance is increasingly becoming the focus of the government, the public and football's governing bodies. FIFA's 'Financial fair play' rule is set to have an impact on how much clubs can spend but at the same time allow them freedom to spend any amount on youth development. Investment: Average Academy budget as a % of gross turnover was 7-15% in Europe. Barcelona, the top producer of elite young players was the highest total amount at 16m. The Premier League 20 clubs currently spend less than £40m per season in total on their Academy's, with the average gross turnover ranging between £40-80m. Talent ID: 'Think local act global'. Most clubs want to develop local talent to keep a local identity but accept that talent from foreign parts brings added value in different areas of the game. Linking into the local community at different levels is a key feature of best practice. Coaching and Development: 'Winning is more than just the score'. The key focus for top producing clubs is development over winning at all costs. This is to say that elite performers are encouraged to be task orientated, persistent and invest time and effort in themselves to achieve their potential. The facilitation of more practice time by catering for the education and welfare

needs of elite performers has long been accepted in countries that have consistently produced high performing professional footballers. Conclusion The presentation concludes with the view that clubs are required to aspire to these aspects of best practice in order to consistently produce high performance footballers.

## 12:00 - 13:15

### Plenary sessions

#### PS-PL04 NEW HORIZONS: In the Integration of Science and Football (Dedicated to Prof. Tom Reilly)

##### IMPORTANCE OF INTENSE TRAINING IN FOOTBALL

BANGSBO, J.

UNIVERSITY OF COPENHAGEN

The physical demands of a football player are high with elements of maximal force development, such as jumping, tackling and jumping, and high speed running. In addition, it has been observed that fatigue does occur both temporally and towards the end of a game. Therefore, it is important to prepare the players by doing aerobic and anaerobic training, which should preferably be performed in drills to ensure that the muscles used in football are trained and are obtaining the adaptations. In addition, such training does also develop the players' technical and tactical abilities. The aerobic training can be evaluated by measuring heart rate, e.g. heart rate during aerobic high intensity should be at the least 80% of maximum heart rate and on average around 90% at the end of each interval. Anaerobic training can be conducted as speed endurance production training, where the players are performing almost maximally for 10-30 s followed by long recovery period, and speed endurance maintenance training with intense exercise periods lasting 20-60 s separated by relative short recovery periods (1-2 times the exercise periods). Additional aerobic and anaerobic training during the season have been shown to improve performance level even for elite players. Thus, an additional 30-min aerobic high intensity training session a week for 12 weeks elevated the Yo-Yo intermittent recovery test performance (level 2; Bangsbo et al., 2008) by 18% (Jensen et al., 2009). Furthermore, in a recent study the effects of a 2-wk intensified training period were examined in trained soccer players (Thomassen et al., 2010). After the last match of the season seven elite soccer players in a 2-wk period perform 10 training sessions mainly consisting of aerobic high intensity training (8 x 2 min) and speed endurance training (10-12 x 30-s sprints). After the 2 weeks performance in ten repeated 20-m sprints was enhanced ( $33.44 \pm 1.17$  vs.  $32.81 \pm 1.01$  s;  $P < 0.05$ ; Fig. 2). In addition, the protein expression of the Na<sup>+</sup>/K<sup>+</sup> pump  $\alpha 2$  isoform was 15% higher ( $P < 0.05$ ) after the intervention period, whereas no changes were observed in  $\alpha 1$  and  $\beta 1$  isoform expression. Furthermore, running economy was improved ( $P < 0.05$ ), and the amount of pyruvate dehydrogenase was higher (17%;  $P < 0.05$ ). Apparently, intensified training of already well-trained soccer players can cause significant muscular adaptations and improve performance. References Bangsbo J. et al (2008). The Yo-Yo intermittent recovery test: a useful tool for evaluation of physical performance in intermittent sports. *Sports Med.* 38: 37-51. Jensen JM et al (2009). Intermittent high intensity drills improve in-season performance of elite soccer players. In: *Science and Football VI*. Eds. Reilly T. & Korkusuz F. Routledge; 296-301. Thomassen M. et al (2010). Effect of 2-wk intensified training and inactivity on muscle Na<sup>+</sup>-K<sup>+</sup> pump expression, phospholemman (FXYP1) phosphorylation, and performance in soccer players. *J Appl Physiol.* 108:898-905.

##### THE TWO CULTURES OF FOOTBALL RESEARCH: EXPLORING THE POSSIBILITIES OF GREATER INTERDISCIPLINARITY

GIULIANOTTI, R.

DURHAM UNIVERSITY

This paper discusses the interconnections and synergies between researchers in the natural and social sciences with respect to research into football. Hitherto, collaborative research has been rather limited. I examine some of the main institutional and political constraints that have militated against collaborative work in the past. In social science, the lack of full engagement is notable, given shifts into new research and cross-disciplinary territories since the late 1980s, the rise of science and technologies studies (STS), and collaborative work in other fields across the 'two cultures'. I explore the broader professional context in which research might develop, for example with regard to common research settings, funding issues, and external performance pressures (e.g. the REF). I set out some of the possible research problems and issues which may be pursued collaboratively.

## 14:00 - 15:00

### Poster presentations

#### PP-SH17 Physical Activity & Health in Special Populations

##### THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND ARTERIAL STIFFNESS IN PUBERTY

MATSUMOTO, N.1, YOSHIOKA, A.2, TAKAHARA, T.3, NOSE, Y.3, TAKAGI, Y.3, SAITO, T.3, ARAKANE, K.3, YAMAGUCHI, H.4, IEMITSU, M.5, TAKAHASHI, K.6, MIYACHI, M.7, ONODERA, S.8

1)SHUJITSU JUNIOR COLLEGE. 2)KAGAWA UNIV. 3)GRADUATE SCHOOL, KUMMW. 4)KIBI INTERNATIONAL UNIV. 5)RITSUMEIKAN UNIV. 6)TAU. 7)NATIONAL INSTITUTE OF HEALTH AND NUTRITION. 8)KUMMW.

PURPOSE: The systemic arterial stiffness increases with aging. In addition, the high level of systemic arterial stiffness is an independent risk factor of cardiovascular disease. The systemic arterial stiffness is measured by the pulse wave velocity between brachial and ankle arteries (baPWV). Several studies reported that the increase in baPWV was restrained by habitual aerobic exercise in adults. However,



there are a few reports to show the systemic arterial stiffness in puberty. The purpose of this study were to measure blood pressure and baPWV in Japanese adolescents. In addition, we examined the relationship between physical activity and arterial stiffness in puberty. METHODS: four hundred eighty-one healthy Japanese adolescents participated in this study (290 boys and 191 girls, mean age: 13.5±1.0 years). We measured their height, body weight, baPWV and blood pressure. And we examined a sport habit and an outdoor play habit from questionnaire survey. Subjects were divided into two groups from sport habit; sport group (n=395) and non-sport group (n=104). In addition, we divided subjects into four group as physical activity by sport habit and outdoor play habit: Group1 had sport habit and outdoor play habit. Group2 had only sport habit. Group 3 had only outdoor play habit. Group4 had neither habit. We compared each baPWV and physical characteristics. RESULTS: The %body fat and baPWV of sport group was significantly lower than the non-sport group. The time of sport activity minute of one week in exercise group was 521.1±341.6 minutes. No significant correlation was between baPWV and time of sport activity of one week. The baPWV of Group1 was lowest (Group1: 937±133cm/s, Group2: 986±145, Group3: 1016±121, Group4: 1009±129). DISCUSSION: Results of this study suggest the systemic arterial stiffness of adolescents is restrained by physical activity. These results agree with the result of adult. It could be considered that the physical activity affects the arterial stiffness of the adolescents low. (The Ministry of Education, Culture, Sports, Science and Technology, Grant-in-Aid for Scientific Research (C) 21500548) REFERENCE: Matsumoto, N. et al (2010). J Train Sci Exer Sport, 247-256

## INTERACTION OF PHYSICAL MATURITY, BIRTH DATE, AND PHYSICAL FITNESS IN 10–11 YEARS OLD SCHOOLCHILDREN

WATANABE, M., YUGE, M.

COLLEGE OF EDUCATION

**Introduction** Children who mature earlier have larger bodies and superior muscle strength, which affect their selection as sports players. In fact, elite young players in many sports show early maturation (Malina et al. 2004). Their birth date affects their physical fitness and selection as players (Cobley et al. 2009). Because physical maturity and birth date have been researched separately, those factors' interaction (early maturity and later birth) with physical fitness remains unclear. This study is intended to assess the interaction of physical maturity, birth date, and physical fitness. **Methods** Subjects were 10–11 years old (fifth grade) public elementary school students: 396 boys and 371 girls. Their height, weight, hand grip, 50 m run, 20 m shuttle run, and softball throwing data were examined. Three four-month birth date groups were made (three of boys, three of girls). Physical maturity was assessed by height maturity (observed height / predicted adult height). Then students were separated to create three groups (three male, three female) of equal number. All events were compared for Early birth date - Early maturity (EE), Early birth date - Late maturity (EL), Late birth date - Early maturity (LE) and Late birth date - Late maturity (LL) groups using ANOVA. Here, early and late birth dates refer to their relation to the academic year. Results Early maturity groups (both sexes) showed large values for height, weight, and BMI. Hand grip data (both sexes) were significantly different between EE and LL. The 50 m run data for EE and LL in girls were significantly different. Results of the 20 m shuttle run for EL and EE in girls were significantly different. Softball throw data showed no significant difference between sexes. Most physical fitness events showed no significant difference among boys. **Discussion** Physical maturity affects body size and muscle strength more than the birth date does. The EE girls showed high performance for the 50 m run (explosive strength). This result suggests the influences of body size, muscle strength and maturation. In contrast, the later maturing girls showed superior results in the 20 m shuttle run (endurance ability). The lack of difference in softball throw results might be related to their high throwing skill. Although young athletes are affected by physical maturity and birth date, the influence is small for 10–11 years old school children. **References** Cobley S, Baker J, Wattie N, McKenna J. (2009). Sports Med, 39, 235-56. Malina RM, Bouchard C, Bar-Or O. (2004). Growth, maturation, and physical activity, Human kinetics, Champaign, 623-649.

## ASSESSMENT OF AEROBIC CAPACITY AND MUSCLE FUNCTION IN HIGH SCHOOL MALE STUDENTS

MANCHEV, A., PENCHEVA, N., STOILOV, A., KOTCEV, CH.

SOUTH-WEST UNIVERSITY

**ASSESSMENT OF AEROBIC CAPACITY AND MUSCLE FUNCTION IN HIGH SCHOOL MALE STUDENTS** Manchev, A.1, Pencheva, N.1, Stoilov, A.2, Kotcev, Ch.1 1:Department of Sports and Kinesitherapy and 2:Department of Physics of SOUTH-WEST UNIVERSITY (Blagoevgrad, Bulgaria) **Introduction** The role of the physical education teacher is to prepare proper programs of the students and to develop their fitness level in aerobic capacity and muscle strength. So, the aim of our study was: - to test the aerobic capacity and isokinetic knee and ankle muscle strength of male students; and - to assess the correlation between the isokinetic muscle strength and aerobic aptitude of the students. **Methods** Twenty male, high school students (age: 22.5±2.3 years; height: 178.4±1.3 cm; weight: 79.1±3.0 kg) performed treadmill test (Tzvetkov et al., 2008) at an initial speed of 6 km/h, an increase by 1.2 km/h every 90 s until exhaustion. To measure student's maximal ankle (plantar/dorsal flexion: speed - 30, 60, 120 °/s) or knee (flexion/extension: speed - 60, 180, 300 °/s) muscle strength, an isokinetic dynamometer (Biodex System 4 Pro) was used. Body composition was assessed by electrical bioimpedance. Results The mean values ± SD for the peak responses of VO<sub>2</sub> (ml/min/kg), VE (l/min), HR (bpm) and speed (km/h) were: 48±5, 115±25, 190±8 and 11.2±0.9, respectively. The knee extensor/flexor peak torque (mean±SEM) at 60, 180 and 300 °/s was 230±12/117±6, 150±8/87±5 and 104±6/67±4 Nm respectively. The maximal isokinetic plantar/dorsal flexion torques at 30, 60 and 120 °/s were 118±9/45±4, 101±8/34±2 and 75±5/23±2 Nm respectively. A decrease (p<0.05) of the knee flexion/extension ratios, was established. The individual muscle strength for knee extensors, knee flexors and ankle plantar flexors was significantly (p<0.05) related to the fat free mass (r=0.80). However, neither peak VO<sub>2</sub>, nor other parameters of aerobic capacity were related to the muscle strength. **Discussion** Isokinetic muscle strength and maximal aerobic capacity are independent of each other in untrained male students. However, the values for isokinetic knee and ankle muscle strength, which are in agreement with those of other researchers (Dvir, 1995; Schiltz et al., 2009), are accompanied with average aerobic capacity and low pulmonary ventilation. So, the relevant physical education programs have to be recommended in order to increase the cardiopulmonary endurance and aerobic power of the students, although the majority of them prefers isometric training. Because of the muscle imbalance between knee flexors/extensors, special exercise, to increase the strength of hamstring is also appropriate. **References** Dvir Z. (1995) Edinburgh, United Kingdom: Churchill Livingstone. Schiltz M, Lehance C, Maquet D, Bury T, Crielaard JM, Croisier JL. (2009) J Athl Train 44(1), 39-47. Tzvetkov, S (2009) Facta Universitatis, Series Physical Education and Sport, 7(1), 45-53. **Acknowledgements.** The study was supported by Grants D002-54/08 and DVU 01/197 of NS Fund.

## CASE STUDY OF THE EFFECTS OF DAILY PHYSICAL ACTIVITY ON THE ENDURANCE ABILITY IN A BOY WITH DOWN'S SYNDROME

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**Introduction** Much research points out that the physical fitness levels of special needs children are much lower than that of healthy children. The main factor is thought to be a result of a low quantity of daily physical activity among special needs children. Moreover, in children with Down's syndrome, fitness levels are much lower and the incidence of obesity is much higher. The purpose of this study is to investigate the effects of daily physical activity on the endurance ability in a boy with Down's syndrome. **Results** The subject was 11 years old and was a student at a school for special needs education in Japan. We examined the subject's obesity index using the Rohrer-index and Skinfold thickness method, as a result he was termed mildly obese (Rohrer-index: 161.4, body fat: 24.8%). The quantity of his daily physical activity and intensity (light, moderate and vigorous) was estimated by a pedometer (Lifecorder) over two periods: during the school term and the summer vacation. There were significant differences between the school term period and the summer vacation period in number of steps: steps/day ( $9347 \pm 1561$  vs  $7086 \pm 2517$ ,  $p < 0.001$ ), light activity: min/day ( $70.7 \pm 10.3$  vs  $52.6 \pm 13.0$ ,  $p < 0.001$ ) and vigorous activity: min/day ( $6.4 \pm 2.9$  vs  $2.7 \pm 1.6$ ,  $p < 0.001$ ). There was no significant difference in moderate activity. We conducted walking tests before and after the summer vacation to examine the regression line between walking speeds(y) and heart rate(x), which we used as the index of endurance ability. The regression line changed from  $\text{prely} = 1.432x - 108.2$ ,  $r^2 = 0.97$  to  $\text{postly} = 0.415x + 1.42$ ,  $r^2 = 0.99$ , for example the walking speeds at HR 120 beats/min changed from 63.6m/min to 51.2m/min. **Findings** The subject's walking speeds at HR 120 beats/min decreased from 63.6m/min to 51.2m/min after summer vacation. This shows the possibility of a decline in endurance ability over that period of time. We suggest that the decrease in the quantity of daily physical activity during summer vacation influenced the decline in endurance ability. Therefore children with Down's syndrome should maintain a certain level of physical activities as much as they can in their daily lives, and improve their fitness for prevention of other lifestyle-related diseases in the future. We must also support them to become, and remain, healthy in cooperation with teachers, family and their community. We're developing a Smart Phone application that will act as a physical activity support tool for special needs children. We plan to work with teachers of special needs education and will try to support special needs children's physical activity using Smart Phone with particular attention on long-term holidays.

## PHYSICAL ACTIVITY AND BREAST CANCER PREVENTION

CAZZOLI, S., MANO, M.P.

MIUR MINISTER INSTRUCTION UNIVERSITY RESEARCH UST TURIN

**PHYSICAL ACTIVITY AND PREVENTION BREAST CANCER** Cazzoli S., 1, Mano MD 2, 1: MIUR Minister Instruction University Research (Turin, Italy) 2: Department of Biomedical Sciences and Human Oncology, CPO Piedmont, University Hospital San Giovanni Battista Turin (Italy) **Introduction** Physical inactivity has been identified as the fourth leading risk factor for global mortality (6% of deaths globally). The Physical Activity for Health are relevant for the following health outcomes as cancer (breast and colon cancer); functional health and prevention of falls; depression and cancer (breast and colon cancer). (WHO, 2010) La maggior parte degli studi indicano una riduzione del rischio tra il 20% l'80% del CA mammario nelle donne che praticano l'Attività Fisica The literature show that physical activity to prevent from 20% to 80% the development of recurrences in breast cancer (BC) (Fraser GE, Shavlik D, 1997- Dallal CM, Sullivan-Halley J, RossRk, Wang Y, Deapen D, Horn-Ross PL, Reynolds P. Stram Do, Clarke CA, 2007) The aims of the study is education programme for change the life style in woman after breast cancer treatment and prevention of secondary . recurrence in Piedmot (Italy Methods The educational protocol was based nutrition and PA lecture, cooking and gymnastic session. (low impact aerobic gymnastic, yoga , Tai Chi, dance, martial arts, Nordic Walking Results The sample was 58 womens (Breast cancer operated by less than 5 years) and after 1 years of PA educational training the style of life changed: no activity (before 62% after 46,5%): Tipe of activity: no formal (before and after 13,8%) formal (before 24,1% after 34,5%); PA in different age and intensity aged 0-3years; 6-11y; 11-14y; 14-19y; 19-26; 26-35y, Over. Discussion The active life style was determined by personal and cultural factors. They can be supported by: Information Training Support structural and tutorial short-and long-term intervention References WHO, Global recommendations on physical activity for. (2010). Berrino, , Randomized trial of diet, physical activity and breast cancer recurrences: the DIANA-5 study (2005-2010) Bouchard , Bouchard, Bar-Or (1990) Growth, Maturation and Physical Activity, Human Kinetics, Champaign-Il . Cazzoli S., Cecchin S., Griseri G., Scaglia R. (2008) Health in Physical Education Teacher Education curricula and best practices: an Investigation of status of art in the last three years (2004-2007) in Italian secondary school, European College of Sport Science, ISBN 978 972 735 156 5 Wilmore J.H, Costill D. L. (1988) Training for sport and activity. The Physiological Basis of Conditioning Process, 3rd edition, Human Kinetics, Champaign-Il pp350-354

## RISK FACTORS OF BACK PAIN IN PRIMARY SCHOOL CHILDREN

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**INTRODUCTION** The aim of this study was to determine the impact of back pain in primary school children and identify any predisposing risk factors. We aimed to address two fundamental questions: 1) What percentage of primary school students suffer for back pain? 2) What are the main risk factors of back pain in this population? **METHODS** A group of 804 children aged from 5 to 11 years was tested. The sampling involved both sexes and was based on random sampling. Data were collected through a survey sent to the pupil's parents and involved a questionnaire, SDQ-Ita (R. Goodman, 1997) concerning anthropometric data, ability/ difficulties (psychological /psychosocial) and lifestyle. Specific questions on pain and back diseases were asked only to those parents whose children had already encountered this problem. Data are expressed as Average and Standard Deviation, where appropriate. Graph data are expressed as a percentage. Descriptive Statistics was performed with the Microsoft Office Excel 2003 (Professional Edition). Inferential Statistics was performed with the statistical program Statview 5.0. implementing the Binary Logistic Multiple Regression, also calculating the Odds Ratio and Confidence Interval. **RESULTS** Risk factors considered were: female sex, the index of weekly lack of movement and family history of back pain. The incidence of back pain in the sample analyzed was 18%. The incidence of back problems steadily increased from the Year 1 (7.4%) to Year 5 (27.5%) of primary school. The difference between the sexes was 5.3%, (20.2% in girls versus 14.9% in males). Pathological familiarity with at least one family member presenting back pain, was found in 48% of sample examined. The data show for Years 1, 2 and 3 that, as the average time spent in sedentary activities increases from 24% in Year 1 to 40% in Year 3, reaching up to 50 hours per week in Years 4 and 5, the probability of back pain/disorders increases to 57% and 58%. **DISCUSSION** In correspondence with the literature, we

found that there was no correlation between back pain and sleeping position during the night and between back diseases and psychological/psychosocial factors identified by the questionnaire SDQ-Ita. Too much activity or the practice of a sport on a regular basis for more than twice a week does not seem to increase risk of back pain. The present findings warrant the implementation of programmes aimed at reducing physical inactivity among school children. The effectiveness of such programmes requires not only the involvement of coaches and educators but also family support. The best prevention of back pain and spine disorders should in fact start at an early age.

### PHYSICAL ACTIVITY BEHAVIOUR OF UK WOMEN WITH BREAST CANCER

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**PHYSICAL ACTIVITY BEHAVIOUR OF UK WOMEN WITH BREAST CANCER** Clare Stevinson [1], Anne Lydon [2], Ziv Amir [2] 1. School of Sport, Exercise and Health Sciences, Loughborough University, UK 2. School of Nursing, Midwifery and Social Work, University of Manchester, UK Physical activity is recommended following breast cancer treatment based on evidence of positive effects on quality of life, weight control, and survival. Nonetheless, data from North America suggest that few breast cancer survivors meet the minimum guidelines ( $\geq 30$  minutes of moderate/vigorous intensity activity on  $\geq 5$  days per week). **PURPOSE** To determine the prevalence and predictors of physical activity among women with breast cancer in the United Kingdom. **METHOD** As part of a national survey of cancer support group participation, questionnaires including items on physical activity and demographic/medical information were completed by 365 women with breast cancer. **RESULTS** The mean number of minutes of moderate/vigorous intensity physical activity reported per week was 70.7 (standard deviation = 119.5). Overall, only 63 (17.3%) participants were meeting minimum guidelines. The likelihood of meeting physical activity guidelines was higher in participants who were younger than 60 years [relative risk (RR) = 1.93; 95% confidence interval (CI): 1.23 to 3.03], working full/part time [RR = 2.10; 95% CI: 1.34 to 3.27], and in good health [RR = 2.31; 95% CI: 1.28 to 4.18]. Medical variables (disease stage, disease status and time since diagnosis) were not associated with physical activity behaviour. Among those not currently meeting guidelines, 64.4% felt that they should be more physically active. **CONCLUSION** Physical activity levels are low among women with breast cancer in the United Kingdom. However, the majority of insufficiently active participants showed awareness of the need to increase their activity, and may be receptive to interventions for promoting physical activity.

### THE RELEVANCE OF THE BIOMARKER S100B IN THE CONTEXT OF PHYSICAL ACTIVITY – AN OVERVIEW

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**Introduction** S100B is a biomarker for various central nervous system injuries predicting a bad outcome with increased concentrations. It has received growing attention in scientific publications over the last decade. However, there is still no consensus regarding the physiological mechanisms alternating the concentration of S100B (S100B) such as physical activity. The aim of this study is to provide an overview of all publications concerning S100B as a diagnostic tool in the context of physical activity. **Methods** A) Content analysis of a full sample survey of abstracts enlisted in the database PubMed from the last 15 years (1995-2009). • Questionnaire: 4 sections with 22 variables (CR>0.9) • Software: EndNote X3, SPSS Statistics 19 B) In-depth content analysis of selected articles resulting from A) **Results** A) 1747 abstracts are assembled thereof 17 abstracts with S100B used as a diagnostic tool in the context of physical activity. These 17 abstracts are considered in the results: - Published in: 14 journals (2003-2009) - Address corresp. author: Europe (15) (Sweden, Germany, Greece, UK, Italy) and in the United States (North (2), South (1)) - Name of the protein: S100B (5), S-100B (7), S100beta (4), S-100beta (1) - Method of measurement: Immuno Assay (1), biochip array technique (1), not detectable (15) - Unit of measurement: mg\*L-1 (6), ng\*mL-1 (2), not detectable (9) - Carrier: serum (11), saliva (1), peripheral tissue (1), not detectable (4) - Measured values: 0.05-0.28 mg\*L-1 - test subjects: human (16), rat (1) - sex of the test subjects: male (7), female (1), not detectable (10) - physical activities: apnoe diving (2), boxing (2), exercise in heat (3), heading/soccer (8), physical exercise (1), running long/short distance (3/1), swimming race (1), walking (1), not detectable (1) B) Further results will follow **Discussion** Relevant information is often not detectable on the level of abstracts. Further results will follow by an in-depth content analysis of articles based on the choice of A). The design and the results described in the selected abstracts differ. Hence, it is difficult to gain a consistent knowledge regarding the impact of physical activity on [S100B]. Serum S100B values in healthy individuals range from 0.02 to 0.15  $\mu\text{g}\cdot\text{L}^{-1}$ . Results of our investigation show increased [S100B] in healthy persons after physical activity that exceeding this range and discuss it as a possible health risk. The dualistic view that values S100B alterations by physical activity as 'bad' or 'good' distorts the comprehension of the role of this protein in physiological conditions and in cerebral disorders. **References** 1 Dassan P, et al. (2009). Cerebrovasc Dis. (27), 3, 295-302. 2 Ben Abdesselam O, et al. (2003). Clin Chem, (49), 5, 836-7.

### FATTER - BUT MORE ACTIVE? LEVELS OF LEISURE TIME PHYSICAL ACTIVITY IN A NORWEGIAN POPULATION 1984-2008. THE NORD-TRØNDELAGE HEALTH STUDY

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**Background** As all western countries experience an increase in the prevalence of overweight and obesity, one could expect a decrease in leisure-time physical activity (LTPA) level. The aim of this study was to describe changes in LTPA in a general Norwegian population from 1984-86 to 2007-08, and to analyze these changes in relation to changes in body mass index (BMI), resting heart rate, and blood pressure in the same time period. **Methods** We used data from the Nord-Trøndelag health study (HUNT, part 1-3), with data on self-reported LTPA amount and intensity from 61 547 subjects in HUNT1 (1984-1986) and from 42 753 subjects in HUNT3 (2007-2008). We compared LTPA in subgroups of participants, according to gender, age, and BMI, and considered LTPA-data in light of population changes in BMI, blood pressure and resting heart rate. **Results** The main changes in physical activity from 1984-1986 to 2006-2008 include a decline in the proportion of the population reporting < once weekly LTPA (from 41.0% in HUNT1 to 21.8% in HUNT3), and an increase in the proportion reporting  $\geq$  twice weekly LTPA (from 35.0% in HUNT1 to 56.7% in HUNT3). In this time period, BMI increased from 25.2 (SD 3.9) to 27.1 (SD 4.4) Resting heart rate decreased from 74.7 (SD 12.5) to 70.4 (SD 11.7), and systolic and diastolic blood pressure decreased from 138.5 (SD 23.5) to 130.8 (SD 18.5) and from 84.6 (SD 11.6) to 73.5 (SD 11.2), respectively. We saw similar increases in frequency, duration and intensity of LTPA across genders, age groups and BMI subgroups from HUNT1 to HUNT3. **Conclusion** Although self-reported LTPA increased in a Norwegian population from 1984-1986 to 2007-2008, BMI increased in the same time period. This apparent paradoxical trend could possibly be explained through a parallel increase in sedentary time or by changes in diet.

## THE PHYSICAL ACTIVITY LEVELS AND PLAY BEHAVIOURS OF YOUTH WITHIN A SPECIAL SCHOOLS SETTING: AN OBSERVATIONAL STUDY

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THE PHYSICAL ACTIVITY LEVELS AND PLAY BEHAVIOURS OF YOUTH WITHIN A SPECIAL SCHOOLS SETTING: AN OBSERVATIONAL STUDY Boddy, LM,1-3, Bingham, D,2, Ridgers, ND,4, Stratton, G.,2,3 1: ECL, LJMU, UK, 2: RISES, LJMU, UK, 3: The REACH Group, UK, 4: Centre for Physical Activity and Nutrition Research, Deakin University, Australia Introduction Limited research has been conducted within Europe investigating the habitual physical activity (PA) levels and recess PA behaviours of children with Special Needs (SN). International evidence suggests that children and adolescents with disabilities and/or SN are less active than their non-SN peers (Pan, 2008). The aims of this study were to estimate the habitual PA levels and recess play behaviours of children that attended special schools, and to investigate whether PA levels and play behaviours differ by classification of SN. Methods Twenty-five children/adolescents (aged 8-16 years) from 3 special schools in the North West of England participated in this study. PA was monitored over a 7-day period using accelerometry. Recess behaviours were observed for 10 minutes during one recess period using the System for Observing Children's Activity and Relationships during Play (SOCARP). Participants' individual special need(s) were reported by parents and participants were categorised into one of three groups, namely: autism (AUS), behavioural and emotional needs (BEN) and any other SN (OTH). Results Participants failed to meet the recommended daily amount of 60 minutes of moderate to vigorous physical activity (MVPA) per day (group mean 46.88 minutes, SD = 9.10). SN group comparisons found that participants with BEN (65.55 min, SD = 20.50) were significantly more active than participants with AUS (43.40 min, SD = 27.50) and OTH (32.35 min, SD = 17.84) ( $p \leq 0.05$ ). Using SOCARP, group differences in recess MVPA were observed between the groups, (BEN group: 65.54%, AUS: 43.40% and OTH: 37.92%) however these differences were not statistically significant. Participants with AUS spent more time playing alone and less time playing in groups in comparison to the BEN and OTH groups ( $p \leq 0.05$ ). Furthermore, interactions between all participants and their peers were low, with a group mean of 3 interactions per 10 minute observational period. Discussion Findings of the study suggest that children and adolescents with SN did not meet the national PA guidelines of 60 minutes MVPA per day. Furthermore, children with BEN were more habitually active than those with AUS and OTH. Mean data also suggest that children with BEN took part in more MVPA during recess. In addition, AUS participants spent less time playing in groups than OTH and BEN, suggesting that recess behaviours differ by SN. Larger studies are required to gain a better understanding of recess behaviours and the habitual physical activity levels within SN youth. References Pan, C.Y. (2008). Journal of Autism and Developmental Disorders, 38, 1292-1301.

## INFLUENCES OF PHYSICAL EXERCISES ON ALLEVIATING LOWER BACK PAIN AND PSYCHOLOGICAL CONDITIONS

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Introduction Lower back pain (LBP) in Japanese peoples became a serious social problem. There are several previous researches that have indicated that certain types of exercise are effective for alleviating and preventing LBP. Among these researches, there have been some findings that suggest that the basic movements of the traditional Japanese sport of 'sumo wrestling' may be effective for alleviating LBP. However, there have been hardly any empirical studies conducted on this subject. On the other hand, several researches have pointed out that psychological factors may be involved in LBP. At the present time, however, these research results have not yet reached the level of being generally accepted, and it is hoped that further studies will be conducted. Accordingly, this study was conducted to demonstrate the effect of 'the sumo exercises' on alleviating LBP, and to clarify the relationship between LBP and psychological factors. Methods The subjects of the study consisted of 242 adults (77 men and 165 women). These subjects were interviewed to determine the presence or absence of LBP and subjected to four types of psychological tests. The psychological tests consisted of the Big Five personality test, Daily Hassles Scale, SRS 18 test and Purpose in Life Tests. Moreover, the subjects were divided into the following four groups and assigned tasks consisting of 'the sumo exercises', 'conventional lower back exercises', 'the Rikkyo University-type exercises' and 'no exercises' those performed for 10 months. A comparative study was then made of the preventive and ameliorative effects demonstrated by these exercises. Results Correlations with LBP were detected for all psychological parameters. These results showed that persons in a desirable psychological state having low levels of apprehension or anger had a lower degree of LBP. In addition, the effects of each type of exercise were also demonstrated. Discussion In the prevention and alleviation of LBP, an organic (anatomical) approach has conventionally been primarily employed that consists of strengthening supporting muscles of the spine, including abdominal muscles and muscles along the spine. The results of this study, however, supported former reports suggesting the correlation between LBP and psychological factors. It was suggested that a psychological approach should be adopted when attempting to alleviate LBP in the future. In addition, it was discussed that those exercises not only had the effect of strengthening muscle groups that supported the spine, but also refreshed the subjects performing the exercises.

## Poster presentations

### PP-SH18 Sociology of Sport

#### WHAT'S THE DIFFERENCE BETWEEN NORWEGIAN AND DUTCH ELITE FOOTBALL PLAYERS

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Introduction The Norwegian top football centre have started a project they have called the "Worlds best". The aim for the project is to identify world-class competence in football and to find what's behind the success. The centre have made an analyse to separate "good to great", "built to last" and "how the mighty falls" nations. (Collins 2009) Holland was the "good to great" nation that was most similar to Norway. (Johansen 2010) The main aim of this study was to look for differences between Norwegian and Dutch players in age, age when they debuted at the top level, their club background and national background, if they have played for the youth national teams, if they have played on the second highest level before they entered the highest level, what time of the year they was born, their height and if the Dutch players had went trough one of the top level clubs academies. Method: The data is collected from the internet pages for the clubs. The population consists of 321 (mean age 25,92 years +/- 5) Norwegian players and 389 (mean age 24,73 years +/- 4,5) Dutch players

from 16 Norwegian and 18 Dutch clubs. Data were coded for further analysis in SPSS 15.0. Chi square analysis were undertaken to check for differences between the two countries. Significance level was set to  $p \leq 0.05$ . Results: 50 % of the Norwegian players were under 25 years old compared to Holland 63 %. 50 % of the Dutch players came from a club in the two highest divisions compared to Norway 33 %. In Holland 64 % of the players had their debut in the "Eres" division at the age of 19, compared to Norway where 45% had their debut at the age of 19. In Norway only 32 % of the players are foreigner and in Holland it is 45 %. 30 % of the Dutch players played on the second level before entering the highest, in Norway 40 % did the same. 70 % of both Norwegian and Dutch players are higher than 180 cm. There is no difference between the two populations when it comes to which time of the year they are born. About 33 % of the players are born in the second quartile which is higher than the other three. Only 12 % of the players in both countries had played on the national youth team. In Holland 47 % of the players had been through any of the academies. Discussion: There are some differences between Norway and Holland when it comes to age of the players, when they have their debut on the highest level; there are more foreigner players in Holland than in Norway and more of the Norwegian players had played on the second highest level before entering first level, but there is no significant difference in any of the items. There are no differences at all between the two countries in height of the players, which time of the year they are born and how many players which have played on the national youth teams. References: Collins, Jim (2009) How the mighty fall : and why some companies never give in. London, Random House. Johansen, P.A. (2010) "Verdens beste fotballnasjoner- slik tenker og jobber de Norge kan lære mest av" Fotball treneren nr. 3 2010.

## THE CORDIAL IDENTITY OF BRAZILIAN OLYMPIC FEMALE ATHLETES

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**Introduction** Until the second half of the twentieth century, sports was seen as a male institution, whereas the female athletic experience was disregarded. Once excluded from stadiums and other sport places, as well as from the public life determined in that age, the female condition was limited to the dedication to home and family. In Brazil this situation repeats itself. Although the Brazilian women participation on Olympic Games started in Los Angeles 1932, the first medals, symbol of Olympic sportive efficiency, were conquered only in 1996. Although there is an official speech denying the prejudice towards the female sports practice, it is possible to observe throughout Brazilian History the forbiddance for girls of some sportive practice at school like soccer and judo, triggering a delay in performance comparing men in Olympic competition. **Objective** The objective of this paper is to present the trajectory of Brazilian female sports and to show social and cultural aspects that contributed for the actual stage. **Method** The method for this investigation was Oral History, more specifically Life Histories. 270 interviews with female athletes were made, who participated in Olympic Games since 1948 until 2008, medalists and non-medalists. The age from these athletes ranged from 22 to 83 years old. From their narratives specific elements were taken to debate the identity issue. **Discussion** The development of the Brazilian Female Athlete's identity in Brazil follows different paths than in the USA or in Europe. This situation is directly connected with the directions of the feminist movement in the broadest sense, nearing what Buarque de Holanda features as "cordiality". The sense of cordiality in Brazilian culture points to a way of solving disagreements and disputes in an affective way, avoiding the straight and objective conflict. The development of this attitude can be perceived in the non-observance of discrimination and prejudice by the female athletes themselves. From the 270 interviewed athletes, only 7 of them have attributed discrimination to the fact of being women, either receiving less prizes and sponsorship than men or being forbidden to take part in some competitive activity because clearly for the fact of being women. **Conclusion.** The non-recognition of gender discrimination by Brazilian Female Athletes indicates a characteristic of the feminist movement in Brazil: to look for a way of conciliation, more than confrontation. This appeasement of gender relations in sports brings results such as the difference in the prizes' payment, less participation in sponsorship's money and less social recognition for the effort that provided the conquest of this position.

## RESPONSIBILITY IN WILDWATER SPORTS

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**Introduction** In the last years, the sports practice in natural areas has experienced an exponential growth, both in number of users and in diversity of the existing modalities. The shortage of legislation about it (Nasarre et al., 2001) causes the non-existence of standard criteria for the determination of the responsibility in all the incidents. Therefore, focusing our attention on the wildwater sports modalities - canyoning, canoeing, rafting and hydrospeed-, we present the analysis of the judgments of the accidents happened in Spain since the 80s. **Method** The method used is based on the analysis of content of the existing judicial judgments on Spain of accidents during the practice of wildwater sports: findings of fact, grounds of law and ruling of the judgment. **Results and discussion** In 5 of the 15 analyzed cases the accident ended with the death of the victim. Even so, it is surprising to realize that only one of them was taken to the criminal courts. In relation to the ruling of the judgment, only in the 13 % of the cases the demand sued by the victims or their family was totally considered. In more than the half of the cases (67 %), the demand was totally rejected and in a 20 % of the cases, it was partially considered. In only a 13 % of the cases considers the sued party (people or entities in charge of the activity) as the entire responsible of the accident. On the other hand, in a 33 % of the cases, the victim is defined as the responsible of his own injuries, by the consideration of the own assumption of risk (Ortí, 2001) and the principle of self-protection. In only a case it is considered the shared responsibility. It is necessary to emphasize that in almost the half of the analyzed judgments (47 %) it is determined that the responsibility cannot fall on any of the implied parties, because of the assumption of the implicit risk of the activity. The changeable conditions of the natural areas and the diversity of accidents that can take place, do not allow an establishment of a few criteria applicable to all the cases. Nonetheless, through the analysis of the existing judgments, we can observe trends in the jurisprudence on the accidents happened during the sports practice in the natural areas. **References** Nasarre, J.M.; Hidalgo, G.M.; Lucia, P. (2001). La vertiente jurídica del montañismo. Zaragoza: Prames. Ortí, A. (2001). La jurisprudencia sobre responsabilidad civil deportiva. Pamplona: Editorial Aranzadi.

## ROLES' DYNAMICS INSIDE SPORTS TEAMS: FACTUAL AND PERCEPTUAL ASPECTS

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**Introduction** The first step in analyzing the evolution of a team is to understand the dynamics of the group as a social unit. Focusing on the dynamics of roles inside the team, the main aim of this study is to analyze the relationship between the social dimension and the task dimension of the group. Moreover, these aspects of group dynamics are approached from two complementary perspectives that are

based on a re-contextualisation of the looking glass self model: the manner in which each athlete perceives that he is seen by his colleagues and the way he himself evaluates other members' positions inside the team. **Methods** The research design of this case study on a professional handball team from the Romanian Feminine Handball Championship is based on a mix-method approach that combines a sociometric analysis of group members' relationships, on both factual and perceptual level, with the observation method applied during training and competition contexts over a period of two competition seasons and in-depth interviews with the team's coach. **Results** The results revealed the fact that there is a contamination effect between the social evaluation of the members' positions inside the team and the task evaluation of their positions at the group level. Another key finding is that, if the difference between athletes' individual performance is not very significant - in terms of objective indicators of performance, the level of intra-group competition has a direct impact on how other group members' positions in the team are evaluated. **Discussion** The fact that the analysis of team's dynamics follows the group social evolution and is not limited to just a one-time frame is relevant for understanding the nature of interactions inside a sports team. Based on the comparison between the athletes' self perception and their actual position inside the team, one can therefore understand the possible directions of evolution regarding team's dynamics. Moreover, the study outlines the relationship between the actual positions that athletes have in the team and their perceptions of group dynamics, setting the objective dimension against the subjective dimension of roles' dynamics inside the team.

## SPORT CLUBS IN CATALONIA. CATALAN SPORTS OBSERVATORY

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**Introduction** The Catalan sports system generates a large volume of information that is dispersed among organisations, communities, teams and individuals of the world of sport. In this sense, the main objective of the Catalan Observatory of Sport is to manage and structure all this knowledge and make it accessible to everyone. One of the working lines in order to build this knowledge is through research studies. Here, we present the study results on the situation of sport clubs in Catalonia (General Secretariat of Sports. Catalan Sports Council, 2010). Due to the lack of previous studies at the state level, a research study carried out in Germany was used as a model (Heinemann & Schubert, 1994). **Methods** The method used for this research was based on a questionnaire and its application has been through a standardized interview (demoscopic interview). The questionnaire consisted of a total of 52 questions of which only 2 were open and the rest were closed. The sample of 1,000 clubs was considered to be of a high representativeness as the results were applicable to 95% of the Catalan sport clubs with a margin of error of only  $\pm 3.0\%$ . **Results and discussion** In Catalonia there are 8,285 sport clubs. Half of them have no more than 100 individual members and only 5% exceed 1,000. More than one third (36%) of the clubs were founded after 1997. In relation to their members, 62.6% are men and 37.4% are women. This difference is even bigger in the presence of women (20.7%) on the boards, where only 11.9% hold the presidency. In the Catalan sport club 39% of the people involved in the daily running of the club are voluntary. This implies a valuation of more than 213 million euros annually. Catalonia has 69 sport federations and 91% of the Catalan sport clubs are members of one or more of them. The three federations with more clubs are Football (17.7%), Hunting (9.4%) and Basketball (5.8%). Although, the majority of the sport clubs (88%) were constituted with the purpose of competing, 71% of these offer complementary activities outside competition. **References** Heinemann, K., Schubert, M. (1994). *Der Sportverein: Ergebnisse einer repräsentativen Untersuchung*. Schorndorf: Karl Hofmann. [Schriftenreihe für Sportwissenschaft Bundesinstituts December; 80] Heinemann, K. [Et al.] (1997). 'Sports clubs in Spain and Germany: a theoretical and empirical comparison [online]. Notes. Physical Education and Sports, no. 49, p. 40-62. Available: [http://articulos.revista-apunts.com/49/ca/049\\_010-019\\_cat.pdf](http://articulos.revista-apunts.com/49/ca/049_010-019_cat.pdf)

## CAREER TRANSITION OF ELITE ATHLETES IN HONG KONG

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**Introduction** According to the statistics of the Home Affairs Department of Hong Kong China, the number of athletes receiving training and support from the Hong Kong Sports Institute (HKSI) in elite and non-elite sports has grown from 545 in 2005 to 863 in 2009 (LegCo, 2010). Whether or not an elite athlete experiences his/her glorified moment in the sports arena, ultimately, retirement from a sports career is inevitable (Stier, 2007). There are approximately 30-40 elite athletes who retire every year. The retirement age ranges from 25 to 29 (LegCo, 2010). Therefore, the purpose of this study was to explore the process of career termination of retired elite athletes in Hong Kong. The research aimed at adding information to the literature of sports career transition in an Asian context. The results of the research would help athletes, coaches, and managers to understand the process, and how elite athletes cope with career transition. In addition, the intent was to provide insights for development of career assistance and support systems in Hong Kong. **Methods** A qualitative research design was adopted. Utilizing a purposive sampling method, 3 elite athletes in the fields of swimming, fencing and rowing, who had retired from training, participated in an in-depth semi-structured interview. Each of the athletes had participated in the East Asian Games (EAG) or the Asian Games (AG) and was medalists. One of them participated in the Summer Olympic Games (OG). Interview questions were modified, from guided questions created by Kadlicik and Flemr (2008), to suit the Asian context. The questions focused on the participants' experiences in the transition process from the athletic life to the post-sport life. Applying the principles of grounded theory (Strauss & Corbin, 1998), qualitative data generated from the interviews were analysed, coded and utilized. **Results** The results were developed from the following three dovetailing transition stages: a) the active athletic identity stage; b) the realization of termination stage; and c) the adjustment stage. The associations between each stage are variable according to an individual's response to the environment, and to the impact of interventions for coping with the termination experience. **Discussion** Although the three conceptualized stages of career transition are based on the retrospective data of three retired elite athletes, the findings were consistent with the previous findings of Stambulova et al. (2009) and Taylor & Ogilvie, (2001) which suggested that athletic career termination was not a single event but a transitional process. Career transition might not be a crisis or "social death," but could evolve as a result of appropriate interventions at different stages. This study also revealed that each transitional stage dovetailed with the other which means that the termination factors had started somewhere in the strong identity stage and were on-going through the process.

## PSYCHOSOCIAL INTERVENTION PROGRAMME USING BASKETBALL TO DEVELOP LIFE SKILLS IN YOUTH AT RISK OF DELINQUENCY \*

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**Introduction** Adolescents from underserved multiethnic milieus are at risk of school drop out and of getting involved in street gangs. The "Bien dans mes baskets" (BdmB) programme, implemented in 2001 in a high school of Montreal (Québec), uses basketball to reach adolescents at risk of delinquency. The main characteristic of BdmB is that the coaches are also social workers that intervene among adolescents through an extracurricular basketball programme. They focus on the development of life skills in youth at risk. Objectives The aim of this study was to examine how the experiences lived through BdmB contributed to the development of life skills in young adults who have participated in the programme between 2001 and 2009, and how they transferred these life skills in their everyday life. Methods We used a retrospective qualitative study design. Semi-structured interviews (mean length = 90 min) were conducted with 14 young adults (mean y. o. = 22) who were involved in the BdmB programme during their high school. Interviews were audiotaped and transcribed verbatim. Analysis was guided by the grounded theory approach (Glaser & Strauss, 1967). A thematic multilevel (vertical and horizontal) content analysis of participants' accounts was performed to identify the specific role of team sport involvement with psychosocial interventions on the alumni players' life skills development, and its transfer to their everyday life in post-intervention. Results Group interactions and social workers' interventions were significant factors in the improvement of life skills. The sense of belonging to the programme also seemed to have contributed to this development. Moreover, BdmB was perceived as a protection to the negative influences in their living environment. However, the maintenance of these improved skills appeared to be influenced, positively and negatively, by post-high school interactions with the social environment. Conclusions While team sport appears to be a favourable context for the development of life skills in youth, the psychosocial interventions represent a key factor in this development. Furthermore, their maintenance seems to be influenced by the "quality" of the social environment during post-high school period. References Danish SJ, Forneris T, Wallace I (2005). *J Applied School Psych*, 21, 41-62. Glaser BG, Strauss AL (1967). *The discovery of grounded theory*. Chicago: Aldine Papacharisis V, Goudas M, Danish SJ, Theodorakis Y (2005). *J Applied Sport Psych*, 17(3), 247-254. \* This research was funded by the Fondation Lucie et André Chagnon and the Fondation du CSSS Jeanne-Mance

## JAPANESE SWIMMING EDUCATION FOR THE FOLLOWING GENERATION -A COMPARISON WITH WATER SAFETY EDUCATION IN NEW ZEALAND-

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**Introduction** In Japan, more than 90% of the elementary and junior high schools have swimming pools, and the schools hold swimming classes as part of physical education in accordance with the teaching guidelines. However, deaths due to water accidents are the highest in Japan among all the OECD countries (WHO, 2004). The above mentioned Japanese swimming classes have low effectiveness in decreasing deaths caused by water accidents in Japan (Toriumi et al., 2009). To consider the purpose of swimming education for the following generation, it is important to compare Japanese swimming classes with such classes in other countries. New Zealand is one of the countries with a successful system for swimming and water safety education (Moran, 2009; Moran, 2010). Thus, we conducted interviews to understand swimming and water safety education in New Zealand. Methods The author and co-author visited various facilities related to water safety in Auckland, the capital of New Zealand. The following sites were visited: (1) Auckland University, faculty of education, (2) Water Safety Auckland Inc., (3) Surf Life Saving, (4) Coastguard Service/Maritime Police. Results Water safety education in Auckland is often held in natural environments, such as rivers and lakes, as it is difficult to prevent water accidents in such environments. However, teachers and trainers utilize guidelines that water safety companies and researchers have created to ensure safety during swimming classes held in such environments. Water safety companies and researchers study and summarize aspects of water safety every year, and teachers and trainers study these results to ensure safety during swimming classes held in natural environments. Discussion This system of reciprocity between water safety research and education in Auckland is one reason why New Zealand's mortality rate due to water accidents is lower than that of Japan. In Japan, such a reciprocal system does not exist, and water safety education is seldom held in natural environments because the number of such environments is limited, and most natural environments are equipped to protect people from water accidents. References Moran.K.(2009) *International Journal of Injury Control and Safety Promotion*, 16(4):215-221. Moran.K.(2010) *International Journal of Aquatic Research & Education*, 4(3):269-277. Toriumi T., Haruki T., Fujimoto H., Ishide Y., Nomura T., (2009) *Proceedings of 13th annual congress of Japanese Society of Science in Swimming and Water Exercise*, 13(1): 110-111. WHO, (2004) *Mortality Database*

## POLISH FENCERS AS AN ATHLETES SITUATED BETWEEN AMATEURISM AND PROFESSIONALISM

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**Introduction** The purpose of this study was to establish what kind of sport's model is represented by Polish Fencers. To analyze this issue, Zbigniew Krawczyk's theory (1995) was used. In his concept there are four models of modern sport (complete amateur sport, not complete amateur sport, not complete professional sport, complete professional sport). This typology is based on the economic factor, which is a main stimulator of athletes sport activity (Krawczyk, 1995). The next step was to investigate, which dimension of competitive sport (Heinemann, 1989) is the most important for respondents. To achieve this goal respondents were asked about the most important thing for them in fencing. Possible dimensions of competitive sport, like bodily, sporting, intellectual, social, economic, esthetic and a mix of them were taken into account (Heinemann, 1989). The amateurism can be treated as a sociological problem (Gruneau, 2006). Methods This research was conducted with 100 polish fencers (47 women and 53 men). The largest group (68%) was represented by seniors (21 years old and more). Rest of respondents were juniors (18-20 years old) - 25% and cadets (15-17 years) - 7%. An average competitive experience was 10,7 years. The diagnostic pool was used. Questionnaire had both close and open questions. The purposive sampling (Babbie, 2004) technique was used in the selection of the sample. The research was conducted during Polish Seniors Championship in 2009. Collection of data have taken two days. The SPSS program was used to process data and statistical analysis. Results and Discussion Most of the respondents were representing a model which is between "not complete amateur sport" and "not complete professional sport". Respondents declared, that in fencing, victory was most important for them (95%). It means that sport dimension is the most important for Polish fencers. This was admitted by 100% women and 90% men. The research also emphasize the economic dimension

as similarly important. Stipends and awards are crucial for 62% of respondents. It is worth to remember that these are theoretical models. In reality, the situation of amateur athletes is more complicated. The meaning of economic factor increases with the athletes professionalism, even if these athletes in theory are amateurs. References Babbie, E. (2004). *The Practice of Social Research*. PWN, Warsaw Gruneau R. (2006). *Sport in Society*, 9, 559- 582 Heinemann K. (1989). *Introduction to sociology of sport*, 54-56, Warsaw Krawczyk Z. (1995). *Sociology of physical education*, 214-226. University of Physical Education, Warsaw.

## THE RELATIONSHIP BETWEEN SOCIAL COMPARISON AND COACHES' ORIENTATION TOWARDS COMPETITIVE SITUATION

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**Introduction** How coaches behave depends on the representation they have towards their role and towards the competitive situation itself. Therefore, the aim of this study is to analyze the relationship between the coaches' orientation towards the competitive situation and the way they define their role in relation to the competitors. Based on combining conceptual elements from social dramaturgy, achievement goal theory and social comparison theory, the study outlines the main perspectives on sports field from the view point of the coaches' social representations upon sport context and actors. **Methods** The qualitative approach is based on semi-structured interviews with handball coaches from the first and the second professional leagues from the Romanian Feminine Handball Championship. **Results** The results show that the dominant orientation in defining the competitive situation is the goal orientation and the differences between self-improvement and domination type of goal orientation is based on the nature of social comparison the coaches' use towards their competitors. **Discussion** When faced with a downward or lateral comparison, coaches tend to use an orientation to domination, while in case of upward comparison they prefer a self-improvement goal orientation to minimize the impact of the competition result on the level of self-esteem. Moreover, the balance between social and temporal comparison is strongly influenced by contextual factors, among which the evaluation of the competitor and of the winning chances are the main ones.

## Poster presentations

### PP-SH19 Sports Management 2

## TO LEAVE A 'SPORTING LEGACY'? THE DEBATES ON INCREASING GRASSROOTS SPORTS PARTICIPATION OF HOSTING THE 2012 LONDON OLYMPIC GAMES

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**Introduction** This discussion is about the potential impacts of the Olympic Games and primarily about debates on increasing grassroots sports participation of hosting the 2012 London Olympic Games in UK. **Methods** The documentary-based element takes the form of qualitative content analysis, which applied to the form of analysis of a number of British sport official reports, academic articles, and media commentaries in the 2008-10 period. In total, 107 documents were reviewed and 53 commentaries were identified to conduct this research. The data was subject to analysis and coding employing the NVivo 8 software package. **Results** The 'predicted or claimed' benefits of increasing grassroots sports participation from the 2012 Olympic Games may not be as large as expected. Arguments from governmental sectors or academic research are divided. As attitude toward the potential impacts on increasing grassroots sports participation, the number of pessimists and optimists both rose slightly, though optimists (51.2 %) still outnumbered pessimists (48.8 %). **Discussion** The relatively even split indicates that the uncertainty of how much increased grassroots sports participation can be generated by the 2012 London Games. Indeed, the promise of increased sports participation was central to London's successful bid to host the 2012 Games. However, hosting a major sporting event is actually one factor among many that has an impact upon grassroots sports participation rather than being a direct causal motivator in and of itself (Weed et al., 2008). Interestingly, those specific elite sport developing programs have invited criticisms from various actors such as charities, arts grass roots sport which are already suffering a decrease in income because of the financing of the Games. Thus, it's hard to claim what extent the grassroots sports participation would be boosted/increased by hosting the 2012 Olympic Games. **References** Weed M., Coren, E, Fiore J. (2008). A systematic review of the evidence base for developing a physical activity, sport and health legacy from the London 2012 Olympic and Paralympic Games, 1-127. Canterbury Christ Church University, Kent.

## SPORT ORGANIZATIONS THAT DELIVER YOUTH SOCCER: SAME COMPETITION, DIFFERENT MODELS?

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**Introduction** The clubs are important to sport offer and promotion, being responsible for the individual's organized sports participation. They provide conditions for athlete's development and the involvement of significant others in sport and, as organizations, they transmit their organizational culture. It is believed that this ecology of practice can influence the way athletes and communities perceive their sport experience. The aim of this study is to identify the soccer clubs model of organization, their culture, goals and answers to the demands of the surrounding environment. **Methods** Three Portuguese soccer clubs were analyzed, in different contexts. One professional club (PC) and two amateurs (AC) of regional level (one of rural area RAC, other of urban area UAC). A documental analysis of the clubs was performed. Semi-structured interviews with presidents in AC and, with the manager of youth specialization department in the PC were made. To analyze the interviews content analysis was used. **Results** The AC seems to be homogeneous among themselves and heterogeneous in relation to PC. The PC contains more formalized, specialized, complex and orientated to performance operating principles. That is verifiable by a structure with specialization of function and personnel. The AC present a much more simple structure, low formalizing and bureaucracy, which suggest a strong centralization. Their declared goals are related to community and local development. Both refer difficulties in hiring and securing collaborators. **Discussion** The results about structure, human resources and goals fit with those of previous studies (Papadimitriou, 2002; Nichols, Gratton, Shibli, & Taylor, 1998). The PC, by its way of function, holds a more prepared and solid position, provides better conditions to sports development, disassociating itself from the organizational style of UAC and RAC. The



PC orientation to performance results, may lead to promotion of anti-social and anti-ethical attitudes and values in the athletes (Rocha & Turner, 2008). The AC, despite their less complexity, foster a greater sense of community and confidence, as well as a greater pleasure and opportunities to health improvement (Institute for Volunteering Research, 2007). References Institute for Volunteering Research (2007). Volunteers in sport: assessing the impact. Volunteering England. London. Nichols, G., Gratton, C., Shibli, S., & Taylor, P. (1998). Local Authority support to volunteers in sports clubs. *Managing Leisure*, 3, 119-127. Papadimitriou, D. (2002). Amateur structures and their effect on performance: the case of Greek voluntary sports clubs. *Managing Leisure*, 7, 205-219. Rocha, C., & Turner, B. A. (2008). Organizational Effectiveness of Athletic Departments and Coaches? Extra-Role Behaviors. *Journal of Issues in Intercollegiate Athletics*, 1, 124-144.

## THE INTERGRATIVE STUDY OF RECREATION INDUSTRY IN PING-TUNG REGION OF TAIWAN

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**Introduction** The development of recreation industry has gathered great importance in recent years, especially in Ping-Tung region, Taiwan. With the increasing usage of recreation, government's requirements for recreation planning have become more critical. The purpose of this study was to determine if the use of leisure theory would improve the recreation industry of Ping-Tung area in Taiwan. **Methods** This study adopts the Delphi Method to integrate the leisure theory and the opinions of experts from the enterprise, the authority, and relevant academic fields through questionnaire survey, in order to construct an integrative study between recreation enterprise and policy, and thus the integrative model emerged from the Ping-Tung recreation enterprise and policy oriented mechanism is to meet the challenges and to adjust policy enforcement. **Results** By the way of analyzing the recreation industry of Ping-Tung region, there are some conclusions as followings: 1. The plan of public administration: (A) To integrative the justice and rational recreation industrial policies. (B) To establish internationalization, liberalized and competition recreation industrial policies. (C) To take this profit (I/O) as the execution basis of recreation industrial policy. 2. Leisure administration organization achievement: (A) To ponder five W-Hs. (B) To use SWOT. (C) To considerate the legal relationship. (D) To construct the problem solving patterns. (E) To adopt the management by objectives. 3. The future administration organization models: The Ministry of Transportation and Communications should set up the standard rules including the tourist, the tourism management, the environment and the traveling security. **Discussion** The development of recreation industry is a reflection of society patterns and life quality, and government's recreation planning with relevant service behaviors has educational implication and manifests value judgment. The value of the study lies in highlighting the government's planning and management, which will determine the efficacies of customer experience, inclusive of economic, and non-economic efficacies; economic efficacy refers to the use of expenditure amount to measure the service value of recreation industry, whereas non-economic efficacy refers to the emphasis of patterns of consumption and recreation to fulfill educational implications and behavioral changes. References Chang K M, Ting W C, Cheng J C M. (2011). Program Book of 2011 ICHPERSD Asia Congress, Taipei, Taiwan. Dattilo, J. (2008). *Leisure Education Program Planning: A Systematic Approach* (3rd Ed) .Pennsylvania: Venture Publishing, Inc. Veal, A. J. (2002). *Leisure and Tourism Policy and Planning*, CAB International, Wallingford, Oxon, UK.

## ASSESSMENT OF FUNCTIONS OF SPORTS IN TERMS OF INTERNATIONAL RELATIONS

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**Introduction:** This research has aimed reveal whether some of the reference groups that have given a shape to sport use it as a means of an objective of foreign policy at the international relations or not. The research group consists of 57 members of parliament, 32 federation chairmen and federation secretary, and 51 academicians, total 140 persons. **Methods:** As a means of data collection; "International Relations and Sport Interaction Survey" was used. After survey factor analysis was completed, it has been divided into three dimensions (political, economic, and military). The views of these persons have been examined through the personal variants. These variants are age, seniority and education. At the data analysis t-test and at the groups more than two unidirectional variances analysis (Anova), and at settling in which groups there is a difference Tukey statistic techniques were used. At the research,  $p < 0.05$  relevance level has been the base. **Result and discussion:** In the wake of the research, when the data of the ones taking part in the study on International Relations and sport Interaction (academic personnel, federation chairman, federation general secretaries and members of parliament) has been examined according to their ages, age 31 and underneath, between 31-40, up-40 economic means consequences respectively; %12.0, %55.1, %32.9, political means consequences; %11.9, %54.9, %33.2, military means consequences; %11.2, %57.9, %30.9. When the data has been examined according to the seniority, age 11 and underneath, between 11-20, up-20 economic means consequences respectively; %16.3, %60.8, %22.9, political means consequences; %16.1, %60.4, %23.5, military means consequences; %15.9, %63.1, %21.0. When the data has been examined according to the education, undergraduate and master, economic means consequences respectively; %28.5, %71.5, political means consequences; %28.3, %71.7, military means consequences; %27.9, %72.1. Among the reference groups that have taken part in the study in Turkey, sport is used for a political tool in the international relations mostly. References: SUNAY, H. (2010) *Organization in Sport*. Gazi Kitabevi, Ankara. BUDD, A. (2004) *Sport and International Relations*, 1st Published, New York.

## SPORTS SERVICES IN TIRANA: CUSTOMERS' SATISFACTION OF TOWARDS SERVICE QUALITY OF FITNESS CENTRES

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**Abstract** Lalazi, Y.1, Lile, A.1, Rizvanolli, V.1, 1: UST (Tirana, Albania) **SPORTS SERVICES IN TIRANA: CUSTOMERS' SATISFACTION OF TOWARDS SERVICE QUALITY OF FITNESS CENTRES** **Introduction** Sports and leisure service is an emerging field in Albanian marketplace. The sport product is a complex package that offer bundles of benefits to satisfy customer wants and needs (Mullin, Hardy, & Sutton, 2007). As competition among the fitness centers is increasing, customers' satisfaction becomes an integral part in the sport business. The aim of this study was to investigate and recognize elements of sport services that contribute to enhance the service quality in sports and leisure, in Albania context. **Methods** This study was focused on analyzing sport services in Tirana comprising to stages: Stage1) General overview of Sport Services in Tirana, where the data was gathered from the Municipality tax office; Stage 2) Measuring Customer Satisfaction using SERVQUAL service quality (Parasuraman, Zeithamal, & Berry, 1991). Participants in this study were 120 members randomly selected from 3 fitness centres in Tirana. 96 out of 120 members responded. The data for this study were gathered over a 7-week period using questionnaires. SERVQUAL was the instrument used in this study- a perceived service quality questionnaire which examines five dimensions of service quality: Reliability, Responsiveness, Assurance, Empathy, and Tangible. SPSS 17.0 was used for statistical analyses. Results There

are currently 60 private activities operating in the sport field from 2001 to 2010, classified in sports complex (30%), gym(38%) and fitness centers (32%) in Tirana, where (77%) are small business and (23%) are big ones. The highest satisfaction level was placed on the 'empathy' dimension, followed by 'assurance', 'tangibles', 'reliability' and 'responsiveness' respectively. Two-ways statistical ANOVA analyses were conducted and revealed four statistically significant differences between "actual" and "preferred" scores for the 'assurance', 'tangibles', 'reliability' and 'responsiveness' scales. Results revealed large F-ratios for 'tangibles' (3.661), 'reliability'(4.883) and 'responsiveness' (3.879) scales. Discussion Results revealed that the customers' satisfaction was at the average level in overall aspects (2.89), and sport business should invest more in this direction. Support on the items of critical scales ('tangibles', 'reliability' and 'responsiveness') should be improved to increase service quality perception. Future studies may extend this research through increasing the customers participation in the survey and adding other criteria in parallel with changes in the sport field. References Mullin, B., Hardy, S., Sutton, W.(2007). In Schang M., Pyrtel T. R., Ewing S. A. (Eds.), Sport Marketing, 3rd edition, chap. 7 "Sport product", (pp. 147-170), Human Kinetics. Parasuraman A; Zeithaml V. A; & Berry L.L. (1991). Refinement and reassessment of the SERVQUAL scale. Journal of Retailing. Vol.67. pp. 420-450.

## Poster presentations

### PP-TH02 Altitude Hypoxia 2

#### EFFECTS OF ACUTE NORMOBARIC MODERATE HYPOXIA ON FATIGUE AND STEADINESS DURING SUBMAXIMAL ISOMETRIC CONTRACTIONS

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Introduction Acute hypoxia alters fatigue of isometric contractions of skeletal muscles (Goodall et al., 2010) and is associated with changes in electromyographic responses (Katayama et al., 2007). Muscle fatigue during sustained isometric contractions results in an increase in force fluctuations, i.e. a decline in steadiness. Neuromuscular responses during hypoxia may influence fatigue and steadiness of skeletal muscles. We examined the effect of acute normobaric moderate hypoxia on the performance of isometric contractions of skeletal muscles. Methods Ten (8 male, 2 female) subjects (23±3 yr, 78±8 kg, 179±8 cm) volunteered. Subjects breathed normoxic (N, FIO<sub>2</sub>: 21%) or moderate hypoxic (H, FIO<sub>2</sub>: 14%) gas mixtures providing arterial oxygen saturation of 98% and 88%. Familiarized subjects produced maximal voluntary isometric force (MVIF) of m.quadriceps femoris (knee angle 90°), a 20%MVIF until force fell below 18% for 3 s and 20 seconds after completion of the 20%MVIF a measurement of MVIF to quantify fatigue. Steadiness during 20%MVIF was quantified by the coefficient of variation (SD/mean x100). Surface EMG (Bagnoli-2, Delsys) of m.vastus lateralis and m.vastus medialis was recorded and analysed for root mean square (RMS) and median frequency (MF). Data were analysed with 2-way ANOVA and paired t-tests with significance set at P<0.05. Results There were no differences between conditions for force of maximal voluntary contractions (N: 565±116 N, H: 540±187), steadiness (N: 6.9±2.0; H: 6.3±1.7), time to fatigue (N: 358±97 s, H: 357±112 s), and fatigue index (N: 40±19%, H: 41±16%). In the hypoxic condition, changes in RMS during 20%MVIF were lower in m.vastus medialis but not in the m.vastus lateralis (n=9). During 20%MVIF, there was no change in MF of the m.vastus medialis in both conditions but similar decreases in MF for the m.vastus lateralis (n=9). Discussion Moderate hypoxia did not affect time to fatigue during a sustained 20% isometric force which may be due to partial occlusion of blood flow at this intensity (Sejersted et al., 1984) resulting in similar muscle oxygenation levels in both conditions during fatigue testing. Neuromuscular responses to acute normobaric hypoxia were different for muscles of the m.quadriceps femoris with the level of activation higher during normoxia for m.vastus medialis but without effect on steadiness. Peripheral mechanisms contributing to isometric fatigue of submaximal sustained contractions during moderate hypoxia may be muscle-dependent. References Goodall S, Ross EZ, Romer LM. (2010). J Appl Physiol 109, 1842-1851. Katayama K, Amann M, Pegelow DF, Jacques AJ, Dempsey JA. (2007). Am J Physiol Regul Integr Comp Physiol 292, R1279-R1286. Sejersted OM, Hargens AR, Kardel KR, Blom P, Jensen O, Hermansen L. (1984). J Appl Physiol 56, 287-295.

#### EFFECTS OF TIMING FOR HYPOXIC EXPOSURE ON GROWTH HORMONE RESPONSE AFTER RESISTANCE EXERCISE

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Introduction Previous studies (Kurobe 2010) have reported that when resistance exercise is performed in hypoxia, growth hormone (GH) secretion after exercise is further increased compared to that after the same exercise is done in normoxia. However, it has not been clarified whether the greater GH secretion after exercise is affected by timing for the hypoxic exposure, i.e. hypoxic exposure from pre-exercise, or only after the exercise. Therefore, the present study aimed to examine the effects of the timing for hypoxic exposure on GH response after resistance exercise. Methods Twenty-one healthy male adults (23±1 yrs) were matched for exercise capacity level into three groups, and then randomized to normoxic group (N; n=7) and 2 hypoxic groups (H1; n=8, H2; n=6). H1 was exposed to hypoxic condition (O<sub>2</sub> 12.7%) from pre-exercise (30 min) to recovery period (60 min) through the experiment, and H2 was exposed to the same hypoxic condition only after the exercise (i.e. during recovery period). They performed elbow extension exercise at the workload of 10 repetition maximum (RM) to the exhaustion in each set, and it was repeated 3 sets with 1 min rest between sets. Blood samples were obtained before exercise and during post-exercise recovery period (immediately, 15, 30, and 60 min after the exercise) to determine blood lactate (LA), serum GH, serum cortisol concentrations. Results In each group, LA values at immediately and 15 min after the exercise were significantly higher than that at pre-exercise (P<0.05). In the comparison among the groups, there were no significant differences in LA values through the experiment. GH during recovery period was significantly increased only in H1 but not in N and H2, when compared to that at pre-exercise (P<0.05). Furthermore, when GH during recovery period was compared among groups, the values at immediately and 15 min after the exercise in H1 were significantly higher than those in H2 (P<0.05). Also, GH at 60 min in H2 was significantly higher than that in N (P<0.05). Cortisol in N was significantly decreased at 60 min compared to that at pre-exercise (P<0.01), while no significant changes were found in H1 and H2 throughout the experiment. Discussion/Conclusion Our results indicate that even in hypoxic exposure only after the exercise, GH secretion is enlarged when compared to that in normoxia, but that GH secretion is further enlarged when the hypoxic exposure is done from pre-exercise to recovery period. Therefore, it is suggested that the timing for hypoxic exposure would affect GH secretion after the exercise. Reference Kurobe, K., et al. (2010) Effects of resistance training in hypoxic condition on muscle hypertrophy and muscle strength. Book of Abstracts, 15th Annual Congress of ECSS: 357.

## EFFECTS OF INTERMITTENT HYPOBARIC HYPOXIC EXERCISE OF 5 DAYS ON BLOOD PRESSURE AND VASCULAR ADAPTATIONS

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**Introduction** Recently, we have observed that aerobic exercise in hypobaric hypoxia of 4 weeks could induce beneficial circulatory adaptations, such as a reduction of total peripheral resistance and blood pressure, and an increase in flow mediated vasodilation (FMD) response, stroke volume and cardiac output (Ogita 2008). However, it has not been clarified whether such cardiovascular adaptations can be obtained within a relatively short training period. Therefore, the present study aimed to examine the effects of intermittent hypobaric hypoxic exercise of 5 days on blood pressure and vascular adaptations. **Methods** Sixteen healthy male adults (23±1 yrs) were matched for physical fitness level into two groups and then randomized to normobaric normoxic exercise group (N, n=8) and hypobaric hypoxic exercise group (H, n=8). The aquatic exercise training was done in a swimming pool located in a chamber where atmospheric pressure could be regulated. The exercise was performed at the intensity of 50%VO<sub>2</sub>max level for 30 minutes/training session for consecutive 5 days. H had the exercise in the hypobaric condition corresponding to 2500m above sea level, and was exposed to the condition for 2 hours/session. Before and after the training, systolic (SBP), diastolic (DBP) and mean blood pressure (MBP) were determined at rest and during cycling exercise at 50%VO<sub>2</sub>max. Also, arterial stiffness was assessed by brachial-ankle pulse wave velocity (baPWV), and FMD was evaluated by peak diameter of the popliteal artery during reactive hyperemia, which was measured by ultrasound imaging system. **Results** After the consecutive 5 days training, no significant changes were observed in all measured values for N. For H, SBP, DBP and MBP at rest and during submaximal exercise did not change significantly, either. On the other hand, peak diameter during reactive hyperemia and %FMD tended to increase, and baPWV as an index of arterial stiffness was significantly reduced ( $P < 0.01$ ). **Discussion** These findings suggest that a reduction of arterial stiffness and vascular functional adaptation such as an increase in FMD response could be induced by intermittent hypobaric hypoxic exercise of relatively shorter terms, when compared to the same exercise performed in normoxia, and that the changes in blood pressure would not be necessarily associated with the reduction of arterial stiffness and/or increase in FMD response. **Reference** Ogita, F., et al. (2008) Effects of exercise training at different hypobaric hypoxic conditions on cardiovascular adaptations. Book of Abstracts, 12th Annual Congress of ECSS: 394-395.

## INTERMITTENT HYPOXIC TRAINING TO ENHANCE ATHLETES ENDURANCE

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**Introduction** The improvement of sports achievements occurring in the process of swimmers training reflects the process of adaptation under the influence of means and methods used in training. Means and methods used in training of swimmers are differentiated by the direction of physiological influence. Depending of the chosen characteristics of physical loads such as type of exercise its intensity and duration, recovery breaks, number of repetitions; all training loads used in training of swimmers can be divided into the following groups: loads of aerobic effect; loads of combined aerobic-anaerobic effect; loads of glycolytic anaerobic effect; loads of alactate anaerobic effect. Intermittent Hypoxic Training (IHT) has been used as an additional method to enhance effects of different types of training loads. **Methods** Twelve swimmers of high qualification were divided into two groups: control and experimental. The control group was training with usual capacity using traditional techniques. Experimental group of swimmers together with the same traditional methods of training used different variants of IHT during the recovery periods followed the main training loads. Hypoxicator Everest (joint project of Climbi Ltd., Russia and Praxsep Inc., Canada) was used for creating hypoxic atmosphere. Each single hypoxic exposure was 3-10 min followed by 3-10 min rest period when athletes were breathing regular air. Combined exposure did not exceed 1.5-2 hours within one day. The period of experimental training continued for three months. Before and immediately after the end of experiment the athletes of both groups were tested in standard ergonomic procedures for the maximum of aerobic and anaerobic work capacity. **Results** Under the conditions of the given experiment IHT resulted in significant increase in parameters of maximum aerobic capacity for the experimental group: VO<sub>2</sub> max increased on average 11%; VE - 6.4%; Wcr - 10.8%; ΔpH - 44.6%; ExcCO<sub>2</sub> - 23%, and Wmax - 9.8%. **Results** for the control group were significantly lower. **Discussion** According with these findings the greater improvement in swimming performance was to be expected for athletes in the experimental group in middle distances such as 200, 400, and 800 m. The use of IHT as additional training method for qualified swimmers made it possible to considerably improve sports results in short period of training. **References** Viru A. Adaptation in Sports Training. Boca Raton: CRL Press, 1995, 310. Volkov NI. Bioenergetics of Sport Activities. Moscow: Theory and Practice of Physical Culture and Sports, 2010, 141. Kolchinskaya AZ. Hypoxia. Med. J. 1993;1(2): 30-36. Wolkow NI, Szmatlan-Gabrys U, Gabrys T. Hipoksja w treningu sportowym: Interwałowy trening hipoksyiczny. Warszawa: AWF Jozefa Pilsudskiego, 2003, 99.

## PO2 AND PH AFTER DIFFERENT EXHAUSTIVE EXERCISES IN MODERATELY TRAINED ATHLETES.

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**INTRODUCTION:** There is a lot of scientific evidence about the differences in maximal oxygen consumption between different ramp test and step test protocols. Furthermore the differences in VO<sub>2</sub> between running and cycling are also well investigated. Comparisons between the maximal decline of the partial oxygen pressure (PO<sub>2</sub>) as well as the pH at the point of exhaustion are less investigated. We hypothesized that the pH and the PO<sub>2</sub> after a ramp test protocol will be more reduced than after a step test protocol. **METHODS:** 14 subjects (10 m and 4 w) (24.4 ± 2.1 yrs, 180.7 ± 8.8 cm, 76.3 ± 11.8 kg) participated in the study. All participants completed four different tests to exhaustion with at least four days in between in randomized order. Two tests were step tests with step duration of 5min. Two protocols were ramp test protocols with step duration of 30s after an initial step of 2min. One step and one ramp test was carried out on a cycle ergometer (bike) and on a treadmill (run), respectively. During all tests VO<sub>2</sub> was measured breath by breath (nSpire, Zano 600). Immediately after the tests pH and PO<sub>2</sub> were measured in capillary blood. **RESULTS:** Peak power output were significantly different between all tests except between both ramp tests (bike ramp 362 ± 47; run ramp 361 ± 64; run step 206 ± 56; bike step 255 ± 45). Highest rel.VO<sub>2</sub>peak was reached at the end of the run ramp test (54.8 ± 6.0 ml/min/kg). Lowest rel.VO<sub>2</sub>peak was obtained during the bike step test (45.8 ± 8.8 ml/min/kg). Rel.VO<sub>2</sub>peak during the other two tests was 47.2 ± 9.7 ml/min/kg (bike ramp) and 49.9 ± 7.1 ml/min/kg (run step). The greatest reduction of the PO<sub>2</sub> was detected after the run ramp test (pre vs. post: -3.5 ± 1.8 mmHg). However the only statistical significance was found between the run ramp test and bike step test. The pH showed lower values after both ramp tests than after the

both step test protocols (ramp: run  $7.22 \pm 0.06$ ; bike  $7.23 \pm 0.04$ ; step: run  $7.30 \pm 0.05$ ; bike  $7.26 \pm 0.05$ ). DISCUSSION: Our results are in accordance with our hypothesis. During the ramp test on both ergometers that we used the pH was lower than during the longer protocols (step tests). It seems that during the end of the shorter test protocols the subjects were able to use more glycolytic muscle fibers to achieve higher power and produced more H<sup>+</sup>-ions that weren't metabolized. After the running tests, subjects' PO<sub>2</sub> declined more than after the bike tests. Compared to tests on a cycle ergometer this is due to the higher mass of muscles used during running which need oxygen supply during high intensity exercise.

### EFFECTS OF INTERMITTENT NORMOBARIC HYPOXIA ON AUTONOMIC NERVOUS SYSTEM IN YOUNG MALE ATHLETES

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**Introduction** The strategy, in which the altitude exposure is combined with intermittent normoxia for training purpose, the so-called "live high-training low" (LHTL) model, has been demonstrated to be particularly effective and is becoming widespread among endurance athletes. Previous studies found that continuous 3-4 weeks exposure to hypoxia cause decreased parasympathetic and increased sympathetic tone. However, it is unknown whether there is similar effect in the intermittent nightly hypoxic exposure (e.g. nightly hypoxic exposure for 10 days – staying at sea level for 5days – nightly hypoxic exposure for 10days) on autonomic nervous system. The purpose of this study was to investigate the effects of intermittent nightly hypoxic exposure on autonomic nervous system in young endurance athletes. **Methods** Eight young male athletes (long distance runner) volunteers participated in the study. All subjects entered the hypoxia-chamber (3,000m) during sleep for 10days, after staying at sea level for five days, and then all subjects entered the hypoxia-chamber (3,000m) during sleep for 10days again. The study consisted of four phase: the pretesting phase, the first continuous 10days hypoxia-chamber exposed phase, after staying at sea level for 5days, and post-testing (after second continuous 10days hypoxia-chamber exposed) phase. Subjects abstained from caffeine and fasted for at least 12h before each test and all data were collected every morning between 7:00 and 9:00 a.m. in the three phases. In the supine position, resting heart rate (HR) and beat-by-beat blood pressure (BP) were measured. Beat-by-beat BP was derived by radial artery tonometry (Jentow7700; Nihon Colin, Komaki, Japan). After a10min resting period, we measured time and frequency domain parameters of resting HR variability (HRV) and spontaneous baroreflex sensitivity (SBRS). To assess HRV and SBRS, we applied the power spectral analysis and sequence method, respectively. Results We found no significant differences in indexes of HRV and SBRS between pretesting and post-testing phases in young male athletes. The influence of staying at sea level for 5 days in indexes of HRV and SBRS were not observed. **Conclusion** These results suggest that the intermittent nightly normobaric hypoxia do not affect the autonomic nervous system in young endurance athletes.

### VALIDITY OF THE JÄEGER OXYCON-PRO® EXPIRED AIR ANALYZER IN NORMOBARIC HYPOXIA

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**INTRODUCTION:** When utilising a high precision O<sub>2</sub> analyser, the closed-circuit Douglas Bag Method (DBM) arguably provides the 'gold standard' estimation of oxygen uptake (VO<sub>2</sub>) (Macfarlane, 2001). However, open-circuit breath-by-breath analysers give greater insight into the physiological conditioning of athletes, so are now commonplace in exercise science laboratories worldwide. One such unit, the Jäeger Oxycon-Pro® (JOP) provides valid and reliable estimates of VO<sub>2</sub> in normobaric normoxia (NN) (Foss & Hallen, 2005), but there are no published data regarding the performance of the JOP in normobaric hypoxia (NH). **PURPOSE:** To investigate the validity of the JOP in NH. **METHODS:** 10 physically active males ( $29.4 \pm 7.1$  y,  $74.9 \pm 5.2$  kg) completed two identical cycling tests; one in NH (fraction of inspired oxygen (FIO<sub>2</sub>) =  $16.0 \pm 0.1$  %), and one in NN (FIO<sub>2</sub> =  $20.9 \pm 0.1$  %), separated by 1-2 days, in a randomized order. The JOP was calibrated using a modified procedure, involving feeding the ambient air intake with bottled NN air. Participants cycled at 120 W for 4 consecutive 4 minute stages, while VO<sub>2</sub> was estimated from expired air using the JOP and DBM. VO<sub>2</sub> was estimated over 60 s intervals, twice by each analyzer, in an alternating, randomized order, then repeated at 160 W. Correlation coefficients were estimated using linear regression analyses, and standard error of the estimate and coefficient of variation (CV) were calculated. **RESULTS:** Linear regression analyses revealed VO<sub>2</sub> agreement between the 'criterion' DBM with the JOP estimations: correlation coefficients in NN were  $R^2 = 0.70$  at 120 W, and  $0.85$  at 160 W, and in NH  $R^2 = 0.74$  at 120 W, and  $0.82$  at 160 W. The statistical comparison between the JOP and DBM in NN gave a CV at 120 W of 5.0% (95% likely range: 3.4 to 9.8%), and at 160 W a CV of 3.3% (95% likely range: 2.2 to 6.3%). In NH, the CV was calculated at 120 W as 4.3% (95% likely range: 2.9 to 8.4%), and at 160 W as 3.1% (95% likely range: 2.1 to 6.0%). **CONCLUSION:** The JOP performed well in both NN and NH, providing a more valid estimation of VO<sub>2</sub> in NH than in NN. Further investigations should be conducted to establish this validity at higher ventilatory rates, either using participants with greater lung capacities, or using an 'automated pulmonary simulator' (Gore et al, 1997). **REFERENCES:** Foss, O. & Hallen, J. (2005). *Int. J. Sports Med.* 26(7): 569-75. Gore, C.J., Catchside, P.G., French, S.N., Bennett, J.M., & Laforge, J. (1997). *Med. Sci. Sports Exerc.* 29(8): 1095-103. Macfarlane, D.J. (2001). *Sports Med.* 31(12): 841-61 Supported by Sporting Edge UK Ltd and the English Institute of Sport.

### EFFECT OF HYPEROXIC-SUPPLEMENTED INTERVAL TRAINING ON ENDURANCE PERFORMANCE IN TRAINED CYCLISTS

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**EFFECT OF HYPEROXIC-SUPPLEMENTED INTERVAL TRAINING ON ENDURANCE PERFORMANCE IN TRAINED CYCLISTS** Kilding, A.E., Wood, M., Sequira, G. Sport Performance Research Institute New Zealand, AUT University, Auckland, New Zealand **Introduction** Inspiring a hyperoxic gas mixture while performing prolonged intense exercise allows higher power outputs to be achieved, both acutely (Welch 1987) and chronically (Perry et al 2005;2007), compared with breathing normoxic air. However, while it has been clearly demonstrated that higher power outputs can be maintained with hyperoxic training, and plausible mechanisms exist supporting its efficacy, evidence of performance enhancement following hyperoxic training in athletes is unclear. The aim of this study was to determine the effect of hyperoxic-supplemented interval training on endurance cycling performance. **Methods** Using a single-blind, randomised control-trial design, 16 well-trained cyclists were randomly assigned to either an experimental group that trained in hyperoxia (HYP, FIO<sub>2</sub>=0.60), or a sham HYP training group that trained in normoxia (N, FIO<sub>2</sub>=0.21). Participants visited the laboratory twice per week, for four weeks, to perform supervised high-intensity interval training sessions in HYP or N. A range of tests were performed pre- and post-intervention including: 1) a 20 km time-trial; 2) an incremental step test for determination of VO<sub>2</sub>peak and lactate threshold (LT); and 3) a 60s all-out test. Heart rate

and power output were measured during all sessions. Results Small effects on most physiological measures, including  $\text{VO}_{2\text{peak}}$  ( $1.9 \pm 4.3\%$ ) and LT ( $0.3 \pm 8.3\%$ ), were observed after HYP. In most instances, physiological changes in N were greater than in HYP. There was a small increase in mean power during the 20 km time-trial in HYP ( $2.1 \pm 3.7\%$ ) but this was less than that observed in N ( $4.9 \pm 3.9\%$ ; ES:  $-0.44 \pm 0.60$ ). During the 60 s all-out test, the peak relative power was slightly reduced after HYP ( $-0.4 \pm 1.3\%$ ), but not after N ( $0.3 \pm 1.6\%$ ; ES:  $-0.24 \pm 0.76$ ), whereas there was a tendency for mean relative power to be increased in N ( $2.3 \pm 3.4\%$ ), but not HYP ( $0.3 \pm 1.2\%$ ; ES:  $-0.34 \pm 0.49$ ). Discussion Hyperoxic-supplemented interval training in the competitive season had less effect on endurance and anaerobic cycling performance and physiological measures in trained endurance cyclists compared to interval training in normoxia. Despite higher power output during training, the use of hyperoxic-supplemented training at sea-level appears to be not worthwhile for competitive endurance athletes. References Perry CG, Reid J, Perry W et al. (2005). *Med Sci Sports Exerc*, 37(7): 1175-9. Perry CG, Talanian JL, Heigenhauser GJ et al. (2007). *J Appl Physiol*, 102(3): 1022-7. Welch HG (1987). *Exerc Sport Sci Rev*, 15: 191-221.

### OPTIMAL TIMING OF ALTITUDE TRAINING

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Introduction: Altitude training is generally accepted to improve sea level performance. The optimal time lapse, however, between return from altitude and best performance has not been systematically investigated. The aim of this project, therefore, was to determine performance after altitude training with two different approaches in order to give recommendations for the optimal timing of altitude training before important competitions. Study I - Methods: Total haemoglobin mass (Hb-mass) of 45 elite swimmers had been measured over a period of two years using the optimized CO-re-breathing method. 25 of the athletes participated between 1 and 3 times at classical altitude training camps, which lasted 3 to 4 weeks, at 2300m. All competition results of this 2-yr period (in total 886 results, 135 within 5 weeks after return from altitude) were converted into the official German point system (world record = 1000 points) and were analysed based on a covariance mixed model. Results: While no effect of altitude training occurred until 3 weeks after return to sea level, a positive effect (+42 pts) was detected 25-35 days after returning ( $p < 0.001$ ). Significant effects were also found for changes in Hb-mass ( $+0.34$  pts/g Hb,  $p < 0.001$ ) and a negative effect was observed 2 weeks after illness and injury ( $-38$  pts,  $p < 0.001$ ). Study II - Methods: In order to check the results of the 2-year study, 10 elite swimmers participated at a 3-week conventional altitude training at 2300m and at a 3-week sea level training camp 5 weeks after returning from altitude. Emphasis was placed on Hb-mass measurement and on standardized performance tests. Four swimmers completed the whole set of swimming step tests (4 tests before, 3 at altitude, and 8 after the altitude camp). The test consisted of 5 200m-steps in the individually chosen swimming style with decreasing time ( $-6$ sec/step) up to the individual maximal speed. For submaximal performance the speed was calculated for fixed [Lac] (4, 6, 8, and 10mmol/l). Results: Hb-mass significantly increased one week after altitude training ( $4.4 \pm 4.4\%$ ,  $p < 0.05$ ). It returned to base line values within the following 4 weeks and was not affected by the sea level training camp. Maximal and submaximal performance clearly decreased at altitude (max speed  $-3.1 \pm 1.9\%$ ,  $p < 0.05$ ), continuously increased until 3 weeks after return ( $+2.8 \pm 1.6\%$ ,  $p < 0.05$ ), and remained at that level for the following weeks. No relationship could be detected between changes in Hb-mass and performance. However, the athletes with the highest response in Hb-mass also showed best performance after a delay of two weeks. Conclusion: Both the long and the short term approach coincide in their results. Best swimming performance was observed 3-5 weeks after returning from altitude training which should be considered when planning an altitude training camp.

## Poster presentations

### PP-BN15 Performance and Coaching Analysis

#### QUANTITATIVE ANALYSIS OF OFFENSE TRANSITION IN HANDBALL GAMES

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Introduction It was reported that the handball is becoming speedy and high intensity (Aagaard, Hergeirsson). Recently, it is very important the offense transition after getting a ball. In this study, we evaluated the differences of offense transition aspects between Japan and European teams, to quantitative analyze the offense transition aspects. Methods 1210 offense transitions, from 15 games of 6 teams (NOR, ROU, HUN, JPN, TUN, CHI) participating in the Preliminary Round Group C of 19th Women's World Handball Championship 2009 in China, were analyzed. The offense transition was divided by no fast break and fast break (FB). FB was categorized as 1st wave, 2nd wave or 3rd wave. Furthermore, the results of categorized FB were classified with a successful attack with shot or unsuccessful attack, including offense error, a defended attack or an own discontinuation. The result of the successful attack with shot also was recorded as success or failure shots. Results The numbers of a gotten ball, as successful defense, per a game were  $45.4 \pm 6.7$ ,  $46.2 \pm 13.8$ ,  $42.8 \pm 17.1$ ,  $37.4 \pm 6.2$ ,  $37.4 \pm 12.3$  and  $32.8 \pm 6.4$  in NOR, ROU, HUN, JPN, TUN, CHI, respectively. The rates of FB, including 1st, 2nd and 3rd wave, against the gotten ball were  $75.2 \pm 9.8\%$  in NOR,  $70.8 \pm 15.3\%$  in ROU,  $73.9 \pm 15.2\%$  in HUN,  $62.9 \pm 8.1\%$  in JPN,  $62.3 \pm 15.5\%$  in TUN,  $61.8 \pm 14.7\%$  in CHI, respectively. The rate of FB against the gotten ball in JPN was small tendency compared with that in NOR and ROU. The rate of successful attack with shot against the gotten ball was smaller in JPN ( $31.1 \pm 8.6\%$ ) than in NOR ( $47.4 \pm 7.2\%$ ,  $p < 0.05$ ) and ROU ( $43.4 \pm 18.0$ ,  $p = 0.1$ ). The rate of 1st wave against the gotten ball in JPN ( $10.5 \pm 11.1\%$ ) was smaller than that in NOR ( $28.7 \pm 12.2\%$ ,  $p < 0.05$ ) and ROU ( $26.1 \pm 18.5\%$ ,  $p < 0.05$ ). In contrast, the rates of 2nd wave against the gotten ball were greater in JPN ( $27.9 \pm 5.0\%$ ) than in NOR ( $19.7 \pm 5.5\%$ ,  $p < 0.05$ ), ROU ( $10.6 \pm 4.0\%$ ,  $p < 0.05$ ), HUN ( $19.2 \pm 5.4\%$ ,  $p < 0.05$ ) and TUN ( $19.5 \pm 7.3\%$ ,  $p < 0.05$ ). There were similar in the rate of successful attack with shot and successful shot against the gotten ball in 2nd wave among six teams. The rates of unsuccessful attacks against the gotten ball in 2nd wave were greater in JPN ( $16.0 \pm 6.5\%$ ) than in NOR ( $7.8 \pm 4.9\%$ ,  $p < 0.05$ ), ROU ( $3.9 \pm 1.6\%$ ,  $p < 0.05$ ), HUN ( $8.2 \pm 2.9\%$ ,  $p < 0.05$ ) and TUN ( $9.1 \pm 3.3\%$ ,  $p < 0.05$ ). In the 3rd wave, the rate of goal in 3rd wave against the gotten ball was smaller in JPN ( $5.1 \pm 3.0\%$ ) than in NOR ( $9.5 \pm 6.5\%$ ,  $p < 0.05$ ), ROU ( $12.1 \pm 4.8\%$ ,  $p < 0.05$ ). Conclusion In JPN, the FB frequency was not only small but also the rate of successful attack with shot was small, compared with EUROs. The 1st wave frequency in JPN was smaller than EUROs. The unsuccessful attack frequency during 2nd wave was greater in JPN although JPN had more attacked using the 2nd wave during fast break compared with EUROs. This inefficient attack in JPN was caused by defended attack or an own discontinued attack. The 3rd wave attack was more affected in EUROs than JPN.

## MATCH DEMANDS OF FUTSAL PLAYERS DURING A TOURNAMENT

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**Introduction** Coaching teams for multiple games in a short time period such as a tournament situation is different from coaching teams competing in regular competition matches that are typically played weekly. The recovery time between matches in a tournament is often inadequate, and fatigue may be accumulated over successive matches, impacting upon individual and team performance. This study quantified the movement demands and match activities of futsal players during a tournament, with a view to examining differences in movement demands and ball possession throughout the tournament. **Methods** One team from New South Wales (NSW) competing in the Open men's division at the Australian National Futsal Championships participated in this study. Matches were played over 3 consecutive days. There was a minimum of 3 hours between matches involving the same team. The team analysed for this study played 1 game on day 1, 3 games on day 2 and 2 games on day 3, with a total of 6 matches contested. For each match assessed, movement demands, match activities and ball possession were monitored by video analysis. **Results** Relative to total match time, the NSW team decreased their ball possession from 32.7% in match 1 to 21.0% in match 5 ( $p=0.02$ ), and increased the duration of the ball out of play from 36.8% in match 1 to 49.2% in match 5 ( $p<0.01$ ). There was a 55.3% increase in the average relative match distance walking from match 1 to 5 ( $p=0.05$ ), and a 38.1% decrease in the average relative match distance sprinting from the first half of the tournament (matches 1 – 3) to the second half (matches 4 – 6) ( $p<0.01$ ). Furthermore, there was a 34.1% decrease in the average relative sprinting duration from the first half of the tournament ( $0.85 \pm 0.58\%$ ) to the second half of the tournament ( $0.56 \pm 0.41\%$ ) ( $p=0.04$ ). There were no significant differences for match activities throughout the tournament. **Discussion** The decrease in the ball possession duration indicates that the NSW team may have reduced their ability to control the ball towards the end of the tournament, and may have been forced to deliberately kick the ball into an open area or out of play, in order to take away the opportunities for the opposition to gain control of the ball. This may be directly related to the increase in the duration of the ball out of play from match 1 to match 5. The changes in movement demands observed suggest that the players experienced fatigue towards the end of the tournament as indicated by the decrease in sprinting distance and duration as a result of limited recovery between matches. Coaches can use this information to control the game more effectively whereby players can be rotated before they fatigue, in order to optimise team performance for the duration of the tournament.

## MATCH EVENTS IN FUTSAL: DIFFERENCES BETWEEN RELATIVELY HIGH CALIBRE AND LOW CALIBRE TEAMS

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**Introduction** Several team sport studies have examined the physiological and match-play differences between teams of different playing levels. However, no previous study has performed an investigation comparing differently skilled teams of the same relative playing level within the same sport. This study aimed to investigate the differences in match demands between sub-elite futsal teams from Australia, Brazil and Spain, as well as detect key performance indicators which differ between the teams. As Brazilian and Spanish futsal match-play is superior to Australian futsal (current world rankings), the outcome of this study may aid the improvement of Australian futsal match performance. **Methods** One futsal team from Australia, Brazil and Spain were used for this study. All teams were at a level of play where players could be scouted to represent their country in futsal, therefore, they were of an equivalent competition standard. Four matches involving the Australian team, four matches for the Brazilian team and five matches for the Spanish team were analysed. For each match, movement demands and match activities such as passing and goal-shooting success were monitored by video analysis, with these activities tracked during the entire match-play with the exceptions of timeouts and half-time periods. **Results** The Brazilian team recorded the greatest possession duration of the ball ( $40.0 \pm 10.4\%$ ) when compared to the Australian and Spanish teams ( $30.9 \pm 2.54\%$  and  $23.5 \pm 2.73\%$ , respectively,  $p<0.05$ ). The Brazilian team also performed the greatest number of successful passes per minute of match-play ( $31.2 \pm 1.06$ ), when compared to the Australian and Spanish teams ( $21.2 \pm 0.60$  and  $23.5 \pm 0.81$ , respectively,  $p<0.05$ ). Additionally, the Australian team performed the greatest number of shots on goal per minute of match-play ( $1.40 \pm 0.07$ ). **Discussion** The greater ball possession percentage of the Brazilian team suggests that they were in greater control of the game when compared to the Australian and Spanish teams. The Brazilian team also made a significantly higher number of successful passes per minute of match-play, followed by the Spanish team and the Australian team. The Australian team produced the highest number of shots on goal per minute of match-play, suggesting a greater determination to score goals rather than retain possession. Australian futsal players and teams may need to focus on motor skill and technical skill training in order to improve ball possession skills and team performance during futsal match-play. Further, Australian futsal players should have more patience when in control of the ball, rather than taking risks in passing and kicking which may result in losing possession or a goal being conceded.

## ALTERATION OF PLAYING PATTERN IN MALE OLYMPIC HANDBALL

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**Introduction** Notational analysts have focused on general match indicators (technical and tactical demands) in team sports (Hughes, Barlett, 2006). Statistics, presented in official documents of the International Handball Federation, enable to make further deep analysis of sport performance in olympic male handball (Skarbalis, 2002). The aim of the research was to carry out the tendencies of playing pattern of male olympic handball through 4th decades: from Munich (1972) Olympic Games (MOG) to the Beijing (2008) Olympic Games (BOG). **Methods** Statistics of matches ( $N = 388$ ) played by national teams in 10th Olympics were taken from the official statistics documents of the International Handball Federation. All values were expressed as means  $\pm$  SD. The value of  $P < 0.05$  was accepted as significant. **Results** During 36 years (MOG –  $16.3 \pm 1.9$ ; to BOG –  $27.3 \pm 4.3$ ) teams scored 11 goals more ( $P < 0.001$ ) per match, both teams scored 22.3 ( $P < 0.001$ ) goals more ( $32.3 \pm 7.2$ , and  $54.6 \pm 6.9$  respectively). Winners scored 19.6  $\pm$  3.7 goals in MOG, and 9.5 goals more ( $P < 0.001$ ) in BOG ( $29.1 \pm 3.9$ ). Goals scored by losers increased ( $P < 0.001$ ) by 10.5 goals ( $13.9 \pm 1.8$ , and  $24.4 \pm 4.3$  respectively). Number of attacks increased ( $P < 0.001$ ) by 16.6 attacks ( $39.4 \pm 6.2$ , and  $56.0 \pm 4.4$  respectively), efficacy of attacks increased ( $P < 0.001$ ) by 14.1% ( $34.6 \pm 6.3$ , and  $48.7 \pm 7.4$ ). Shots efficacy increased ( $P < 0.001$ ) by 15% ( $40.3 \pm 5.3$ , and  $55.3 \pm 9$  respectively), but goalkeepers efficiency decreased ( $P < 0.001$ ) by 8.5% ( $43.8 \pm 6.9$ , and  $30.0 \pm 8.0$  respectively). **Discussion** The difference between scored and missed goals through fourth decades decreased by 1 goal. This allows to assert of increasing equitable performance by rival teams in elite male handball. Increasing a number of attacks, efficacy of attacks, and efficacy of shots might be characterise as the dominant features of players individual skills in offense as in defense (Skarbalis, 2002, 2010). Decreasing ratio (4.8%) of positional attacks and increasing ratio of counterattacks as well as efficacy of latter index might be thought as increasing dynamics of the game (Skarbalis, 2002, 2010). The

phenomenon of modern olympic male handball is that winners play more vigorous and aggressive, and make more violations (2 minutes suspension increased [ $P < 0.001$ ] in duoble: from  $3.3 \pm 1.6$  to  $7.1 \pm 3.2$ ). In conclusion: modern olympic male handball is more dynamic; winners play more active and aggressive handball; prevails individual actions in offence; elite rival teams are the same performance level; complex indicators of sport performance might decide the end of a match. References Hughes M., Barlett R. (2002). *J Sports Sci*, 20, 739–54. Skarbalius A. (2002). *Olympic Mens' Handball: Peculiarities and Tendencies*. Kaunas: LAPE. Skarbalius A. (2010). *Optimization of Coaching High-Performance Handball Athletes*. Kaunas: LAPE.

## A COMPARISON OF PLAYER AND COACH IMPRESSION OF TRAINING LOAD OVER THE SOCCER SEASON

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To optimise performance it is important to monitor training load to ensure that the planned load is executed by athletes. Especially in team sports objective player monitoring through heart rate and time-motion analysis may be out of reach due to its cost limitations. The use of session Rating of Perceived Exertion (RPE) has proven useful for monitoring players' internal training load. When no direct player monitoring options are used, many coaches will rely on their own impression of executed training load. This study investigated the relationship between the planned training load, the coaches' perceptions of executed load and the team's session RPE load. The potential differences in perception throughout the soccer season were also addressed. Sixteen male elite soccer players (age  $25 \pm 4$  yrs, height  $1.83 \pm 0.05$  m, weight  $82.2 \pm 7.5$  kg) were monitored over 30 training sessions, consisting of 15 pre-season and 15 in-season sessions. Training load was matched so there was no significant difference in planned load between pre-season and in-season. Upon completion of each training, players' session RPE (10 point scale) was recorded and each of the three coaches was individually asked for their impression of executed load on the same RPE scale. Team load was calculated as player's mean session RPE x session duration (min), and coaches' load as coaches' mean impression of load x duration. Before each session players were asked to rate their stress, fatigue, soreness and training enjoyment on a 5 point scale (1 very bad to 5 very good). Over all sessions there was a strong correlation between coaches' load and both planned load ( $r=0.90$ ) and team load ( $r=0.91$ ). When split into season phases the correlation between coaches' load and team load dropped from 0.96 pre-season to 0.83 in-season. This coincided with a significant drop in the difference between coaches' load and team load from pre-season ( $36 \pm 52$ ) to in-season ( $-17 \pm 72$ ). Player ratings indicated no difference over the season for stress and soreness, while both fatigue and training enjoyment were significantly greater in pre-season. These findings indicate that coaches tend to overestimate training load in pre-season, while underestimating training load in-season. It may be expected that players are more fatigued in-season and therefore report a higher session RPE, which may be un-observed by coaches. However, this assumption is contradicted by the finding of a greater fatigue rating in the pre-season. The players did report a decrease in training enjoyment in-season, which may reflect staleness. This may account for the players' higher perceived training load in season and the concurrent under-estimation of coaches' load.

## TEACHING DANCE TO CHILDREN: SHOULD IT CONTINUE TO BE DONE KINAESTHETICALLY?

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TEACHING DANCE TO CHILDREN: SHOULD IT CONTINUE TO BE DONE KINAESTHETICALLY? Cunliffe, D.1, Stopforth, M.2, Rist, R.3 1: SSU (Southampton, UK), 2: SSU (Southampton, UK), 3: TPSPA (Tring, UK) Introduction The art, or skill, of teaching often breaks down at the point of transferring the information from the teacher to the pupil. Varying methods of teaching dance have been used, such as a Movement-Based approach (Marx, 2009): Student-Centred Approach (McCarthy-Brown 2009) and Kinaesthesia method (Geber & Wilson, 2010), yet neither of these authors have addressed the issue of teaching to a child's preferred learning style. The issue of preferred learning styles has been recently addressed (Beadle, 2010; Cunliffe, 2010 and Myers 2010) when in a teaching domain, and as such, dance teachers who only educate through direct movement appear to be failing to maximise the potential of their pupils' 'understanding' of what they are asked to perform. Methods Appropriate ethical clearance was granted from a University's Ethical Committee before permission was sought and granted to assess the preferred learning styles of each pupil across school years 7-13 ( $n=194$ ) from one Music and Dance Excellence (MADE) school within the UK. The Learning Styles Questionnaire for Children - LSQ-C was selected as it divides preferred learning styles into three distinct categories, either Visual, Auditory or Kinaesthetic learners over a 30-point questionnaire. To improve reliability, the LSQ-C was administered three times over a six week period to get a mean score for each child. Results The mean scores for each preferred learning style (VAK) for all children across all seven year groups exhibited a difference; Visual (14.23, SD 4.19); Auditory (6.51, SD 2.71); Kinaesthetic (9.26, SD 3.87). When differences in preferred learning styles were analysed using a Oneway ANOVA, the results indicated that there was no significant difference for kinesthetic preference between all seven year groups ( $F=1.425$ ,  $p=0.207$ ). Discussion Whilst these results support the work of dance teachers who educate children through the practical delivery of movements, it must be stressed, that from this pilot study, only using this teaching method could alienate the learning of children who prefer a different mode of learning. Therefore, dance teachers need to ensure they select a differentiated delivery strategy to allow all children to learn together without any disadvantage being placed upon them. Further research will see the project extending to the other eight MADE school within the next year. References Beadle, P. (2010). *How to Teach*, 201-203. Crown House Publishing, Carmarthen. Cunliffe, D. (2010). *Physical Education Matters*, 5(3), 36-37. Geber, P., Wilson, M. (2010). *Journal of Dance Medicine & Science*, 14(2), 50-57. Marx, (2009). *Recreation & Dance*, 80(4), 12-17. McCarthy-Brown, N. (2009). *Journal of Dance Education*, (9)4, 20-25. Myers, E. (2010). *Physical Education Matters*, 5(3), 21-24.

## Poster presentations

### PP-BN16 Sports Biomechanics 3

#### IS SOCCER KICKING TECHNIQUE AGE AND GENDER DEPENDENT?

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**Introduction** The examination of females and young soccer players kicking performance have not received the appropriate attention (Kellis and Katis, 2007). For this reason, training programs for female and young players are based on experimental data which are appropriate for men. The purpose of the present study was to examine the kinematic differences in soccer kick biomechanics between male, female and young soccer players. **Methods** Ten male (age:  $26.3 \pm 4.9$  yrs), ten female (age:  $24.4 \pm 4.2$  yrs) and ten boys (age:  $15.1 \pm 0.7$  yrs) amateur soccer players performed consecutive instep kicking trials. The kick with the highest ball velocity was further analyzed. Three-dimensional kinematics (6-camera Vicon motion analysis system, 120 Hz) allowed estimation of ball speed, ball-to-foot speed ratio, linear velocities of the ankle, knee and hip during the kick. Ground reaction forces were also recorded using a Bertec force plate. A one-way analysis of variance was used for comparisons between the three examined groups. **Results** Ball velocity was significantly higher ( $P < 0.05$ ) for male ( $21.5 \pm 2.1$  m/sec) compared to female ( $18.4 \pm 1.5$  m/sec) and young players ( $19.4 \pm 1.7$  m/sec). In contrast, foot/ball ratio (1.60, 1.44 and 1.58 for male, female and young players, respectively) and joint linear velocities did not differ ( $P > 0.05$ ), with the exception of the linear velocity of the ankle at ball impact, being significantly higher ( $P < 0.05$ ) in male ( $13.3 \pm 1.6$  m/sec) compared to female ( $10.8 \pm 0.8$  m/sec) and young players ( $11.1 \pm 0.7$  m/sec). Vertical and mediolateral ground reaction forces were significantly higher ( $P < 0.05$ ) for young players ( $2.6 \pm 0.6$  BW and  $0.8 \pm 0.2$  BW) compared to male ( $1.8 \pm 0.4$  BW and  $0.4 \pm 0.1$  BW) and female players ( $2.3 \pm 0.3$  BW and  $0.5 \pm 0.2$  BW for vertical and mediolateral GRFs, respectively). **Discussion** Previous studies underline the importance of the muscle mass (Manolopoulos et al., 2006) and the velocity of the distal segments (Asai et al., 2002) for better performance. The present study indicated that the kicking performance of male players is higher compared to female and young players, probably due to higher levels of muscle mass and higher ankle velocity of the ankle at ball impact. However, the kicking pattern was similar among the three examined groups indicating that soccer kick is a well-practiced skill with similar joint and segment movements. **References** Asai T., Carre M., Akatsuka T. & Haake S. (2002). *Sports Eng*, 5, 183-192. Kellis E. & Katis A. (2007). *J Sports Sci Med*, 6, 154-165. Manolopoulos E., Papadopoulos C. & Kellis E. (2006). *Scand J Med Sci Sports*, 16, 102-110.

#### MUSCLE COORDINATION IN AN OUTDOOR CYCLING TIME TRIAL

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**MUSCLE COORDINATION IN AN OUTDOOR CYCLING TIME TRIAL** Blake, OM., Wakeling, JM. *Biomedical Physiology and Kinesiology*, Simon Fraser University, Canada **INTRODUCTION** Muscle activity in cycling has primarily been studied in the laboratory. The activity underlying muscle coordination is dependent on cadence, workload, body position, fatigue, shoe and pedal interface and training status (Hug et al., 2009). However, it is important to conduct research in a natural setting as conclusions from laboratory studies are limited by the ability to recreate realistic environmental conditions. The purpose of this study was to determine the coordination patterns in an outdoor time trial and investigate their relationships to power output (IPO), total muscle activity (Itot), cadence and slope. **METHODS** Six competitive male cyclists cycled 4 laps of 5km on paved roads in the shortest time possible. Muscle activity of 10 leg muscles was measured using surface electromyography (EMG) while PO, cadence, heart rate and slope were recorded. The time-varying intensity of the EMG (Iemg) was calculated (von Tscharnner, 2000) and the dominant coordination patterns were identified using principal components (PC) analysis (Wakeling et al., 2009). Coefficients for muscle coordination were statistically compared to the Itot, PO, cadence, velocity, heart rate and slope. **RESULTS AND DISCUSSION** The first PC (IPC1) highlighted vastus lateralis (VL) and rectus femoris (RF) Iemg. IPC2 differentiated between Iemg in the VL and RF and Iemg in the rest of the muscles. IPC3 uncoupled the VL and RF with more VL in lap 1 and more RF in laps 3 and 4. There was a significant relationship of RF and VL to PO similar to Bini et al. (2008) and both PO and VL Iemg followed a reverse J-shaped pacing strategy (Abiss et al., 2008). In support of previous studies, despite different pacing strategies, the Iemg of the VL (Bini et al., 2008) and RF (Duc et al., 2005) followed the same trend as the PO distribution. Decreased VL appears to have been compensated for by increased Sol, a relative shift to more RF and to a lesser extent GM activation. The muscle coordination patterns significantly covaried with the PO, cadence, heart rate and slope. The VL and RF appear to be primary power producers although compensation from other muscles may be crucial to maintaining PO while delaying fatigue. These results show that muscle coordination changes with the altered locomotor demands of outdoor cycling, and highlights the importance of recording these parameters under field conditions. **REFERENCES** 1. Hug F, et al. (2009). *J Electromyogr Kinesiol*. 19 :182-198 2. von Tscharnner V. (2000). *J Electromyogr Kinesiol*. 10:433-445. 3. Wakeling JM, et al. (2009). *J Neurophysiol*. 101:843-854. 4. Abiss CR, et al. (2008). *Sports Med*. 38:239-252. 5. Bini RR, et al. (2008). *J Sci Med Sport*. 11:363. 6. Duc S, et al. (2005). *Int J Sport Med*. 26:145-150

#### CHANGES IN THE JOINT TORQUE OF UPPER LIMB IN OVERHAND THROW AT VARIOUS BALL SPEEDS

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**Introduction** Overhand throw is multi-joint movements and unique in human. Studies on joint torque about adjustment of movements have been reported mainly in lower limb. However, joint torque in upper limb during overhand throwing with increasing ball speed is not investigated. In the various sports, adjustment of ball speed is an important ability. The aim of this study was to examine the regulation of each joint torque of the upper limb to the different ball speed. **Methods** Five males, without specialized training in throwing, threw balls with overhand at five different conditions: 20%, 40%, 60%, 80% and 100% of the maximal ball speed. The motions were recorded using three high-speed video cameras. Three-dimensional coordinate data from maximal shoulder horizontal abduction position to the ball release position were calculated by the DLT method and thereafter were smoothed by fourth-order Butterworth filter. Peak joint torque before ball release and joint torque at ball release for each ball speed in wrist palmar/dorsal flexion, elbow extension/flexion, shoulder internal/external rotation and shoulder horizontal adduction/abduction were calculated. Repeated-measure one-way ANOVA was used to examine differences between ball speed conditions. **Results** The peak joint torque in wrist palmar flexion, elbow extension, shoulder internal rotation and shoulder horizontal adduction before ball release increased with higher ball speed ( $F(1.302, 5.208)=30.458$   $p<0.05$ ,



$F(4.000, 16.000)=11.983$   $p<0.001$ ,  $F(4.000, 16.000)=25.555$   $p<0.001$  and  $F(2.898, 11.591)=64.437$   $p<0.001$ , respectively). The joint torque in elbow flexion, shoulder external rotation and shoulder horizontal adduction at ball release increased with higher ball speed [ $F(4.000, 16.000)=4.937$   $p<0.01$ ,  $F(2.152, 8.609)=7.699$   $p<0.05$  and  $F(1.248, 4.991)=12.724$   $p<0.05$ , respectively]. However, the joint torque in wrist dorsal flexion at ball release didn't change. Discussion In line with the previous study (Miyanishi et al., 1996; Miyanishi et al., 1997), peak joint torque in shoulder internal rotation, elbow extension and wrist palmar flexion contributed to the acceleration of ball speed. In contrast, joint torque at ball release in shoulder external rotation, elbow flexion and wrist dorsal flexion were used to transfer the energy into ball. In summary, these results indicate that "whip-like motion" is performed for the regulation of ball speed. References Miyanishi, T. Fujii, N. Ae, M. Kunugi, Y. Okada, M. (1996). Japan Journal of Physical Education Health and Sports Sciences, 41. 23-37 Miyanishi, T. Fujii, N. Ae, M. Kunugi, Y. Okada, M. (1997). Japanese Journal of Physical Fitness and Sports Medicine, 46. 55-68

### STUDY ON THE KNEE ANGLE SIZE EFFECT IN A SUCCESSFUL FIRST TENNIS SERVE

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Study on the knee angle size effect in a successful first tennis serve Sgrò,F.,Mango,P.,Schembri,R,Lo Piccolo,A.,Lipoma, M. Physical activities and wellness science Faculty (Enna, Italy) Introduction In last years several definitions have been formulated about the tennis serve. Elliott et al. defined the tennis serve as one of the fundamental strokes during the development of a match (Elliott et al., 1986), while Sakurai et al. described the serve as the most effective shot that can influence the result of the game (Sakurai et al., 2007). The serve is based on bio-mechanics principle of "kinetic chain" but, as reported by Girard (Girard et al, 2007), an important role on the serve effectiveness is covered by the knee motion. In this work we propose a study about the proprioceptive angle size provided by the knee in the first serve produced by tennis players of different performance levels. Methods The twelve athletes involved in the experimental study have the follow characteristics: age:  $22.5 \pm 6.5$  years; height:  $176 \pm 6.7$  cm; body mass:  $70.1 \pm 4.9$  kg. Based on International Tennis Number (ITN) the athletes are grouped in: Novice (N), Intermediate (I) and Elite (E), with ITN respectively 10, 7 and 4 (4 athletes for each group). The experimental scenario is an outdoor clay tennis court, where we have placed 3 sync digital cams, one radar gun and a multimedia station. We analysed by means of a professional software of video analysis, Dartfish®, ten successful serves of each athlete, five for each side of the court which have been chosen according to tennis professional coach indications concerning the maximum speed obtained. Results The analysis of performance has interested the knee angle size ( $\theta$ ), the height of impact (Hi) and the speed of the ball (Sb) experimented for each serve. A statistical approach was used to analyse our data, collected by ITN level group. The results of correlation coefficient (r) for  $\theta$ -Hi,  $\theta$ -Sb and Sb-Hi relations show less positive value for N players than I and E ones; moreover, while the trend of r is the same for right/left-court side in N, it is different for I and E. Conclusion The knee angle plays an important role on the effectiveness of successful serves. The performance levels obtained by statistical analyses are consistent within the three groups. The correlation coefficient values suggest, for the I and E players, a specific study based on the skill of each player. References Sakurai S, Jinji T, Reid M, Cuitenho C, Elliott B.(2007). Direction of spin axis and spin rate of the ball in tennis service. Abstracts of XXI Congress. International Society of Biomechanics, July 1-5, 2007. Taipei, Taiwan Elliott B, Marsh T, Blanksby B. (1986). A 3-Dimensional Cinematographic Analysis of the Tennis Serve. International Journal of Sport Biomechanics. 260-71 Girard O, Micallef JP, Millet GP.(2007). Influence of restricted knee motion during the flat first serve in tennis. J Strength Cond. Res. 2007; 950-7

### SAFETY IN VIA FERRATA CLIMBING FOR CHILDREN

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TU MÜNCHEN

The goal of the study is the optimization of safety requirements and the development an adequate test method for safety equipment for children mountain routes called klettersteig or via ferrata. Via ferrata climbing has become increasingly popular by families with children, but there is currently no specific safety equipment is available for child use and the existing safety equipment for adults are not secure enough for child use. A modification of the equipment for children is not possible because the only criterion to obtain a safety certification is to fulfill the safety requirements specified in European standard EN 958: 2006 "Mountaineering equipment – Energy absorbing systems for use in klettersteig (via ferrata) climbing", where the experimental test method specifies the use of a falling mass of 80 kg. Therefore a human model including a detailed head-neck region has been developed using the multi-body simulation (MBS) software SIMPACK (SIMPACK, Gilching , Germany). The developed 15 segment parameterized human model is based on the up-to-date anthropometrical database of Size Germany. The detailed head-neck model is based on CT data of vertebrae (T3 to C1), ribs, clavicle, sternum and cranium. Corresponding 3D surface models were created describing the exact bone geometries. Implementation of user routines allows the modulation of force elements describing the material behavior of human soft tissue structures such as ligaments, tendons, and cartilage layers. The visco-elastic behavior of each soft tissue structure was calculated as a function of the geometry, loading velocity and the current strain situation. All force elements were validated by tensile tests. A realistic model of the safety equipment includes the fixation to the wobbling masses and a model of a brake employs stitching which progressively tears in case of a fall, providing a gradual deceleration. Different falling situations were simulated, e.g. in a horizontal or vertical start position of the model. For verification of the simulation results a comparison with experimental studies using crash test dummies was performed. One result of the simulations is the release distance of the brake for child and children. Depending on the start situation of the analyzed fall the difference in the release distance of the brake is 0.2 m for a 14 year old child and 0.8 m for a 50 percentile man.

### FACTORS AFFECTING LATERALITY OF STEP LENGTH DURING SPRINT RUNNING

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Introduction In human sprint running, it is considered ideal to run with an equal right and left movement. However, because of the difference between the physical characteristics of the right and left sides of a track and field sports player, laterality of step length occurs during sprint running. The aim of this study was to clarify the factors affecting the laterality of step length during sprint running; the factors that were considered were leg length, muscle strength, jump strength in each leg, and the position of the center of balance. Methods The subjects were 26 university students who belonged to the track and field club. To analyze their sprint motion, they were recorded during a 60-m sprint run with high-speed cameras (210 fps) set up on both sides of the sprint track. Therefore, both legs of the subjects were measured for leg length (tibia and femur), isokinetic muscle strength, and jump strength, and the position of the subjects' center of bal-

ance while standing was also determined. Results Laterality of step length was observed in 25 subjects. The step length of the right side was  $1.83 \pm 0.15$  m and that of the left was  $1.81 \pm 0.13$  m. However, a significant difference in the step lengths was not found. On the other hand, a significant correlation ( $r = -0.36$ ) was found between the laterality of step length and the tibia length. Discussion It was hypothesized that the laterality of the tibia length influences the running motion. Therefore, the movements of the support leg were analyzed, and parameters such as the change in angle and angular velocity of hips, knees, and ankle joints were measured. Path analysis result indicate that the leg with the longer tibia had a greater knee joint angle at the time of foot contact ( $\beta = 0.44$ ). After the foot contact, the change in the knee angle of the longer leg was large ( $\beta = 0.65$ ). Moreover, the angular change in the extension of the hip joint became small during the foot contact period ( $\beta = -0.44$ ), because of which the step length became short ( $\beta = 0.37$ ). To produce a high sprint speed, there must be an adequate movement of the support leg (Miyashita et al., 1986; Ito et al., 1998). In other words, the better sprinters had a smaller change in the knee angle during contact. In conclusion, the longer leg produces bad motion during contact, because of which the step length becomes shorter. References Ito A, Ichikawa H, Saito M, Sagawa K, Ito M, Kobayashi K. (1998). Japan J Phys Educ, 43, 260-273. (In Japanese) Miyashita K, Ae M, Yokoi T, Hashihara Y, Ooki S (1986). J J Sports Sci, 5, 892-898. (In Japanese)

## **RUNNING SPEED, JUMPING ABILITY AND THE JUMPED RESULT AMONG UNIVERSITY STUDENTS IN LONG JUMP**

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**Introduction** The aim of the study to investigate the correlation of running speed, jumping ability and the jumped result among university students in long jump. **Methods** Eighty-two physical education university students (40 women and 42 men) participated in an eight-week/eight-lesson unit on long jumping. During the lessons they participated in traditional learning drills, followed by commonly accepted step by step elongated approach jump attempts, and finally, a 12 stride approach long jump competition. Besides registering their jumping results, a questionnaire was administer in order to find out the subjects' opinion about the relationships between their learning progression and initial motor skills in track and field. **Results** We detected very high correlation among females between 60m and long jump (0,8), but for males correlation was small (0,23). Fifty percent of the subjects indicated that their former sprint experience had the greatest positive inter task transfer on their learning progression. The standing long jump was named as the most important even by 38.9% of subjects. In addition, 63.3% of the subjects appointed jumping ability to be more important than running speed. The majority of the subjects (60.5%) felt the 12 strides as the most effective length for their approach, while others (21.9% and 15.4%) preferred 10 and 8 strides, respectively. **Discussion** It was very interesting not to find a correlation among 60m and long jump results in case of male. The other strange thing, that the majority of the subjects (63.3%) felt the jumping ability to be more important than running speed.

## **ANALYSIS OF THE LONG JUMP TAKE OFF PHASE**

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**ANALYSIS OF THE LONG JUMP TAKE OFF PHASE** Mampieri, L.I, Piacentini, M.F.1 **1:Department of human movement and sport sciences (University of Rome-Foro Italico, Italy)** **INTRODUCTION** Run-up and take-off are the two phases that will determine the success in long jump. Results from previous studies showed that take-off execution can discriminate between the best and the worst performance (Chen-Fu and Chen-Shou, 2007). The purpose of the present study was to show that cinematic parameters discriminate among different performance levels with the hypothesis of a better performance achieved with a higher angular joint speed in the propulsive phase and a lower angular joint speed in the braking phase. These two parameters have never been evaluated previously. **METHODS** Five athletes were divided in two groups on the basis of their experience and age: more experienced (group A:  $n = 2$ , age  $20 \pm 1$  years), seven years of previous specific training and less experienced (group B:  $n = 3$ , age  $15.5 \pm 0.92$  years), four years of previous specific training and tested during a training session. At least three jumps were analyzed for each athlete. The following long-jump parameters were obtained by videoanalysis (Dartfish TeamPro): penultimate step length; horizontal and vertical touchdown and take-off velocity; time on board; angular metatarsal speed; braking and propulsive speed of ankle and knee respectively, measured from touchdown to take-off; braking and propulsive duration of ankle and knee respectively; long jump training distance (LJTD). Differences between parameters were analyzed with an unpaired student t test ( $P < 0.05$ ). A Pearson correlation was performed between all parameters and LJTD for both groups ( $P < 0.05$ ). **RESULTS** Significant differences ( $P < 0.05$ ) were observed in LJTD between A ( $6.22 \pm 0.25$  m) and B ( $4.9 \pm 0.57$  m). Significant differences ( $P < 0.05$ ) were observed between groups in long jump parameters: penultimate step length (A:  $2.12 \pm 0.5$  m; B:  $1.96 \pm 0.2$  m); ankle propulsive speed (A:  $1083 \pm 333.3^\circ/\text{s}$ ; B:  $767.6 \pm 282^\circ/\text{s}$ ); knee braking speed (A:  $-405 \pm 92.7^\circ/\text{s}$ ; B:  $-524.7 \pm 124.9^\circ/\text{s}$ ) and knee propulsive speed (A:  $711.4 \pm 110.3^\circ/\text{s}$ ; B:  $550.5 \pm 83.4^\circ/\text{s}$ ). Knee propulsive duration was significantly different between groups (A:  $0.05 \pm 0.01$  s; B:  $0.07 \pm 0.01$  s). Time on board was significantly correlated with performance in A ( $r = -0.58$ ,  $P < 0.05$ ) but not in B. **DISCUSSION** The most important results of the present study demonstrated that angular ankle and knee propulsive speed during take-off were higher in more experienced athletes while time on board and knee braking speed were lower. Differences between groups showed how more experienced athletes tried to perform long jump using run up velocity, a correct last two steps technique and less time in take-off execution. **REFERENCES** Chen-Fu H., Chen-Shou K. (2007) J. Biomech XXI ISB Congress, 2007.

## **THE EFFECT OF SEAT HEIGHT AND CADENCE ON GASTROCNEMIUS MUSCLE LENGTH, ACTIVATION AND CONTRACTION MODE DURING CYCLING**

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**Introduction** Research suggests that large variations in seat height and cadence are detrimental to cycling economy (e.g. Lucia et al., 2004). The optimal seat height and cadence range is likely to be narrow with studies typically finding optimal values between 96-100% of trochanter height (TH) for seat height and 90rpm for cadence suggesting that specific knee and ankle angles are important for optimal cycling biomechanics (Rankin and Neptune, 2010). The gastrocnemius muscle length is influenced by the ankle and knee joints and transmits muscle forces to the pedal (Raasch et al., 1997). Changes in cadence and seat height influence the length and activation of the gastrocnemius which could affect its function and cycling economy (Sanderson et al., 2009). Gastrocnemius contraction mode during late propulsion (eccentric vs. concentric) has also been shown to change with cadence but has not been shown to change with seat height (Gregor et al., 1991). Eccentric contractions of gastrocnemius could be evidence of slowing the rate of knee extension during propulsion

(Roberts and Azizi, 2010). This study aimed to determine if narrow ranges of cycling cadence and seat height influence oxygen cost, gastrocnemius length, activation, contraction mode and peak knee extension velocity. Methods Ten cyclists performed nine 5 minute cycling bouts at 200Watts which comprised 3 cadences (75, 90 & 100rpm) and 3 seat heights (100, 98 & 96%TH). 3D kinematics of the right lower limb and EMG from gastrocnemius were recorded for 30 seconds. Muscle length was calculated using ankle and knee position. Results VO<sub>2</sub>, gastrocnemius activation, gastrocnemius eccentric contraction and peak knee extension velocity significantly increased with cadence. The gastrocnemius operated at a shorter length at higher cadences. However, only gastrocnemius eccentric contraction during late propulsion and peak knee extension velocity increased with seat height. Discussion Changes in seat height that do not affect oxygen cost of cycling, gastrocnemius activation or gastrocnemius operating length may still influence cycling biomechanics. Seat height is likely to affect the capacity of the gastrocnemius to transmit forces to the pedal because during late propulsion the gastrocnemius eccentrically contracts possibly to limit knee extension velocity. References Gregor, R. J., Komi, P. V., Browning, R. C. and Jarvinen, M. (1991). *Journal of Biomechanics*, 24(5): 287-297. Lucia, A., San Juan, A. F., Montilla, M., Canete, S., Santalla, A., Earnest, C. and Perez, M. (2004). *Medicine and Science in Sports and Exercise*, 36(6): 1048-1054. Raasch, C. C., Zajac, F. E., Ma, B. and Levine, W. S. (1997). *Journal of Biomechanics*, 30(6): 595-602. Rankin, J. W. and Neptune, R. R. (2010). *Journal of Applied Biomechanics*, 26, 493-500. Roberts, T. J. and Azizi, E. A. (2010). *Journal of Applied Physiology*, 109(2): 396-404. Sanderson, D. J. and Amoroso, A. T. (2009). *Journal of Electromyography and Kinesiology*, 19(6), e465-e471.

## THE ANALYSIS OF X-FACTOR ON GOLF SWING USING TWO DIFFERENT IRON ON AMATEURS GOLFERS

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Introduction: During the GS the pelvic and the upper torso rotate about tree anatomical axes. On transverse plane the shoulder rotate against the pelvis to produce a maximum angular displacement between shoulder and hips, normally call as a X-Factor (XF) (McLean, 1997). This movement creates a strongly twisting body to store energy for maximum speed of the club head at impact. The XF beyond physical limits cloud be a main problem on GS. The main purpose of this work is to understand the mechanics of the hip and shoulders during two different club irons (a Pitch and 4-iron) using the changes in the XF. Methods: Three amateurs golfers volunteered to participate in this study. All participants signed an informed consent approved by the Ethical Review Board. The subjects were asked to perform a GS using two different clubs. The pitch shots is use to produce a higher trajectory and the 4-iron is used for longer distances. Subjects were instrumented with 4 reflective spherical markers placed bilaterally at the shoulders (top of the acromion process), and 3 markers defined the pelvis, 2 markers at the anterior superior iliac spines. The golfers hit a minimum of 8 balls for each iron into a hall. We analyzed 3 trials based on the quality of kinematic data. The GS motion was recorded with three Basler (A602fc) camera at 100Hz, And a fourth camera CASIO EX-FH20 of 1000Hz was placed anterior to the ball. The SIMI® Motion 3D software was use to tracking process. We analyze the shoulder and the hip displacement on transverse plane of two vectors; the shoulder vector connecting the shoulder joint centers and the hip vector connecting the anterior and superior iliac spherical markers. The planar angle between these two vectors was measure and compared. To minimize differences between golfers we only compared the angle position in five moments of the GS at (sBS) – start of back swing; (sFS) -start of forward Swing; (hFS) – horizontal position of the club in forward Swing; (iB) - ball impact, and (hFT) – horizontal position of the iron at follow-through. Statistics T-test methods were use to compare the difference between Results: The results of the statistical analysis revealed no significant differences on the angular position of the shoulders and hips using different irons, as well as no differences on the X-F in different instant phases of GS. Discussion: All golfers showed different way to perform the GS according to rhythm and velocity of the motion, but in those particular instants the position of the club maintain also most the same, show some concerned about the technique during the motion. Conclusion: We conclude that the amateur golfers do not change the technique of the GS, which indicates the same mechanic stress even if they use a different iron.

## SOFT TISSUE ARTEFACTS IN THE SHANK DURING THE GOLF SWING

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Introduction Soft tissue artefact (STA) is widely accepted as a considerable source of error in 3D motion capture (Cappello et al., 1997). Research on the magnitude and nature of STA indicate that the phenomenon is highly task dependent (Stagni et al., 2005). Techniques suggested to minimise STA are largely concerned with gait analysis; little consideration has been given to the influence of STA on the analysis of golf swing performance. This study aimed to assess the extent of STA during the golf swing using two alternative marker sets. Methods Ten male right-handed golfers were recruited (mean age 35.1yrs, SD 15.3; mean handicap 11.9, SD 6.1). Exclusion criteria included pathology that impacted golfing performance. A comparison was made between knee joint kinematics using a standard, lower-body six degree of freedom (6DoF) marker set and a 6DoF marker set including an alternative shank cluster. The alternative shank cluster was designed according to guidelines proposed by Cappozzo et al. (1997); it attaches to the anterior aspect of the distal tibia where STA potential is considered to be lowest. Single markers attached to the tibial tuberosity, distal tibia, lateral and medial malleoli provide a reference set of markers with minimal inter-marker movement (Peters et al., 2009). Participants took ten shots with a driver for each of the marker sets. Shot consistency was verified using a Trackman system. Left and right knee angle in the X, Y and Z planes were identified at mid back-swing, mid down-swing and ball impact. Mean error values between reference markers and clusters were calculated and compared using a paired t-test (alpha level of  $p < 0.05$ ). Results Left knee angle showed no significant differences ( $p > 0.05$ ) in errors between clusters for any of the swing phases. Significant differences were evident in the right knee in the sagittal plane (X) at mid back-swing and the coronal plane (Y) at mid down-swing and ball impact. Mean errors were 0.55, 1.15 and 1.48 degrees respectively. Mean errors were smaller in the marker set incorporating the alternative cluster. Discussion The lack of significant differences between the clusters on the lead (left) leg provides some reassurance that a traditional 6DoF marker set provides comparable positional data to an optimised tibial marker set. Measurement of the trailing knee, where there is greater axial rotation and flexion, may improve with a modified cluster. References Cappello A, Cappozzo A, La Palombara PF, Lucchetti L, Leardini A. (1997) *Human Movement Science*, 16, 259–274. Cappozzo A, Cappello A, Croce UD, Pensalfini F. (1997) *IEEE Transactions on Biomedical Engineering*, 44, 1165–1174. Peters A, Sangeux M, Morris ME, Baker R. (2009) *Gait & Posture*, 29, 42–48. Stagni R, Fantozzi S, Cappello A, Leardini A. (2005) *Clinical Biomechanics*, 20, 320–329.

## EFFECTS OF NON-CUSTOM MOUTHGUARDS ON MUSCULAR STRENGTH AND VERTICAL JUMP HEIGHT IN COLLEGIATE ATHLETES

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EFFECTS OF NON-CUSTOM MOUTHGUARDS ON MUSCULAR STRENGTH AND VERTICAL JUMP HEIGHT IN COLLEGIATE ATHLETES Egret, C. 1, AbdelFattah, M. 2, Ludwig, K. 1 1: Barry (Miami, USA) 2: UF (Gainesville, USA) Introduction A complex relationship exists between the joint of the jaw and the muscles of the head and neck, as well as the entire body (Knapik et al., 2007). Therefore, appliances that reposition the mandible may help reduce stress and tension in the muscles, improve abnormalities in body posture, and increase physiological and exercise performance. Most of the literature is focused on fitted oral appliances for muscular strength performance. Therefore, the purpose of this investigation was to examine the effects of a non-custom mouthguard on knee flexion and extension strength, shoulder external and internal rotation strength, and the effects of such mouthguards on vertical jump height. Methods 24 collegiate varsity-level student-athletes volunteered to participate. The subjects were divided into two groups; one using an upper mouthguard, and the second with a double mouthguard compared to no appliance. Muscular strength was measured in a stabilized chair of a Biodex System 3 dynamometer (Drouin et al., 2004). Jump height was assessed using a Vertec jump height apparatus (Hutchinson et al. 2009). Repetitions of knee flexion/extension and shoulder external rotation/internal rotation at 60 °/s and 180 °/s were taken, as well as jump height differentials. ANOVAs were calculated to examine the effects of group and test (with/without mouthguard) on each measured variable. Results Knee extensor torque at 60°/s and total work at 180°/s were significantly higher with both appliances. No differences were found for the shoulder joint. Jump height was improved but not significantly. Discussion The shoulder was unaffected by the appliances, while the knee was slightly improved. A reason may be related to the type of joint. The knee is a more stable, weight-bearing joint, while the shoulder has much less restriction and is not weight-bearing. The stability and structure of the knee may contribute to a stronger "pulley" in the kinetic chain in terms of the effect of placing a mouthpiece in the oral cavity. This improvement may impact some athletes, especially those to which knee extension is often performed (i.e., rowing, and any sport that involves running). Future research should investigate the effects of mandibular adjustment on the different joints of the body, as well as utilize varying sizes of mouthguards while still maintaining the non-custom aspect of the appliances. References Drouin J, Valovich-McLeod T, Shultz S, Gansneder D, Perrin D. (2004). Eur J Appl Physiol, 91:22-29. Hutchinson AT, Stone AL (2009). J Exerc Physiol, 12, 3-4. Knapik JJ, Marshall SW, Lee RB, Darakij SS, Jones SB, Mitchener TA, Delacruz GG, Jones BH (2007). Sports Med 37:117-144.

## Poster presentations

### PP-BN17 Biomechanics: Muscle Properties

#### EVALUATION OF THE LOWER-LEG MUSCLE CHARACTERISTICS IN ATHLETES WITH COMPLETE SPINAL CORD INJURY

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Methods Eight male subjects with complete spinal cord injury participated in this study (average age; 43.3±14.5 years old). The spinal cord injury level was Th2-3 (1 subjects), Th6 (1), Th9 (1), Th10; (1), Th 11 (1), Th12 (2), L1 (1). The average period after injury was 15 years and 8 months. The sports activities with the wheelchair were marathon, tennis, basket and dance. The average frequency of sports activities was 3.9 days a week (1.7 hours / day). The total muscle area in fascia was assessed by MRI (thigh and leg level) and muscle activity was evaluated by electromyography. Results Circumferences of thigh (COT) for more than 20 years after injury incident were 40.0±2.0cm (right) 40.0±2.6cm (left) and COTs for less than ten years were 32.0±0.0cm (right) and 31.0±1.4cm (left). The areas of quadriceps muscle for more than 20 years were 23.2±0.2m<sup>2</sup> (right) and 11.3±0.8 cm<sup>2</sup> (left) and COTs for less than ten years were 23.4±1.9cm cm<sup>2</sup> (right) and 11.2±0.4cm<sup>2</sup> (left). The three subjects (12 yrs and 7 mos, 26 yrs and 2 mos, 31 yrs and 5 mos after injury) were aware of subjective muscle spasms by sports activity. M spike by electromyography were found in all three subjects. However, M spike and muscle spasms could not found in other subjects. Fatty degeneration of muscles in the lower-limb was occurred with the number of years after complete spinal cord injury, even though athletes continued daily sports activities. Discussion The area of quadriceps muscle and COT were not changed after 20 years of injury in athletes with complete spinal cord injury, despite of fatty degeneration of muscles. The muscle activity by electromyography was found even in the degenerated muscles with subjective muscle spasms. Our study suggested that degenerated muscles of the lower-leg muscle in athletes with complete spinal cord injury may retain muscle activity.

#### EFFECT OF SADDLE HEIGHT ON OXYGEN CONSUMPTION AND EMG OF LOWER LIMB MUSCLES DURING SUBMAXIMAL CYCLING ON A FREE-ROLLER IN CYCLISTS

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Effect of saddle height on oxygen consumption and EMG of lower limb muscles during submaximal cycling on a free-roller in cyclists Shinichiro Murade<sup>1</sup>, Akihiro Sakamoto<sup>2</sup>, Ryo Kakigi<sup>1</sup>, Shizuo Katamoto<sup>1</sup> 1 Graduate School of Health and Sports Science, Juntendo University 2 Department of Human System Science, Tokyo Institute of Technology Introduction Oxygen consumption (VO<sub>2</sub>) during pedaling exercise on a cycle ergometer has been shown to increase when the saddle height is low or high as compared to the optimal height (Nordeen-Snyder, 1977). However, this change has not been confirmed using an actual road bicycle although the kinetics and kinematics of pedaling may differ between cycle ergometer and actual bicycle. Therefore, this study aimed to investigate the effect of saddle height on VO<sub>2</sub> using an actual road bicycle. Methods Fourteen male competitive cyclists (18-25 yr) performed 4-min submaximal pedaling using their own road bicycles on a free-roller with a selected gear to produce the speed of 31km/h at 60 and 90 rpm (120-150 w). Five saddle heights (95, 97.5, 100, 102.5 and 105 % of preferred saddle height) were randomly assigned for each cadence without informing the subjects of the saddle height condition. During each trial, VO<sub>2</sub> and heart rate (HR) were measured. Surface EMG signals were also recorded unilaterally (the right side) from the gluteus maximus (GM), biceps femoris (BF), gastrocnemius lateral head (GL), vastus lateralis (VL) and tibialis anterior (TA) between 2'50" and 3'00" of each pedaling trial. Results Increased saddle height resulted in an quadratic rise in VO<sub>2</sub> (p < 0.001) and HR (p < 0.01) for both cadences. Unlike the previous finding using cycle ergometer (Nordeen-Snyder, 1977), VO<sub>2</sub> did not show a U-shaped change with varying saddle heights, demonstrating a different cardiorespiratory response between the cycle

ergometer and actual bicycle pedaling. Higher saddle heights resulted in significantly greater integrated EMG (iEMG, mean of 5 cycles) in GM (60 & 90 rpm,  $p < 0.001$ ) and GL (60 rpm,  $p = 0.001$ ), but iEMG of other three muscles (BF, VL, TA) were not influenced by the saddle height changes for both cadences. Discussion The increased iEMG in GM and GL with higher saddle heights may have resulted from a greater effort to generate torque to maintain a given speed due to the effect of angle-torque relationship, and from exaggerated kinetic or kinematic behaviors of the hip and ankle joints. These changes possibly accounted for the observed rise in VO<sub>2</sub> and HR with higher saddle heights. Further EMG analysis as well as mechanical analysis is warranted to uncover the exact mechanisms for the different cardiorespiratory responses between cycle ergometry and actual road bicycle, and among saddle heights. Reference Nordeen-Snyder, K. The effect of bicycle seat height variation upon oxygen consumption and lower limb kinematics. *Med. Sci. Sports*. 9 (2): 113-117, 1977.

### CHARACTERISTICS OF MUSCLE ACTIVITY ON LOWER LIMB MUSCLES DURING A PEDALING EXERCISE WITH DIFFERENT LOADS AND PEDALING RATES.

TANAKA, S., KUMAGAWA, D., TSUNODA, N.

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**Introduction** The anaerobic power in cycling ergometer was determined by the load and pedaling rate. Therefore, the anaerobic power generation capacity during pedaling exercise affected size of load and pedaling rates. The previously reports on muscle activity during pedaling exercise, many focused on the lower muscles to work initiative. However, the activity level of each muscles during different load and pedaling rate settings were not cleared. Moreover, in each muscle during pedaling, it has not been cleared that the anaerobic power to the muscle activity is affected by the load and pedaling rate. In this study, the purpose of this study was to investigate characteristics of muscle activity on lower limb muscles during a pedaling with different loads and pedaling rates. **Methods** The subjects were twenty four male collegiate athletes. The anaerobic power generation capacity was measured by a cycling ergometer (Power max V II, Combi co. Japan) with costume made measurement-analysis system. The all subjects performed the exercise for ten seconds with maximal effort intermitted between three-step loads. The loads were 5.0% kp, 7.5% kp and 1.0% kp to body mass. The muscle activities of lower limb were observed by surface electromyography (EMG) methods. The muscle activities were evaluated integrated EMG and % integrated EMG from initial pedaling to peak velocity pedaling. **Results** The integrated EMG during pedaling was not changed due to different loads. The power per integrated EMG ratio in rectus femoris, vastus lateralis, biceps femoris and tibialis anterior muscles were changed by the different loads. However, muscle activity level in initial and peak velocity pedaling were no significant difference among the three trials with the different loads. The biceps femoris and gastrocnemius muscles during peak velocity pedaling were showed higher activity levels than that of initial pedaling. **Discussion** In this study, it were suggested that lower muscles activity pattern depends on the each muscle function. Moreover, muscle activity levels were affected by clank velocity than the load in maximal efforts pedaling. **References** Hug F, Dorel S, (2009). *J. Electromyogr. kinesiol.* 19, 182-198. Rouffet DM, Mornieux G, Zameziati K, Belli A, Hautier CA. (2009). *J. Electromyogr. kinesiol.* 19, 6, 1100-1107. Rouffet DM, Hautier CA, (2008). *J. Electromyogr. kinesiol.* 18, 5, 866-878. Samozino P, Horvais N, Hintzy F. (2007). *Med. Sci. Sports Exerc.* 39, 4, 680-687.

### THE INFLUENCES OF WEARING INFRAPATELLAR STRAPS ON EXERCISE PERFORMANCE AND LANDING BIOMECHANICS OF CHILDREN

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**Introduction** Jumping is a common movement seen in daily exercise for athletes. The ground reaction force, as athletes land on the floor, could be several times higher than their body weight. Hence, athletes' knee joints are easily damaged when they jump repeatedly. One of the common injuries on knee joint is patellar tendinitis. This is an overuse syndrome. An infrapatellar strap is a knee brace especially designed for those who suffered patellar tendinitis, and it is commonly used by athletes. However, exercising with braces limits the effects of knee activeness. Whether or not it affects athletes' performance needs to be further investigated. Therefore, the purpose of this study was to investigate the influences of wearing infrapatellar straps on exercise performance and landing biomechanics of children. **Methods** Twelve sixth-grade children were recruited for this study. The high-speed camera and force platform were used simultaneously for collecting data of kinematics and kinetics. Then, the method for inverse dynamics was applied to calculate the biomechanics parameters of lower limb joints with or without having infrapatellar straps on. In addition, scores of exercise performance were retrieved by means of wearing infrapatellar straps or not. The data was analyzed and tested for its significance via paired-sample t-test ( $\alpha = .05$ ). **Results** The results show that there is no significance in exercise performance. Significance is found, when the participants land, in the shear force of leg knee joints and leg ankle joints, as well as in the max Angular velocity of ankle joints ( $p < .05$ ). **Discussion** Wearing infrapatellar straps does not affect the explosive force, agility, and speed of the lower limb joints. Its influence on kinematics parameters does not benefit the cushion for landing impact, but it tends to decrease the inner force of joints. Specifically, the shear force in knee and ankle joints reaches significance. This may avoid over contraction of the quadriceps, lessens burdens of the patellar tendon, and lowers down the risk of knee joint injuries. **References** Bisseling, R. W., Hof, A. L., Bredeweg, S. W., Zwerver, J., & Mulder, T. (2007). Relationship between landing strategy and patellar tendinopathy in volleyball. *British Journal of Sports Medicine*, 41, e8. Bohnsack, M., Halcour, A., Klages, P., Wilharm, A., Ostermeier, S., & Ruhmann, O., et al. (2008). The influence of patellar bracing on patellar and knee load-distribution and kinematics: an experimental cadaver study. *Knee Surgery, Sports Traumatology, Arthroscopy*, 16(2), 135-141. Greene, D. L., Hamson, K. R., Bay, R. C., & Bryce, C. D. (2000). Effects of Protective Knee Bracing on Speed and Agility. *The American Journal of Sports Medicine*, 28(4), 453-459. Hamilton, B., & Purdam, C. (2004). Patellar tendinosis as an adaptive process: a new hypothesis. *British Journal of Sports Medicine*, 38, 758-761.

### COMPARISON OF TENDON STIFFNESS MEASURED UNDER ACTIVE AND PASSIVE CONDITIONS

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Muscle and tendon stiffness have been widely studied in exercise and clinical settings. Stiffness plays an important role in locomotion, and the release of mechanical energy. Tendon stiffness is typically calculated by dividing force and elongation of the tendon. For this purpose, participants are commonly asked to perform a voluntary contraction to activate the muscle, and elongate the tendon ("active method"). An alternative method is to record tendon force and elongation from a passive, isokinetic rotation through joint range of motion

("passive method"). Both methods elicit force and elongation from which tendon stiffness can be calculated. The passive method has the advantage of being able to provide estimates of muscle stiffness in addition to tendon stiffness. Further, when employing the active method, the velocity at which the tendon elongates (which has previously been shown to affect tendon stiffness *in vitro*) is less controlled compared to the constant angular velocity of the passive method. Given that both methods have been previously used to obtain tendon stiffness, it is important to understand whether they are in agreement. Therefore, the purpose of this study was to compare tendon stiffness obtained from both the passive and the active methods. A secondary purpose was to quantify tendon stiffness across different tendon elongation velocities. Ten healthy adults (age  $25 \pm 4.6$  y) volunteered to participate in the study. They began by completing a series of maximum isometric plantarflexions, where they were instructed to use a range of contraction velocities. Following these, a series of passive ankle rotations were performed at varying speeds (1, 10, 30 deg•s<sup>-1</sup>) through the ankle's range of motion. Tendon force and elongation were obtained from a combination of motion analysis, dynamometry and ultrasonography. Achilles tendon stiffness for both methods was calculated as the slope of the force-elongation curve. The force range and the velocity of tendon elongation were standardised across the two methods. Stiffness for both methods was calculated at tendon elongation velocities of 1, 4, and 8 mm•s<sup>-1</sup>. We found strong positive correlation *s* between tendon stiffness obtained from both methods at all elongation velocities ( $r = 0.97$  for 8 mm•s<sup>-1</sup>;  $r = 0.95$  for 1 •s<sup>-1</sup> & 4 •s<sup>-1</sup>), and stiffness increased as tendon elongation velocity increased. For both methods, the relationship between these variables was linear (mean  $r = 0.98 \pm 0.02$  and  $0.96 \pm 0.04$  for active and passive methods, respectively). These findings demonstrate good agreement between tendon stiffness obtained from both passive and active methods as long as the range of tendon force and the velocity of elongation are accounted for. However, tendon stiffness is strongly affected by elongation velocity, so caution should be taken when comparing results from the literature, as the velocity of tendon force is not always standardised.

## MUSCLE STRUCTURE AND ACTIVITY OF LOWER LIMBS DUE TO THE ANAEROBIC POWER GENERATION IN UNIVERSITY RUGBY PLAYERS.

YUTARO, K.

KOKUSHIKAN UNIVERSITY

**Introduction** The purpose of this study was to examine that effect of muscle structure and activity of lower limbs muscles due to anaerobic power generation on positional difference in university rugby players. **Methods** The subjects were 30 forward players (FWG) and 31 backs players (BKG) in university rugby players. The muscle volume and a muscle thickness were measured by the body impedance analysis method and B-mode ultrasonic method, respectively. The anaerobic power generation obtained by cycling ergometer with analyzed program. Subjects performed ten seconds with the maximal efforts intermitted of three steps load. The muscle activities of pedaling with different loads were observed by surface electromyography method. In addition, the ratios of anaerobic power to muscle activities were calculated (Power/iEMG ratio) in all the subjects. **Results** FWG were indicated significantly higher than BKG in whole muscle volume (WMV), lower limbs muscle volume (LMV) and WMV/LMV. Moreover, LMV/WMV was not significant difference among the position. However, muscle thickness/WMV was obtained that FWG were indicated significantly higher than that of BKG in thigh anterior and thigh lateral. Time to peak power was obtained significant difference between FWG and BKG in the pedaling. Power/iEMG ratio in FWG was showed higher value than that of BKG in all the pedaling. **Discussion** From these results, it was clarified that anaerobic power generation characteristic were differed by positional difference in university rugby players. And also, FWG showed high power than BKG in less muscle activity during the pedaling. Whereas, it was suggested that FWG was better than BKG at efficiency of the movement. **References** Brewer J, Davis J, Keur J.(1994). A comparison of the physiological characteristics of rugby league forward and backs. *J Sports Sci*, 12, 2,158 Hug F, Dorel S.(2009). Electromyographic analysis of pedaling. A rebiew, *J.Electromyogr kinesiol*, 19, 182-198 Rouffet D.M, Hautier C.A.(2008). EMG normalization to study muscle activation in cycling, *J.Electromyogr kinesiol*, 18, 5, 866-878

## TIME KINETICS OF ACUTE CHANGES IN MUSCLE ARCHITECTURE IN RESPONSE TO RESISTANCE EXERCISE

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**Introduction** The mechanisms responsible for changes in the arrangement of fascicles within skeletal muscles (i.e. the muscle architecture) observed after prolonged periods of physical training are well understood (s. review by Blazevich, 2006). By contrast, few studies have documented the short-term effects of acute bouts of exercise (Kubo et al., 2001; Ishikawa et al., 2006; Brancaccio et al., 2008). The inconsistent results reported in these studies indicate that acute changes in muscle architecture are specific to the muscle examined and the exercise performed and may reflect distinct physiological mechanisms. Closer scrutiny of acute changes in muscle architecture might allow for insights into these mechanisms and provide a rationale for long-term training adaptations. The study aimed to assess acute changes in muscle architecture and its recovery after exhaustive exercise. We hypothesised that repetitive leg press exercise would decrease vastus lateralis fascicle length (Lf), while increasing both muscle thickness (MT) and pennation angles ( $\theta$ ). By investigating the time kinetics of recovery of these parameters, we wished to gain insight into the mechanisms responsible for muscle architectural changes during exercise. **Methods** Vastus lateralis MT,  $\theta$  and Lf were measured in 41 male volunteers ( $25.2 \pm 3.7$  yrs;  $178 \pm 6$  cm;  $76.4 \pm 11.7$  kg) by ultrasonography. Scans were taken at rest as well as 1, 5, 10, 15 and 30 minutes after induction of fatigue by an exhaustive series of single leg press repetitions. **Results** Following leg press exercise MT and  $\theta$  were increased by approximately 7 and 10%, whereas Lf decreased by 2%. Different recovery times (MT: 30 min;  $\theta$ : 15 min; Lf: 5 min) were observed. The degree of fascicle shortening invoked by the exercise intervention was positively correlated to the Lf baseline value ( $r = 0.41$ ;  $p = 0.039$ ). **Discussion** The differential time courses of recovery suggest that the changes in the parameters of muscle architecture are driven by different exercise-related stimuli. While the increases in MT may be explained by augmented muscle perfusion, tendon creep may account for the fascicle shortening and the increases in  $\theta$  observed. The correlation between the degree of fascicle shortening and the Lf baseline value suggests that longer fascicles shorten relatively more in response to leg press exercise. Future research should directly relate the time course of changes in tendon stiffness and muscle perfusion to acute changes in muscle architecture. **References** Blazevich (2006). *Sports Med*, 36(12), 1003-17. Brancaccio P. et al. (2008). *J Sci Med Sport*, 11(6), 538-41. Ishikawa M. et al. (2006). *Eur J Appl Physiol*, 97(3), 298-306. Kubo K. et al. (2001). *J Appl Physiol*, 91(1), 277-82.

## MUSCLE SHAPE AND DISTRIBUTION OF MUSCLE VOLUME WITHIN THE TRICEPS SURAE MUSCLE GROUP IS INDEPENDENT ON MUSCLE SIZE

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The assessment of muscle volume is essential, when evaluating muscle-tendon unit performance. Muscle volume affects directly the maximum mechanical power that can be generated by a muscle. Furthermore, muscles with a smaller ratio of muscle volume to physiological cross-sectional area generate a given force more economical than a muscle with a higher ratio [2]. However, direct measurement of muscle volume is laborious. In general, muscle volume is a fraction of the product of the maximum anatomical cross-sectional area (ACSA) and muscle length (lm). The size of the fraction (shape factor) depends on muscle shape. It was recently shown for the three triceps surae (TS) muscles that the shape factor showed a low inter-subject variability and that an approximation of muscle volume based on this theoretical consideration was possible with an accuracy of 4 to 7% for people who are exposed to normal daily activities [1]. The aim of the present study was to investigate, whether the shape factor and therefore the possibility to approximate muscle volume from ACSAmax and lm is affected by muscle size. According to their muscle activation level 32 subjects were divided into a low (LA), moderate (MA) and high (HA) activation group. The LA group consisted of 13 subjects that were at least active in recreational sports, the MA group consisted of nine endurance runners (training volume of  $14 \pm 4$  hours/week), the HA group consisted of ten elite track & field athletes (sprint, long jump, triple jump) with an average training volume of  $18 \pm 3$  hours/week. Transversal MR Images were acquired from the calf of the dominant leg. Each muscle was reconstructed to determine muscle volume, lm, ACSAmax, the shape factor and the relative contribution of each muscle to the entire TS muscle volume. The HA group had significant ( $p < 0.05$ ) longer muscles, a greater ACSAmax and a greater muscle volume in comparison to the other groups. The scaling factor and the relative contribution of each muscle to the entire TS muscle volume showed significant ( $p < 0.05$ ) differences across the three muscles but no significant ( $p > 0.05$ ) differences across the three groups. In addition, the coefficient of variance for the scaling factor was similar across the groups (LA 4.3 - 6.7%, MA 4.3 - 7.4%, HA 4.3 - 6.7%). Thus, despite considerable differences in muscle size (length, thickness, volume) the shape factor and the relative contribution of each muscle to the entire TS muscle volume is not affected. The fact, that the shape factor is specific for each muscle but similar across the groups indicates that the shape of each muscle is similar within the population and thus independent of muscle size. Therefore, the theoretical consideration can be used to approximate muscle volume from ACSAmax and lm, which are both easily accessible in comparison to a muscle reconstruction. [1] Albracht et al (2008) J Biomech, 41, 2211-8 [2] Biewener et al (2000) Exerc Sport Sci Rev 28, 99-107

## THE EFFECT OF A 6-WEEK STATIC STRETCHING TRAINING ON THE MUSCLE AND TENDON PART OF THE M. GASTROCNEMIUS MEDIALIS

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UNIVERSITY GRAZ

THE EFFECT OF A 6-WEEK STATIC STRETCHING TRAINING ON THE MUSCLE AND TENDON PART OF THE M. GASTROCNEMIUS MEDIALIS Tilp, M., Rassinger, R. Institute of Sports Sciences, Karl-Franzens-University Graz Introduction There are only few studies which separated the effect of stretching on the different parts of the muscle tendon unit which are the muscle belly and the tendon. While Morse et al. (2008) reported an increase in muscle elongation but not in tendon, Kato et al. (2010) reported increased tendon elongation but unchanged muscle elongation at an identical passive torque immediately following static stretching. Following a 6-week stretching program Kato (2009) also reported increased tendon but unchanged muscles lengths. Due to the different reports on acute effects on stretching and limited amount of research on long term effects we decided to repeat the approach from Kato (2009). Methods Twelve subjects agreed to participate in the study. Seven subjects performed a static stretching training which consisted of 3x1 min static stretching of the calf muscles for each leg. Five subjects were in a control group and did not perform any stretching training. Before and following the six weeks the ankle joint was moved passively over the greatest part of the range of motion ( $\pm 27^\circ$ ) on a dynamometer. Simultaneously, we followed the motion of the muscle tendon junction with ultrasound B-mode from which we calculated the elongation of the muscle and tendon part of the muscle (Kato, 2009). Mean values of maximum passive torque, muscle and tendon elongation before and following the six weeks were compared with paired t-tests. Results The results from two male subjects in the stretching group had to be excluded due to irregularities in the training period. Muscle length changes increased from  $24 \pm 1.4$  to  $29.4 \pm 5.3$  mm and tendon length changes decreased from  $19.4 \pm 1.6$  to  $14.2 \pm 2.1$  mm during passive stretches significantly. Furthermore, there was a tendency ( $p = 0.07$ ) for decreased peak passive torque ( $29.2 \pm 4.6$  to  $26.0 \pm 2.7$  Nm) in the intervention group. However, significance was not reached due to the small amount of subjects ( $n = 5$ ). Values in the control group did not change. Discussion We conclude that static stretching for 6 weeks affects the elasticity of the proximal, muscle part of the gastrocnemius. This supports findings by Morse et al. (2008) and opposes results from Kato et al. (2010) on acute effects and long term effects (Kato, 2009). However, due to the small intervention group we did not reach significant results for changes in passive torque. We suggest further analysis of the effect of stretching on structural parameters like muscle and tendon stiffness, muscle fascicle lengths and pennation angles. References Kato E. (2009) ECSS Abstracts, 194-195. Kato E, Kanehisa H, Fukunaga T, Kawakami Y (2010) Eur. J. Sport Science, 10(2), 111-119. Morse CI, Degens H, Seynnes OR, Maganaris CN, Jones DA (2008) J Phys, 586(1), 97-106.

## TRUNK MUSCULAR RESPONSE DURING 'BRIDGE' STABILIZATION EXERCISES WITH AND WITHOUT LIMB MOTION

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Introduction Bridge exercises, consisting in stabilizing the trunk with a neutral spine in different positions, are usually performed to develop trunk muscle coactivation patterns to improve spine stabilization (McGill and Karpowicz, 2009). The purpose of this study was to analyse the trunk muscle coactivation patterns during bridge exercises with and without limb motion. Methods Twenty-nine healthy subjects volunteered to take part in this study. Surface electromyography (EMG) was bilaterally recorded from rectus abdominis (RA), external and internal oblique (EO and IO), and erector spinae (ES) while performing isometric bridge exercises: back bridge, back bridge with right leg up, side bridge on right elbow, side bridge on right elbow with left hip flexion (left leg forward), frontal bridge, and frontal bridge with right leg up. EMG signals were rectified, averaged, and normalized to maximal voluntary isometric contraction (% MVC). Results When the stabilization exercises were performed without limb motion, back, frontal and side bridges mainly activated the ES (about 17% MVC), the RA (about 30% MVC) and the right side muscles (mostly obliques), respectively. Limb motion produced significant increase in the trunk EMG. This was especially true for the IO, which generated higher mean activation levels for side bridge with hip

flexion (32.7% MVC), frontal bridge with leg up (28.3% MVC), and back bridge with leg up (21.4% MVC). Comparing between exercises, the highest RA activation was found during the frontal bridge. For the right EO, IO and ES the right side bridge with hip flexion produced the highest activation levels. In addition, for the left EO and IO, the frontal bridge with leg up was the exercise that showed the highest activation. Finally, the highest left ES EMG was found during the back bridge with leg up. Discussion The bridge exercises produced low to moderate mean activation levels. For the lumbar musculature, the highest activation levels were found during back and side bridges. On the contrary, frontal and side bridges showed the highest abdominal activation levels. Compared with conventional exercises, bridges with limb motion resulted in more unstable postures which required an increase in muscle coactivation, possibly to ensure spine stability (Vera-Garcia et al., 2006). In addition, bridges with hip flexion/extension generated twisting pelvis torques that were counterbalanced by increasing twister muscle activation, especially IO. Overall, these results can be used to assist decisions regarding the selection of stabilization exercises. References McGill SM, Karpowicz A. (2009). Arch Phys Med Rehabil, 90, 118-26. Vera-Garcia FJ, Brown SHM, Gray JR, McGill SM. (2006). Clin Biomech, 21, 443-55.

### SOME MECHANISMS OF PISTOL SHOOTING PERFORMANCE

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Introduction. Successful shooting performance is associated with good postural balance and the pistol stability. The purpose of the present research was to study mechanisms of successful shots. Methods. 8 shooters took part in this research. 60 control shots were made during 105 minutes (exercise PP-3). Telemetric "Qualisis" and "ME 6000" systems were used to record surface EMG and kinematic parameters. The EMG and kinematic data were synchronized and processed by "Qualisis" system. Results. It was revealed that the highest variability of the pistol's position and the changing of the body's position is observed on the Y axis and the lowest – on the Z axis. The variability of movements in the final series of shots did not change considerably in comparison with the initial shots. Successful shooting performance is determined by the stability of all the parts of the shooter's body in the frontal plane (axis Y). EMG amplitude of the most muscles studied increased within the range of 50-60th shots. Discussion. We speculate that a nice shot performance may be considered as the task of minimization of the pistol position change. The arm position seems to be stabilized by the reflex mechanisms: vestibular-spinal and proprioceptive systems, as well as some others.

## Poster presentations

### PP-PM68 Sports Nutrition: Supplements 5

#### CARBOHYDRATE AND CONCENTRATION ON THE BALANCE BEAM A SOLUTION TO MENTAL AND PHYSICAL FATIGUE.

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Introduction: Artistic Gym is a very demanding sport. Training is usually hard and difficult and fatigue is part of the athlete routine. Carbohydrate is one of the most important sources of energy to the body. Its supplementation decreases the symptoms of fatigue providing energy for muscle and mainly for central nervous system (Enoka & Duchateau, 2008) Objective: Our study had the objective investigate the influence of fatigue on performance of the Gymnastics Artistic and the influence of carbohydrate supplementation on the fatigue and performance. Methods: We had 15 female subjects with 12 years divided in two different groups CG(control group) and FG(fatigue group), in two different days. On the first day (Placebo day-PL DAY) CG had a 10 minute warm up, and then five sets of a determined exercise sequence on the balance beam. FG had a 20 minute fatigue circuit then a 10 minute warm up and then the same set of CG. In the second day (Carbohydrate day-CHO DAY) we had the same process, but all subjects ingested a 20% solution maltodextrin before the warm up. We measured blood lactate and glucose on rest, after the warm up and after the sets from CG on both days. From FG we measured also blood glucose and lactate after the fatigue circuit on both days. We used the number of falls as a mental and physical fatigue parameter of the subjects from both groups. Results/discussion: Before the exercise sequence on the PL Day, blood glucose was no different from rest, but on the CHO Day, blood glucose was significant higher for both groups when compared to rest (136,8±13,8 CG before exercise, 94,5±18,0 rest), (118,33±18,85 FG before exercise, 88,0±8,25 rest p<0,05) immediately before the exercise sequence on the balance beam. Lactate fell significantly from before the exercise sequence to the end of the sequence only for the FG on CHO Day (5,23±1,48 before the sequence 3,67±1,16 after the sequence). Glucose and lactate profile showed that the fatigue protocol was intense enough to put the subjects of FG (on both days) in an extreme condition, it also showed that the exercise sequence in the balance beam is not so intense on a physical aspect but has a demanding component in the mental/focus aspect. The number of falls from the exercise sequence on the balance beam was significantly higher from FG compared to CG on PLA Day (3,33±1,37 CG, 5,4 ± 1,14 FG PLA Day). On CHO Day, FG no differ from CG, but comparing PLA Day with CHO Day we observe a reduction on the falls number from CG to CG (3,33±1,37 PLA Day, 1,88±1,13 CHO Day) and from FG to FG (5,40±1,14 PLA Day and 2,29±1,25 CHO Day), evidencing the carbohydrate effect on the performance (physical and mental) aspect. Conclusion: We can conclude that carbohydrate ingestion prior to exercises that are physical and mental demanding, especially in extreme conditions can prevent the deleterious effects of fatigue on performance both on physical and mental aspects. Bibliography: ENOKA, R. M., DUCHATEAU, J.(2008)Muscle fatigue: what, why and how it influences muscle function. Journal Physiology 586.1 pp 11-2

#### EFFECTS OF CARBOHYDRATE AND PROTEIN COINGESTION DURING ENDURANCE EXERCISE ON SUBSEQUENT SAME DAY EXERCISE PERFORMANCE

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Introduction Muscle glycogen content is related to successful exercise performance and faster replenishment of these stores, that may be influenced by protein modulation of insulin, following an exercise bout will lead to improved recovery and subsequent exercise performance. The aim of this study was to determine the influence of the coingestion of a carbohydrate and protein (CHO + PRO) beverage during an endurance training session on recovery and subsequent same day exercise performance, in comparison to the administration of an isoenergetic carbohydrate beverage. Methods Eight trained, male cyclists (height: 178 +/- 6 cm, body mass: 76.2 +/- 7.7 kg,



VO<sub>2</sub>max: 63±5 ml/kg/min, age: 28±9 years) completed the double-blind, placebo controlled, randomised cross-over trial. Following a 24 hour standardised diet cyclists completed a morning training bout of 2.5 hrs cycling during which they ingested either a CHO + PRO beverage (0.8 g CHO kg<sup>-1</sup> · h<sup>-1</sup> + 0.4g PRO kg<sup>-1</sup> · h<sup>-1</sup>) or an isoenergetic carbohydrate beverage (1.2g CHO kg<sup>-1</sup> · h<sup>-1</sup>) at 250ml every 15 min. Finger-prick blood samples were obtained before the training bout and at 30 min intervals during the training bout to enable the determination of blood glucose and lactate concentrations. Following a four hour recovery period cyclists completed a performance time trial (7kJ/kg). Blood samples were collected pre- and post-training bout and pre- and post-time trial. Differences in the means of biochemical variables were determined with  $p < 0.05$  indicating statistical significance. The uncertainty in the effect was expressed as 95% confidence interval and as likelihoods that the true value of the effect represented substantial benefit or harm (Hopkins, 2002). Results Time trial performance was 2.16% faster with the ingestion of a CHO + PRO beverage (1820s ± 320s, mean ± SD) during the morning training bout, when compared to the ingestion of a carbohydrate only beverage (1864s ± 384s) (77.3% likely to benefit subsequent cycle time trial performance with a 19.1% chance of the effect being trivial and 3.6% chance of the effect being harmful) (44s, ± 72 95% CI). Average blood glucose was significantly lower during the training bout with the ingestion of CHO + PRO (4.11 ± 0.33 mmol/L) when compared to a carbohydrate only beverage (4.94 ± 0.72 mmol/L) ( $p < 0.004$ ). Average blood lactate during the training bout was lower with CHO + PRO ingestion (4.4 ± 1.0 mmol/L; carbohydrate only: 3.7 ± 1.0 mmol/L), although this was not significant ( $p = 0.15$ ). Pre- and post-time trial neutrophil count significantly lower during the CHO + PRO trial ( $p < 0.034$ ). Discussion The co-ingestion of CHO + PRO during an endurance training bout benefited subsequent same day time trial performance. CHO + PRO ingestion during training, as opposed to carbohydrate alone, may enhance recovery. References Hopkins WG (2002). Probabilities of clinical or practical significance. *Sportscience* 6, sportsci.org/jour/0201/wghprob.htm

## THE EFFECTS OF CARBOHYDRATE INGESTION ON THE BADMINTON SERVE FOLLOWING SHORT DURATION FATIGUING EXERCISE

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Badminton is an intermittent high intensity sport, which involves both aerobic and anaerobic metabolism (Faude et al., 2007). The serve is an essential part of successful badminton performance. It requires maintenance of high skill levels and is therefore prone to being negatively affected by fatigue developed through match play. The aim of the present study was to determine whether fatigue affected the long and short badminton serve following fatiguing exercise, and whether carbohydrate (CHO) prevented the deterioration in performance. Nine male club standard badminton players (mass 80.9 ± 8.0 kg and age 22 ± 5yr) volunteered for the study. They attended the laboratory on 3 separate occasions. The first visit involved performing an incremental exercise test to exhaustion on the treadmill to determine peak oxygen consumption and peak heart rate (HR<sub>peak</sub>). Following this, they performed two experimental trials in a randomized cross over design separated by a week. The participants were given a CHO electrolyte drink (6.4% CHO) or a matched placebo (PL). The participants performed 10 long and 10 short serves aiming to hit a target, with accuracy being measured pre and post fatiguing exercise. The duration of the fatiguing exercise was 33 minutes (83 ± 10% HR<sub>peak</sub> and 84 ± 8% HR<sub>peak</sub> for the PL and CHO trials respectively). Each cycle consisted of repetitive cycles of 3 minutes of high intensity ghosting, followed by approximately 30s of an adapted Illinois agility test, then 3 minutes of walking at 5km.hr<sup>-1</sup> on a treadmill. Choice reaction time was determined using the Newtest 300 (Oulu Finland) pre and post exercise with the participants sprinting 5m in the direction of the light. Capillary blood samples (20 µl) were taken at rest and post exercise for blood glucose and lactate. CHO and PL were administered after the serving test (500ml) and during the fatiguing exercise (500ml). There was a deterioration in long serve accuracy with fatigue ( $P = 0.002$ ), and CHO ingestion had a tendency to prevent the deterioration ( $P = 0.077$ ). However, there was no effect of fatigue ( $P = 0.402$ ) or CHO ingestion ( $P = 0.109$ ) on the short serve. There was no difference in blood glucose between trials ( $P = 0.851$ ), however blood lactate was greater during the PL trial ( $P = 0.016$ ). Fatigue had no effect on choice reaction time ( $P = 0.162$ ), and therefore CHO had no beneficial effect ( $P = 0.492$ ). These results suggest that only the long serve is influenced by fatigue and CHO had a tendency to prevent the deterioration in performance. References: Faude O, Meyer T, Rosenberger F, Fries M, Huber G and Kindermann W (2007). Physiological characteristics of badminton match play. *European Journal of Applied Physiology*. 100(4): 479-85.

## METABOLIC RESPONSE ON CHO INTAKE DURING MEDIUM INTENSITY EXERCISE TRAINING

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Introduction The present study investigated the effect of ingestion of a 7.5% carbohydrate solution during prolonged sub-maximal exercise on exercise metabolism. Materials & Methods Sixteen subjects cycled for 90 minutes at constant work-load in two different sessions while consuming 200ml of a 7.5% glucose beverage at the beginning and every 15 minutes in one session and a placebo with the same training protocol in the second one. The main measures concern: plasma glucose concentration, inspired oxygen, expired carbon dioxide, respiratory quotient, total energy consumption, oxidation of fats and carbohydrates, heart rate and RPE. Results The energy expenditure was the same with both beverages 6466 (SEM 331.2) KJ with Placebo, 6658 (SEM 340.3) KJ with the sugar solution. Oxidized fats in P were 59.5 (SEM 8.0) g, 51.5 (SEM 7.3) g in CHO ( $P = 0.05$ ) while 265.7 (SEM 21.6) g and 298.0 (SEM 20.9) g carbohydrates were burned respectively in the situation in the CHO and Placebo ( $P = 0.05$ ). The inspired oxygen and carbon dioxide exhaled were similar both as total values AUC O<sub>2</sub> 159.00 (SEM 8.1) l in P, 163.14 (SEM 8.4) l in CHO; AUC CO<sub>2</sub> 142.04 (SEM 7.3) l in P, 148.45 (SEM 7.5) l in CHO and as average change from baseline during the observation time (IAUC O<sub>2</sub> 119.3 (SEM 8.3) l in P, 129.4 (SEM 8.5) l in CHO; IAUC CO<sub>2</sub> 107.6 (SEM 7.7) l in P, 118.7 (SEM 7.9) l in CHO) and as average values during the observation time (T (AUC) O<sub>2</sub> 1.7 (SEM 0.09) l/min. in P, 1.8 (SEM 0.09) l/min. in CHO, T (AUC) CO<sub>2</sub> 1.5 (SEM 0.08) l/min. in P, 1.6 (SEM 0.08) l/min. CHO) for all  $P > 0.01$ . Discussion There are two main observations can be drawn from the results of our experiments: - The consumption of a beverage enriched to 7.5% of CHO helps maintain the value of blood glucose levels higher than baseline during exercise performed after an overnight fast, moderate-intensity (50% VO<sub>2</sub>max) on normal subjects. - The consumption of a beverage enriched to 7.5% of CHO does not change the relative contribution of CHO oxidation and total triglycerides in the same conditions. Drawing conclusions on our study we can say that: taking a drink at 7.5% glucose, which involves taking 90 g/h of carbohydrate during 90 minutes of exercise done at moderate intensity (50% VO<sub>2</sub>max) in 16 normal subjects (13 males and 3 females) mean age 21.88 (SEM 0.77) years and average VO<sub>2</sub>max 3.89 (SEM 0.25) L/min blood glucose rises keeping this parameter constant over the baseline and does not change the oxidation energy substrates. In accordance with the literature may be suggested a potential 'saving effect' on liver glycogen. Bibliography Leslie Bonci. "Energy" drinks: help, harm or hype? *Sports Science Exchange* 2002; 15 (1):84 Pirnay F, Scheen AJ, Gautier JF, Lacroix M, Mosora F, Lefebvre PJ. Exogenous glucose oxidation during exercise in relation to the

power output. *Int J Sports Med.* 1995; 16(7):456-60 Jentjens RL, Shaw C, Birtles T, Waring RH, Harding LK, Jeukendrup AE. Oxidation of combined ingestion of glucose and sucrose during exercise. *Metabolism* 2005, 54(5):610-618.

### THE INFLUENCE OF A CARBOHYDRATE-ELECTROLYTE SOLUTION ON FLUID BALANCE AND PERFORMANCE IN NATIONAL LEVEL FENCERS DURING TRAINING

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**Introduction** Ingestion of a carbohydrate-electrolyte solution helps maintain fluid balance and under certain circumstances may provide benefits over water (Sawka et al. 2007). However, such solutions have not been used in fencing. The purpose of this study was to examine a possible effect of a carbohydrate-electrolyte solution on fluid balance and performance in fencing. **Methods** Sixteen fencers, 12 men and 4 women, members of the Greek National team in epee [age: 21.4 ± 0.9 yrs, body mass (BM): 74.6 ± 3.3 Kg, height: 178 ± 2 cm, VO<sub>2</sub>max: 49.3 ± ml/Kg/min, and body fat: 15.1 ± 1 %; mean ± SE] performed two identical in content 120-min training sessions separated by 7-14 days under similar environmental conditions (temperature 20.3 ± 0.5 °C, and humidity 45-47 ± 2%). Fencers ingested at regular intervals a total volume of 23.5 ml/Kg BM of either a 6% carbohydrate-electrolyte solution (CE) or placebo (< 0.3%) (P) in a counterbalanced order. Each session consisted of a 60-min period for warm-up and conditioning exercises, and 10 games of 3 min duration against the same opponent with 3 min interval between each game. Urine and capillary blood samples were collected before and after each training session. **Results** There was no difference in the rate of perceived exertion, in the number of games won, or lost, or in the points for and against during the 10 games played between CE and P trials. BM was similar before exercise as well as after exercise between conditions. However, BM after training was maintained in CE (Before Exercise: 73.4 ± 3.2 Kg vs. After Exercise: 73.3 ± 3.2 Kg), whereas in P there was a 0.5 ± 0.1 % decrease (Before Exercise: 73.4 ± 3.2 Kg vs. After Exercise: 73.0 ± 3.1 Kg) ( $p < 0.01$ ). No differences were observed in heart rate responses, changes in plasma volume, creatinine and sodium content in urine as well as in the urine specific gravity between conditions. Blood glucose concentration was higher ( $p < 0.01$ ) post-exercise in CE (5.4 ± 0.3 mmol/l) compared to P (4.5 ± 0.2 mmol/l), whereas blood lactate concentration was no different between trials. **Discussion** The small decrease in BM observed in P may be due to the low sodium content compared to CE condition. The data show that the ingestion of the CE solution was as effective as water in terms of fencing performance during training at a thermo neutral environment. Further research is needed to examine whether sports drinks may provide benefits in fluid balance or performance in a warm environment. **References** Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, Stachenfeld NS. (2007). *Med Sci Sports Exerc*, 39, 377-90.

### INFLUENCE OF CARBOHYDRATE SUPPLEMENTATION ON THE FLUID AND ELECTROLYTE BALANCE DURING INTENSE INTERMITTENT TRAINING

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Investigations of the effect of a beverage containing only carbohydrates on the electrolyte and fluid balance during intermittent exercise of high intensity are rare. Therefore we compared the effects of a supplementation of water and a carbohydrate solution on plasma and blood volume and electrolyte shifts during exercise. **Methods:** 11 male subjects (weight: 82.2 kg; height: 1.82 m, relative power: 4.3 W) performed an intermittent exercise test twice; in one trial tap water (4m /kg/15min) was consumed (Plac). In the other trial the same amount of water was ingested, however, Maltodextrin was added to achieve a 9.1 % carbohydrate solution (CHO). The mean intensity during exercise was 50% of the maximum power reached in an incremental test performed as a pre test. Training schedule: warming up with 50 % for 15 min. Afterwards power changed between 100% of the maximum power minus 10 W and 10 W each for 30 s. The intermittent exercise was performed until subjective exhaustion. Afterwards 10 min at 50% to cool down followed. Cubital venous blood was sampled to measure [Na<sup>+</sup>], [K<sup>+</sup>], [Cl<sup>-</sup>], [HCO<sub>3</sub><sup>-</sup>], osmolality, [Protein] in plasma, Hct, [Lactate], [Glucose], and [Hb]. Plasma volume changes were calculated from the changes of [Hb] and Hct. The changes in blood volume were derived from [Hb]. **Results:** Performance times were not different between the groups. No difference in heart rate and VO<sub>2</sub> between the trials could be detected. [Glucose] was significantly higher after Maltodextrin administration ( $p < 0.001$ ). Initially osmolality was similar in both trials however osmolality increased significantly more during CHO (interaction  $p = 0.002$ ). Blood volume decreased by about 4 % with under both conditions, however recovered partly during exercise under Plac (interaction beverage x time,  $p = 0.002$ ). 50 min after exercise blood volume reached the initial values under both conditions. The reduction of the plasma volume was slightly higher (5%). The time course. Under the different conditions the time course was similar to that of the blood volume ( $p = 0.024$ , beverage x time). MCHC showed a small but significant increase over time after carbohydrate ingestion (interaction  $p = 0.01$ ). 50 min after the end of exercise plasma volume reached the initial resting values, as well. No difference in the behaviour of [K<sup>+</sup>] could be detected between the trials however [Na<sup>+</sup>] and [Cl<sup>-</sup>] decreased with Plac (both  $p < 0.001$ ). In contrast to blood volume and plasma volume both electrolytes did not reach comparable concentrations after exercise under the different conditions. **Discussion:** Sole carbohydrate supplementation seems to stabilize [Na<sup>+</sup>] and [Cl<sup>-</sup>] in the plasma. This can not be explained simply by a co-transport of Glucose, Na<sup>+</sup> and Cl<sup>-</sup>, because that should lead to a recovery of the blood and plasma volume under CHO. In contrast this was found during exercise with Plac.

### EFFECTS OF BLOCK PERIODIZATION MODEL ON PERFORMANCE AND GLYCOGEN STORES IN RATS

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**Introduction** Current recommendations for the training periodization are based in concentrated loads (block periodization) due to large number of competitions during macrocycle. However, the comparisons among the protocols are hindered since innumerable factors such as internal/individual and external interferences may influence physiological parameters and performance. In an attempt to attenuate the external and internal interferences on physiological adaptations in the training, this study was undertaken to characterize the block periodized training (3 blocks during 12 weeks) in rats submitted to swimming exercise on anaerobic performance evaluated by exhaustion time, aerobic performance evaluated by lactate minimum test (LM) as well as the glycogen concentration in soleus muscle. It was hypothesized that the block periodization could be effective to increase the exhaustion time, aerobic capacity and the glycogen concentration in soleus in relation to sedentary group. **Methods** Seventy Wistar rats (60 days old) were randomly separated in two groups: Control/Sedentary (CT) and Block Periodization Training (BPT). The BPT lasted 12 weeks (w) with frequency of 6 days/w. The BPT

was subdivided in 3 blocks: Block 1 (6 w), Block 2 (4.5 w) and Block 3 (1.5 w). The blocks were subdivided in basic, specific and taper periods with intensities equivalent to body weight (% bw) ranging between 60 - 240% of individual anaerobic threshold determined by lactate minimum test (LM) and volume between 10-60 min. Results The exhaustion time (s) was measured with equivalent intensity to 13 % of body weight (% bw) and the aerobic capacity by LM test adapted for rats. The anaerobic performance was higher after Blocks 1 ( $76 \pm 29$  s), 2 ( $73 \pm 18$  s) and 3 ( $77 \pm 18$  s) than CT in respective period (6 w= $40 \pm 19$  s; 10.5 w= $49 \pm 21$  s; 12 w= $47 \pm 8$  s) but unchanged intra-group. The aerobic capacity evaluated by LM test unchanged after blocks 1 ( $4.67 \pm 0.50$  % of bw), 2 ( $4.30 \pm 0.42$  % of bw) and 3 ( $3.83 \pm 0.54$ ) in comparison to CT group in respective period (6 w=  $4.19 \pm 0.40$  % of bw; 10.5 w=  $3.80 \pm 0.41$  % of bw; 12 w=  $3.55 \pm 0.52$  % of bw). The glycogen stores in soleus increased after block 1 ( $0.745 \pm 0.213$  mg/100mg) in relation to CT in respective period (6 w=  $0.465 \pm 0.051$  mg/100mg) but unchanged after block 2 ( $0.345 \pm 0.105$  mg/100mg) and 3 ( $0.501 \pm 0.169$  mg/100mg) in relation to CT (10.5 w=  $0.381 \pm 0.102$  mg/100mg; 12 w=  $0.366 \pm 0.078$  mg/100mg). Discussion The BPT increased the anaerobic performance after the blocks in relation to sedentary rats but the aerobic capacity was unchanged when compared to CT group. Also, the BPT improved the glycogen stores after the block 1 but unaltered after block 2 e 3.

## EFFECT OF INTRANASAL INFUSION OF GALP ON FEEDING AND BODY WEIGHT REGULATION

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Introduction Galanin-like peptide (GALP), a 60 amino acid neuropeptide (Ohtaki et al., 1999), is known to suppress feeding behavior and energy metabolism (Takenoya et al., 2003, Shioda et al., 2008). In order to use GALP as an anti-obese drug, it is important to determine whether or not GALP suppresses feeding behavior when it is administered noninvasively. Recently, we have reported that intranasal infusion of GALP is an effective route of administration for delivery into the brain (Nonaka et al., 2008). Therefore, in the present study, we tried to clarify the effect of intranasal infusion of GALP on feeding behavior and body weight loss. Methods Male C57BL/6 +/+ and ob/ob mice were given continuous intranasal infusion of the vehicle once a day for 7 days followed by of GALP (2 nM) once a day for 7 days, which inhibits GALP degradation. Body weight (BW), food intake, water intake and locomotor activity were measured for 7 days from the onset of the administration. Results In the lean mice, the BW was not significantly different between the GALP- and vehicle-treated animals with a slight reduction of both food and water intake. In the obese mice, the BW in the vehicle-treated group was gradually increased, but in the GALP-treated group it was unchanged. However, in the obese mice, food intake was started to decrease after the first intranasal infusion of GALP and reached the same level in the lean mice. GALP was significantly decreased the water intake and locomotor activity in the obese mice. Discussion The intranasal infusion of GALP decreased both food and water intake and suppressed a spontaneous increase in BW in the obese mice (Shiba et al., 2010). These results strongly suggest that intranasal infusion of GALP is an effective route to exert its effect as an anti-obesity drug and therapeutic exercise especially for obese people. References Ohtaki T, Kumano S, et al. (1999). J Biol Chem 274, 37041-37045. Takenoya F, Kageyama H, Shioda S, et al. (2003). Neurosci Lett. 340,209-212. Shioda S, Takenoya F, et al. (2008). Nutrition 24, 848-853. Nonaka N, Kageyama H, Shioda S, et al. (2008). J Pharmacol Exp Ther 325, 513-519. Shiba K, Kageyama H, Takenoya F, Shioda S. (2010) FEBS J. 277, 5006-5013.

## CONFIRMATORY FACTOR ANALYSIS OF THE SELF-EFFICACY FOR FRUIT AND VEGETABLE CONSUMPTION SCALE IN GREEK YOUTH: TESTING THE ASSUMPTION OF EQUIVALENT STRUCTURE ACROSS GENDER

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Introduction Daily consumption of fruit and vegetables (FR&V) by youth is a behavior associated with an array of health benefits. For example, daily consumption of FR&V is typically associated with reduced risks of various types of cancer such as colon, lung, breast, and stomach cancer (Willet & Trichopoulos, 1996). Although current recommendations are for youth and adolescents to consume five or more servings of FR&V daily, evidence indicates that these recommendations are not being met. Since consumption of recommended amounts of FR&V may result in health benefits, research must identify theory-based determinants of this behavior. One determinant may be self-efficacy beliefs which are hypothesized to influence behavioral behavior. Recently, a valid and reliable task self-efficacy measure for fruit and vegetable consumption (SEFV) has been developed for American youth (Dzewaltowski et al., 2007). Thus, the purpose of this study was to evaluate the factor structure of the translated SEFV with a sample of Greek middle school children and to examine if they are any differences between boys and girls in the FR&V consumption behavior. Methods Participant were 556 middle school students (301 boys and 255 girls), aged 11-15 years, enrolled in 16 middle schools in a suburban area in Athens, Greece. Informed consent from students and their parents or legal guardians were obtained prior to the collection of the data. The SEFV consists of six items that assesses children's confidence in their skills and abilities to consume one to six or more servings of FR&V daily. Confirmatory factor analyses were performed using the FILM estimation in AMOS 7.0 Results Single group analyses indicated an acceptable two-factor structure model for both boys and girls. Multigroup analysis showed that factor structure, factor loadings, and unique variances of the self-efficacy for FR&V consumption scale were invariant across gender. Discussion The overall findings of the study supported the two-factor structure of the self-efficacy for fruit and vegetable consumption scale. Youths' confidence to consume FR&V at internationally recommended levels (factor 2) may be distinct from confidence to consume fewer (factor 1) servings daily. Further work is needed to validate its structure across age and also to examine the factorial and construct validity of the two-factor SEFV measure with other populations. References Dzewaltowski, D., et al. (2007). Measurement of self-efficacy and proxy efficacy for middle school youth physical activity. Journal of Sport and Exercise Psychology, 29, 310-332. Willet, W.C., & Trichopoulos, D. (1996). Nutrition and cancer: A summary of the evidence. Cancer Causes Control, 7, 178-180.

## USE OF PROTEIN SUPPLEMENTS AND DIETARY BEHAVIOUR: RESULTS OF A SURVEY ON PEOPLE ATTENDING COMMERCIAL GYMS IN ITALY

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Introduction Nutrition is traditionally perceived as a crucial component of physical fitness and performance. In the last few decades, the increasing understanding of human nutrition and exercise physiology has showed that a wise management of nutrient intake could positively affect fitness improvements and sport performance. The aim of this study was to examine the use of dietary supplements and

diet behavior amongst regular fitness centers users in Italy. Methods A specific questionnaire was generated for the experimentation. The data were collected using the face-to-face interview method. Only strength and conditioning classes participants were included in the selection criteria. Training information have been collected from 800 regular fitness center attendees; 207 of them were selected for the study. Analysis: Significance differences were assessed by one-way ANOVA, Kruskal-Wallis, chi-square test or exact test of Fisher when appropriate. Results Dietary supplements proved to be used by 30.1% of the respondents. Use of supplements was lasting on average  $2.6 \pm 3.3$  years without any significant difference by gender. Whey protein shakes (50.0%) mixed with creatine and amino-acids (48.3%) was the most frequent choice among users. Supplement non-users consumed more snacks and bakery than users per week ( $P < 0.001$ ). Conclusions A considerable number of regular strength training subjects consume protein supplements mixed with other supplements and high-protein foods, in particular meat. We emphasize the importance of the dissemination of scientifically based information about supplementation in the fitness centers and the promotion of updated education programs for fitness instructors. References Morrison LJ, Gizis F, Shorter B. Prevalent use of dietary supplements among people who exercise at a commercial gym. *Int J Sport Nutr Exerc Metab.* 2004 Aug;14(4):481-92. Goston JL, Correia MI. Intake of nutritional supplements among people exercising in gyms and influencing factors. *Nutrition* 2010; Jun;26, 604–611. Molinero O, Márquez S. Use of nutritional supplements in sports: risks, knowledge, and behavioural-related factors. *Nutr Hosp.* 2009 Mar-Apr;24(2):128-34.

## Poster presentations

### PP-PM69 Physiology: Inflammation/Redox

#### THE BLOOD REDOX STATUS OF ENDURANCE-TRAINED ADOLESCENTS

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THE BLOOD REDOX STATUS OF ENDURANCE-TRAINED ADOLESCENTS Tong, TK. 1, Lin, H. 2, Nie, J. 3, Shi, Q. 3, Tian, Y. 4 1: HKBU (Hong Kong, China). 2: LNU (Dalian, China). 3: MPI (Macao, China). 4: CISS (Beijing, China) Introduction Adult athletes appear to have antioxidant defense either better or similar to that of non-athletes (Finaud et al., 2006). In contrast, prepubescent children who involved in athletic training exhibited increased oxidative stress and less antioxidant capacity compared to untrained counterparts (Gougoura et al., 2007). There is little information available regarding the adaptations of antioxidant system in adolescent athletes participated in endurance sports. This study investigated the effect of chronic endurance training on the blood redox status in adolescent runners and cyclists by comparing it with that of age-matched individuals. Method 36 adolescents [12 runners (Age:  $15.5 \pm 1.3$  yrs, tanner stage:  $3.3 \pm 0.9$ , training years:  $2.2 \pm 0.9$  yrs), 12 cyclists ( $15.3 \pm 0.7$  yrs,  $3.1 \pm 0.3$ ,  $2.4 \pm 0.6$  yrs), 12 untrained ( $15.9 \pm 0.5$  yrs,  $2.8 \pm 0.5$ )] were recruited. With 72 hrs re-trained from intense exercise, venous blood were taken for measuring serum malondialdehyde, xanthine oxidase (XO), total antioxidant capacity, reduced glutathione (GSH), superoxide dismutase, and catalase (CAT). Dietary intakes were also recorded. Results In comparison to untrained subjects, the body size of cyclists was bigger while runners were smaller. % body fat of the athletes was lower. For the redox status, the serum GSH, CAT and XO of cyclists ( $20.4 \pm 10.2$  mg.l<sup>-1</sup>,  $2.61 \pm 0.92$  U.ml<sup>-1</sup>,  $19.9 \pm 2.8$  U.l<sup>-1</sup>) were higher than runners ( $14.1 \pm 5.6$  mg.l<sup>-1</sup>,  $1.89 \pm 0.55$  U.ml<sup>-1</sup>,  $16.1 \pm 2.1$  U.l<sup>-1</sup>) and untrained ( $12.1 \pm 2.9$  mg.l<sup>-1</sup>,  $0.53 \pm 0.36$  U.ml<sup>-1</sup>,  $16.7 \pm 1.3$  U.l<sup>-1</sup>). The CAT of runners was also higher than untrained. Other biomarkers were not different. The intakes of macro-nutrients and micro-minerals including zinc, iron, and magnesium were greater in cyclists comparing with runners and untrained. Higher carbohydrate and lower cholesterol intakes were found in runners compared to untrained. Discussion In contrast to trained prepubescent children (Gougoura et al., 2007), adolescent runners and cyclists in this study did not exhibit augmented oxidative stress or inferior antioxidant capacity in comparison to those of untrained counterparts. Rather, a greater antioxidant defense was potentially found in cyclists compared to runners, indicating that chronic endurance training-induced adaptations of antioxidant capacity may be sport specific. Nevertheless, the factor of various dietary intakes to the difference in the redox status should not be neglected. Taken together, the current findings suggest that the effects of chronic endurance training on the blood redox status of adolescent athletes are in line with those observed in adult athletes. References Finaud J, et al. (2006). *Sports Med*, 36, 327-358. Gougoura S, et al. (2007). *Eur J Appl Physiol*, 100, 235-239.

#### ANTIOXIDANT ENZYMES DEPLETION INDUCED BY INTENSIVE HANDBALL TRAINING

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Introduction Although it is clear that both anaerobic and aerobic exercise have the potential to result in increased production of prooxidants, there is still little information available regarding changes in redox state induced by mixed (anaerobic-aerobic) exercise, especially in adolescent and child athletes. The aim of our study was to assess the changes in redox state of adolescent handball players induced by intensive handball training, as well as to investigate if there is correlation between fitness level (expressed through aerobic power) and pro/antioxidant response to acute exercise. Methods 43 young handball players participated in the study. In the first part of the investigation athletes were subjected to maximal progressive exercise test to measure their maximal oxygen consumption. The second part of investigation consisted of blood sampling immediately before and after one and a half hour intensive handball training. Blood samples were used for redox state analysis which included measurement of nitric oxide (estimated through nitrites), superoxide anion radical, hydrogen peroxide, lipid peroxidation (estimated through thiobarbituric reactive substances), superoxide dismutase activity, catalase activity and glutathione levels. Results Handball training induced statistically significant decrease of athletes' superoxide dismutase activity and fall of glutathione levels. Catalase activity correlated negatively with levels of nitrites, hydrogen peroxide and index of lipid peroxidation both before and after handball training. Aerobic power (maximal oxygen consumption) correlated positively with catalase both before and after training and negatively with after-training levels of hydrogen peroxide and index of lipid peroxidation. Discussion The extent of redox homeostasis disturbance induced by acute bout of exercise depends on many factors, inter alia, exercise mode, intensity and duration (Fisher-Wellman and Bloomer 2009). Although levels of prooxidants of our subjects did not change significantly after exercise, the fact that superoxide anion dismutase activity and glutathione levels decreased significantly suggest that handball training induced increased free radical production which depleted levels of the first line antioxidants. Correlations found between aerobic power and pro/antioxidants support the assumption that fitness level correlates positively with desirable redox state (Chang et al. 2002; Djordjevic et al. 2011). References 1. Chang CK, Tseng HF, Hsuuw YD et al. (2002). *Ann Nutr Metab* 46,103–107. 2. Fisher-Wellman K, Bloomer RJ. (2009). *Dyn Med* 8, 1-25. 3. Djordjevic D, Cubrilo D, Macura M et al. (2011). *Mol Cell Biochem*. DOI: 10.1007/s11010-011-0732-6

## EFFECT OF TRAINING LEVEL OVER OXIDATIVE STRESS AND ANTIOXIDANT RESPONSE AT DIFFERENT EXERCISE INTENSITIES

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**Introduction** Oxidative stress has been defined as a shift in the normal pro-oxidant – antioxidant balance in favour of pro-oxidants. Exercise is associated with oxidative stress, which can induce adverse effects on health and well-being (Finaud, 2006), as well as some long term adaptations (Kabasakalis et al., 2010; Olcina et al., 2006). The aim of this study was to analyse the oxidative stress and the antioxidant response during exercise at different intensities in groups with different aerobic training level. **Methods** The participants were: Well trained (n=20) VO<sub>2</sub>max 68,31±8,65 ml•min•kg<sup>-1</sup>, Trained (n=20) VO<sub>2</sub>max 45,91±7,54 ml•min•kg<sup>-1</sup> and Sedentary (n=20) VO<sub>2</sub>max 35,49±4,93 ml•min•kg<sup>-1</sup>. An incremental maximal test was performed on cycloergometer starting at 100 watts and increasing the workload each 3 minutes 25 watts until exhaustion. Venous blood was collected each three minutes. Plasma malondialdehyde (MDA) as oxidative stress marker and vitamins A and E as lipid environments antioxidants were determined by HPLC. Four points were chosen in order to compare the groups with different exercise duration (Initial, Aerobic Threshold, Anaerobic Threshold and Final). The ANOVA with repeated measured test was performed for statistical analysis. A p<0.05 was used to determine statistical significance. **Results** The highest values in MDA concentrations in the beginning were found in well trained subjects (2,85±0,99 µM/mL), while trained subjects presented higher vitamin A concentrations (0,74±0,23 µg/mL) than well trained and sedentary subjects. Finally, the highest values in Vitamin E were found in sedentary subjects (74,56±10,77 µg/mL). No significant differences were found in the kinetics analysis of MDA, vitamin A and vitamin E in trained and sedentary subjects. However, a significant decrease in MDA concentrations (2,85±0,99 to 2,68±0,92 µM/mL) and a significant increase in vitamin A (0,73±0,27 to 0,77±0,18 µg/mL) and vitamin E (52,28±11,89 to 57,19±12,79 µg/mL) were found in well trained subjects across the trial. **Discussion** Aerobic training causes adaptations to oxidative stress and in the antioxidant response system (Finaud, 2006). As higher is training level, higher is the oxidative stress. However, trained people are able to control the oxidative stress increase during short term efforts at different intensities although they have lower vitamin E levels at rest. Maybe they balance it with higher increase of vitamin A values (Kabasakalis et al., 2010; Olcina et al., 2006). **References** Kabasakalis A, Kyparos A, Tsalis G, Loupos D, Pavlidou A. (2010). J Strength Cond Res. Finaud J, Lac G, Filaire E. (2006). Sports Med, 36(4), 327-358. Olcina G, Munoz D, Timon R, Caballero MJ, Maynar J, Cordova A, Maynar M. (2006). J Sports Sci & Med, 5, 621-628.

## EXERCISE AS A MODEL OF OXIDATIVE ASSAULT: THE ROLE OF PROTOCOL AND SAMPLING POINT

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**Introduction** The development of a valid and robust physiological model to induce oxidative stress would be extremely useful in redox biology. Studies have shown that the effects of aging, obesity or nutrition intervention on redox homeostasis emerge, if not magnified, after having the participants subjected to an exercise stimulus. However, despite the fact that a physiological stimulus such as acute exercise is frequently used to produce a state of oxidative stress, rarely the chosen exercise model has been rigorously tested whether it suitably serves this purpose. For example, muscle damage induced by certain exercise modalities interferes with the time course and magnitude of oxidative stress. In addition, most of the available oxidative stress biomarkers have not been truly validated for the exercise setting. Therefore, the aim of the present study was to investigate the time-course changes of several commonly used markers of oxidative stress during a 96-h sampling period after an acute bout of either a non-muscle-damaging exercise or a muscle-damaging exercise. **Methods** Twenty physically active males ran either on a level treadmill (non-muscle-damaging condition) or on a downhill treadmill at -15% gradient (muscle-damaging condition) for 45 min at 70–75% VO<sub>2</sub>max. Blood and urine samples were collected before and post-exercise (immediately post, 1h, 4h, 24h, 48h and 96h). The following assays were performed: F2-isoprostanes in urine, protein carbonyls in plasma, GSH, GPX, SOD and catalase in erythrocytes. **Results** Both exercise conditions induced oxidative stress, yet in a unique way. In general, the changes in redox biomarkers were evident for up to 1 h after non-muscle-damaging exercise and returned to resting values thereafter. Conversely, there was a biphasic response in redox biomarkers (but GSH) after muscle damaging exercise. Changes were evident for up to 1 h after exercise, returned toward baseline values at 4 h post and altered again 24 – 96 h post exercise. **Discussion** To our knowledge, this is the first attempt to compare the short- and long-term oxidative stress responses of two exercise modalities that cause different degree of muscle damage in humans. The main findings are the monophasic oxidative stress responses detected after non-muscle-damaging exercise compared to the biphasic responses detected after muscle-damaging exercise. In fact, oxidative stress appeared immediately after muscle-damaging exercise and persisted for several days thereafter, as opposed to the early return to the resting values few hours after the acute non-muscle-damaging exercise. The present findings indicate that sampling time after exercise largely depends on exercise protocol and less so on biomarker examined.

## INFLAMMATORY RESPONSE TO CONTINUOUS VERSUS INTERVAL RUNNING

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**INFLAMMATORY RESPONSE TO CONTINUOUS VERSUS INTERVAL RUNNING** Ensenyat, A. (1); Serrano, J. (2); Farreny, D. (1); Blanco, A. (1); Bellmunt, J. (3); Portero, M. (2); Pamplona, R. (2) 1: Laboratori de Valoració Funcional. INEFC-Lleida. UdL (Lleida, Spain) 2: Departament de Medicina experimental. UdL (Lleida, Spain) 3. Departament de Mèdiques bàsiques. UdL (Lleida, Spain) **Introduction** Prolonged exercise is associated with changes in plasma levels of inflammatory and anti-inflammatory markers, such as TNF-alpha, IL-6, IL-10, or CRP. Although several studies have examined the acute-phase reaction after continuous strenuous endurance-type exercise, few studies have reported changes of these markers in the blood after intervallic bouts. Therefore, the aim of the study was to analyse pro and anti-inflammatory time course and magnitude of changes to two training sessions of similar duration but different training purposes. **Methods** Five apparently healthy male physical education students (22,1 (SD:0,9) yrs of age, BMI = 22,2 (SD:1,04) kg/m<sup>2</sup>, VO<sub>2</sub>max= 57,3 (SD:10,5) ml/kg/min) completed two 60-min running workloads in a randomized cross-over design. Workload A consisted of continuous level run with a targeted heart rate of 90% individual anaerobic threshold (IAT); while workload B consisted of interval training (8 series of 4 min, with 2 min recovery) at 110% IAT's heart rate. Blood samples, for the determination of TNF-alpha, IL-6, IL-8, IL-10, CRP and SAA, were taken before, immediately after, and at 60 and 180 minutes post-exercise. Plasma concentrations of these analytes were assessed by a MILLIPLEX Map kit (MPXHCYT0-60K and HCVD-67BK, Millipore, MA, USA) **Results** Both training sessions had a similar total duration but differed

in intensity (speed=9,9 (SD: 1,1) km/h in session A versus 12,3 (SD: 1,6) km/h in session B; heart rate=165,5 (SD: 11,8) and 175,8 (SD: 9,2) bpm, respectively). Total load (sum of heart beats) was not different between sessions. In both sessions, IL-6, and TNF-alpha were significantly higher (84%; 59 %;  $p<0,05$ ) immediately post-exercise but IL6/TNF-alpha index was unchanged at any time-point. No significant effects were observed for SAA. IL-10 and CRP rose after continuous running, and remained significantly elevated (240%, 250%;  $p<0,05$ ) at 60' of recovery. They were not affected by interval running. No significant effects were observed for IL-8 after continuous moderate exercise, however, IL-8 rose (50%) significantly post-interval running and was still raised during early recovery. Discussion Findings indicate that plasma levels of several inflammatory and anti-inflammatory markers are elevated after 60' of continuous /interval running at either 90% or 110% of IAT's heart rate. However the balance between pro-inflammatory and anti-inflammatory indicators was unchanged and suggests that -regardless of intensity and distribution of workload inside the session- exercise protocols produced only a limited acute-phase reaction.

### PHYSICAL ACTIVITY, INFLAMMATION AND ADRENOPAUSE IN POST-MENOPAUSE

IZZICUPO, P.1, D'AMICO, M.A.1, DI FONSO, A.1, BASCELLI, A.1, DI BLASIO, A.2, D'ANGELO, E.2, NAPOLITANO, G.1, BUCCI, I.2, RIPARI, P.2, DI DONATO, F.2, GALLINA, S.2, DI BALDASSARRE, A.1

**Introduction.** Menopause is linked with several hormonal changes, in addition to the age-related physiologic decline of the dehydroepiandrosterone sulphate (DHEA-S) production. Further, a feedback cross-talk with raising systemic chronic inflammation might play a central role in these events. Women typically participate in less physical activity (PA) than men do but, even if physical activity has been shown to be correlated both with systemic inflammation and plasma DHEA-S level, it is difficult to establish whether these changes are due to both menopause and aging process per se or by lack of PA. Considering that after menopause, DHEA and DHEA-S are the main component of sex steroids, the aim of our study was to investigate the complex network among hormonal changes, pro-inflammatory mediators and PA, in post-menopause. **Methods.** Thirty-five sedentary post-menopausal women (55.9±4,2 years) were enrolled into the study. Basal plasma interleukin (IL) 1-alpha, IL1-beta, IL-2, IL-8, IL-10, IL-12p70 and tumor necrosis factor alpha (TNF-a) were measured by with SearchLight Human Cytokine Array 1. DHEA-S and leptin were measured by ELISA analysis. Body composition was assessed by electrical bioimpedance technique. Daily physical activity was measured, under free-living condition and for three consecutive days, through the SenseWear Pro3 Armband, giving information about total daily energy expenditure (TEE), mean daily physical activity intensity (METs) and both time and energy spent on physical activity with intensity >3 METs (tPA, PAEE). **Results.** TEE was found inversely correlated with IL1-alpha and IL1-beta ( $r=-.375$ ,  $P<0.05$ ;  $r=-.347$ ,  $P<0.05$ , respectively), METs with IL1-alpha ( $r=-.387$ ,  $P<0.05$ ), tPA with IL1-alpha, IL-2 and IL-10 ( $r=-.380$ ,  $P<0.05$ ;  $r=-.367$ ,  $P<0.05$ ,  $r=-.347$ ,  $P<0.05$ , respectively), and PAEE with IL-2 ( $r=-.358$ ,  $P<0.05$ ). A significant direct correlation was found among all measured cytokines. Even if neither TNF-a or DHEA-S were correlated with PA parameters, we found a strong relationship between TNF-a and DHEA-S ( $r=-.569$ ,  $P=.001$ ), also controlling for confounding factors such as age and leptin. **Discussion.** In conclusion, in sedentary post-menopausal women, the systemic inflammatory mediator TNF-a and the main adrenal steroid DHEA-S show an inverse relationship. Poor PA might play a role, affecting systemic inflammation and then DHEA-S production at various levels through the hypothalamus-pituitary axis, although evidences from other studies suggest an anti-inflammatory action by DHEA-S.

### LOADING INCREASES INTERLEUKIN-6 EXPRESSION IN HUMAN TENDON TISSUE IN VITRO

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**LOADING INCREASES INTERLEUKIN-6 (IL6) EXPRESSION IN HUMAN TENDON TISSUE IN VITRO** Legerlotz K. 1, Screen H.R.C. 2, Riley G.P. 1 1: University of East Anglia (Norwich, UK), 2: Queen Mary University of London (London, UK) **Introduction** Exercise is known to increase plasma IL6 levels. Whilst the exercising muscle is thought to be the major site of IL6 production (1), a dramatic increase in the interstitial concentration of IL6 has been found in the peritendinous tissue around the human Achilles tendon after running, pointing towards tenocytes as another possible source of IL6 synthesis (2). In a pilot study on bovine tendon, we confirmed that tendon tissue expresses IL6 in response to exercise, reporting a marked increase compared to very low pre-exercise levels (3). The aim of this study was to characterize the effect of a range of overloading conditions on sample fatigue, and to associate the degree of fatigue damage with IL6 expression in human tendon fascicles. **Methods** Fascicles were dissected from healthy human hamstrings tendon and cyclically loaded to 60% of max. strain for 5, 15 and 30min at 1Hz. The fatigue loading was followed by either a failure test to provide a measure of sample damage ( $n=10$ ) or further loading at 10% of max. strain (to mimic physiological conditions) for gene expression analysis at 6 or 24h ( $n=7$ ). Fascicles frozen directly after dissection and fascicles not fatigued but loaded at 10% of max. strain served as controls. RNA was extracted, reversed transcribed and analysed by qRT-PCR (Taqman Low Density Array). Genes were normalized to 18s. **Results** 5, 15 and 30min overloading decreased mean failure stress by 21, 28 and 34% respectively. However, due to high inter- and intrapersonal variability these differences were not significant. Compared to the directly frozen control fascicles, IL6 expression increased significantly 6h post loading in the 5 and 15min overloaded, as well as in the minimally loaded fascicles. **Discussion** In terms of structural integrity, human tendon fascicles were notably more fatigue resistant than bovine tendon fascicles (3). IL6 expression was induced early post loading. However, the threshold to induce IL6 expression appears to be rather low, as it was also induced in the minimally loaded fascicle, designed to serve as a control. Increased IL6 levels might facilitate tendon adaptation by regulating healing processes, as tendon healing has been shown to be impaired in IL6 knockout mice (4). However, since IL6 has been attributed both pro- and anti-inflammatory functions (5) it could play a role in either tendon adaptation or the development of tendinopathy. This highlights the importance of further investigation, as IL6 might be a potential target for therapeutic intervention. **References** (1)Steensberg et al.(2000) J Physiol 529:237-42. (2)Langberg et al.(2002) J Physiol 542:985-90; (3)Legerlotz et al.(2011) ORS abstract 219; (4)Lin et al. (2006) J Biomech 39:61-9; (5)Choy et al.(2002)Arthritis Rheum 46:3143-50

### INTERLEUKIN LEVEL IN RATS' BLOOD AFTER TWO DIFFERENT BRIEF WHOLE-BODY VIBRATION PROGRAMS

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**Introduction** Vibration is a physiological mechanical stimulus affecting different structures of tissues and is recognized by special sensors located throughout those tissues. The literature concerning the effects of vibration on mammalian organism describes a wide spectrum of physiological effects, ranging from harmful impact on the living organism to a useful modality and an effective way to exercise musculoskeletal structures. The important criteria for distinguishing between those two states are specific amplitudes, frequencies, and lengths

of vibration training. The aim of this study was to describe the modulatory effect of two different brief whole-body vibration programs in rats on the concentration of selected pro- and anti-inflammatory interleukins in the blood. Methods Ten male Wistar rats, aged 6 months, were trained for 5 weeks using a brief whole-body vibration program (5 days a week, frequency: 50 Hz, amplitude: 2.5 mm). Five of them underwent vibration training as a single session lasting 30 s (group 1), and the other five animals were subjected to four vibration sessions lasting also 30 s and applied at 60 s intervals (group 2). Animals in those vibrated groups were compared to age-matched control rats of the same age (n=5). After completing the training, blood was taken from all animals. Using the ELISA method, the level of two pro-inflammatory (IL-1 $\beta$ , IL-6) and one anti-inflammatory (IL-10) interleukins were determined. Results The concentrations of pro-inflammatory interleukins in the blood measured after the brief whole-body vibration were about 1 and 3 times higher, compared with the control animals, in the group subjected to one and to four vibration sessions, respectively. The level of interleukin-10 showed an opposite trend, decreasing 3 times, from 36.8 to ca. 12 pg/ml after the vibration program, and that effect was stronger in rats subjected to four vibration sessions (p<0.05). Discussion The brief whole-body vibration program led to higher concentration of both pro-inflammatory interleukins measured in the blood of rats (IL-1 and IL-6), however, the increased level of them was associated with the higher intensity of the applied vibration training. A parallel finding in this study was a decreased level of the IL-10 anti-inflammatory interleukin, which is perhaps a clear immunological message indicating the biological impact of vibration stimuli on a living organism.

## EFFECTS OF MODE AND INTENSITY ON THE ACUTE EXERCISE-INDUCED IL-6 AND CRP RESPONSES IN A SEDENTARY, OVERWEIGHT POPULATION

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Effects of mode and intensity on the acute exercise-induced IL-6 and CRP responses in a sedentary, overweight population Mendham AE; Donges CE; Liberts EA; Duffield R School of Human Movement Studies, Charles Sturt University, Australia Introduction Acute exercise may be an impetus for the inhibition of chronic disease development via the inducement of post exercise inflammatory responses (Kramer and Goodyear, 2007). Anti-inflammatory contributions during acute exercise have shown to be associated with enhanced metabolic function in both non-insulin dependent diabetes mellitus and normo-glycaemic subjects (Kramer and Goodyear, 2007). Therefore, the aim of this study is to investigate the acute exercise-induced plasma IL-6, CRP and total leukocyte count to different modes (resistance or aerobic) and intensities (higher or lower), within a middle aged, sedentary and disease-free subject population. Methods Following baseline testing, and in a randomized cross-over design, 12 sedentary males completed four exercise protocols, including 40 min of moderate-vigorous (M-VA, 50% maximal aerobic workload) or low-intensity (LA, 30% maximal aerobic workload) aerobic exercise on a cycle ergometer; and a moderate-vigorous (M-VR, 80% 1RM) or low-intensity (LR, 60%1RM) full-body resistance session matched for protocol duration, with HR and RPE collected during each session. Venous blood was obtained pre-, post-, 3 h post and 24 h post-exercise and analysed for IL-6, CRP, leukocyte count, myoglobin, creatine kinase (CK), and cortisol. Results HR and RPE showed no significant differences between modes of the M-V protocols or the low-intensity protocols. However, the M-V protocols were respectively higher than the lower-intensity. The 3–24 h post-exercise response of CRP was higher in the M-VR ( $0.68 \pm 0.31$  mg/L;  $80.0 \pm 38.2\%$ ) protocol when compared to the low-intensity protocols (P<0.05); however, no significant difference existed between the respective M-V intensity protocols. The M-V intensity protocols induced significant increases of IL-6, cortisol, and leukocytes in comparison to the low-intensity protocols (P<0.05). Additionally, a significant pre to post change in IL-6 was evident within the M-VA ( $0.9 \pm 0.13$  pg mL<sup>-1</sup>;  $70.9 \pm 4.5\%$ ; P = 0.0001) and M-VR ( $0.74 \pm 0.27$  pg mL<sup>-1</sup>;  $59.1 \pm 2.8\%$ ; P = 0.01), with no significance between the respective protocols, despite the M-VR inducing the largest response of markers indicative of muscle damage (CK, myoglobin, and neutrophil count) (P<0.05). Discussion A disassociation between the IL-6 response and markers of muscle damage within the respective exercise bouts was evident. Additionally, the highest IL-6 response was occurred in the M-V intensity protocols immediately post-exercise. Consequently, it appears the exercise modality did not overtly influence the acute IL-6 and CRP response, with the main determinant of the IL-6 response being exercise intensity when duration is standardized. References Kramer HF, Goodyear LJ (2007). J Appl Physiol 103, 388–395

## INFLAMMATORY BIOMARKERS CHARACTERIZATION IN YOUNG BASKETBALL PLAYERS AT THE PREPARATORY PERIOD

BRUNELLI, D.T., SOUZA, T.M.F., BORIN, J.P., RODRIGUES, A., MONTAGNER, P.C., DANIEL, J.F., CAVAGLIERI, C.R.

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INFLAMMATORY BIOMARKERS CHARACTERIZATION IN YOUNG BASKETBALL PLAYERS AT THE PREPARATORY PERIOD Brunelli, DT. 1, Souza, TMF.1 Borin, JP.1, Rodrigues, A.1, Montagner, PC.1, Daniel, JF.1, Cavaglieri, CR.1 1: State University of Campinas (UNICAMP), Brazil. Introduction Nowadays, it is fundamental that proper training for young athletes in any field of physical activity should be aware of the changes in skeletal muscle brought on by strenuous training. Accordingly, an understanding of these various changes in the human system will help to determine, control and monitor training programs. In particular, the immunological and metabolic systems can reduce the performance level, and influence the development process and the good health of young athletes. Thus, the aim of this study was to investigate the immunological system responses of young basketball players at the preparatory stage. Methods Sixteen young males ( $13 \pm 0.63$  years;  $53.65 \pm 12.86$  kg;  $167 \pm 0.09$  cm). The training sessions were carried out 3 days per week, each session totaling 120 minutes comprising 15 min. of warm up; 90 min. of technical/tactical aspects and 15 min. of stretching). Blood samples (10ml) were collected from the antecubital vein into tubes (Vacutainer; Becton Dickinson, Mountain View, CA) before the period (M1) and after 8 weeks, at the end of the preparatory period (M2), and the total and differential leukocyte counts performed successively. Tumour necrosis factor- $\alpha$  (TNF- $\alpha$ ) and prostaglandin (PGE2) were performed by ELISA (R&D Systems, Minneapolis, MN). To identify the differences between moments of modification, one-way ANOVA was applied. Where a significant main effect and/or interaction was observed, Tukey's HSD post hoc test was carried out (p<0.05). Data are presented in terms of means  $\pm$  standard deviations. Results Significant changes were found in monocytes (M1=902.25 $\pm$ 108.88; M2=442.63 $\pm$ 83.53) (p=0.00233) and prostaglandin (M1=952.07 $\pm$ 109.09; M2=404.84 $\pm$ 75.41) (p=0.000393). No differences were found in total leukocyte counts (M1=9075 $\pm$ 483; M2=8225 $\pm$ 430.84), neutrophils (M1=4603.63 $\pm$ 431.62; M2=4823.5 $\pm$ 275.82), lymphocytes (M1=3194.38 $\pm$ 233.31; M2=2732 $\pm$ 159.43) and TNF- $\alpha$  (M1=1.47 $\pm$ 0.41; M2=1.53 $\pm$ 0.39). Discussion Exercise can promote physiological and metabolic stress, which provokes a defensive reaction in the organism such as inflammation, to recover from these changes, with cytokines acting as an intermediating agent on cellular alterations (KELLEY, 2001). According to the data observed in this study, the decrease in monocytes and prostaglandin after the preparatory period suggest adaptive behavior on the part of the volunteers as a result of the load training applied during the period. References Kelley DS. (2001). Nutrition, 17, 7, 669-673.

**INFLAMMATORY RESPONSE AFTER AN ACUTE STRENGTH PROTOCOL IN TRI-SET**

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**INFLAMMATORY RESPONSE AFTER AN ACUTE STRENGTH PROTOCOL IN TRI-SET** Brunelli, DT.1, Libardi, CA.1, Cavaglieri, CR.1 1: State University of Campinas (UNICAMP), Brazil. **Introduction** Microtraumas are temporary damage which results in an acute inflammatory response produced by neutrophils, macrophages and cytokines which perform the function of repairing the tissue damage (SMITH, 2000). Few studies have investigated the immune and inflammatory responses in light of different strength training protocols. Thus, the aim of this study was to investigate the reaction of cortisol, pro-inflammatory cytokines and immune cell counts to an acute strength protocol in tri-sets. **Methods** Nine trained males were recruited ( $22 \pm 1.87$  years;  $80 \pm 8$  kg;  $175 \pm 5$  cm). The one repetition maximum (1RM) was determined for each exercise performed. After 72 hours of rest, individuals were submitted to a strength training protocol with multiple sets (Tri-set). Two combinations were determined: 1) bench press, incline bench press, dumbbell fly. 2) EZ bar curl, dumbbell biceps curl, Scott machine. Volunteers performed 6 sets with 75% of 1RM for each exercise, 3 passages in each combination and 3 minutes rest between passages. The blood samples were collected from the antecubital vein before the session (M1), after the session (M2), 24 hours after the end of session (M3), and the total and differential leukocyte counts ( $\text{cel}/\text{mm}^3$ ) performed successively. Cortisol ( $\text{pg}/\text{ml}$ ) was measured by serum with the Electrochemiluminescence method. Interleukin-6 (IL-6) and tumour necrosis factor- $\alpha$  (TNF- $\alpha$ ) ( $\text{pg}/\text{ml}$ ) were performed by ELISA. One-way ANOVA and Tukey's HSD post hoc test were applied ( $P < 0.05$ ). **Results** Significant differences were found in total leukocyte count ( $M1 = 9877.77 \pm 2498.88$ ;  $M2 = 15000.00 \pm 2672.07$ ;  $M3 = 8855.55 \pm 1785.43$ ), Monocytes ( $M1 = 877.44 \pm 307.65$ ;  $M2 = 2768.22 \pm 523.96$ ;  $M3 = 633.72 \pm 235.83$ ) and neutrophils ( $M1 = 6200.11 \pm 1973.57$ ;  $M2 = 9105.00 \pm 2116.75$ ;  $M3 = 5338.16 \pm 1349.13$ ). No differences were found in lymphocytes ( $M1 = 2517.00 \pm 628.49$ ;  $M2 = 2769.66 \pm 756.73$ ;  $M3 = 2562.33 \pm 473.12$ ), IL-6 ( $M1 = 1.21 \pm 0.91$ ;  $M2 = 1.30 \pm 0.89$ ;  $M3 = 1.15 \pm 0.74$ ), TNF- $\alpha$  ( $M1 = 2.29 \pm 1.61$ ;  $M2 = 2.57 \pm 1.72$ ;  $M3 = 2.35 \pm 1.62$ ) and cortisol ( $M1 = 2.35 \pm 1.62$ ;  $M2 = 13.30 \pm 4.07$ ;  $M3 = 12.88 \pm 3.40$ ). #Significant differences compared to M1. **Discussion** The mechanisms responsible for the leukocytosis after resistance exercise are not fully understood, but the evidences suggests sympathetic nervous activity, catecholamines and cortisol as mediators of this process (Koch, 2010). However, the leukocytosis found in our study was transitory and probably in response to the action of catecholamines. Furthermore, the intensity in the present protocol was not able to promote a transient immunosuppression, probably because they were trained, since we not found significant changes on lymphocytes and cytokines. **References** SMITH, L. L. (2000). *Med Sci Sports Exerc*, 32(2), 317-31. KOCH AJ. (2010). *American J of Lifestyle Medicine*, 4, 244-252.

**Poster presentations****PP-PM70 Training and Testing: Lactate/Anaerobic****DETERMINATION OF THE ANAEROBIC CAPACITY USING AN ALL-OUT PEAK POWER CYCLE TEST**

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**Introduction:** The anaerobic capacity is a critical factor in many athletic disciplines. However there are fundamental difficulties in modelling the maximum amount of ATP that can be generated through anaerobic substrate metabolism. Therefore the purpose of this study was to examine the validity of using an all-out peak power cycle test for the determination of the anaerobic capacity. **Method:** Following local institutional ethics approval 9 well-trained male athletes volunteered to participate (age  $21.8 \pm 2.1$  yrs, mass  $74.2 \pm 12.7$  kg, height  $178.8 \pm 7.4$  cm,  $\text{VO}_{2\text{max}}$   $62.9 \pm 7.7$  ml/kg/min). Each participant visited the laboratory on four separate occasions separated by at least 72 hr for the determination of  $\text{VO}_{2\text{max}}$ , sub-maximal  $\text{VO}_2$ , maximally accumulated oxygen deficit (MAOD) and all-out peak power (aoPP) (anaerobic capacity). 4 of the participants completed an additional aoPP test for determination of reliability. All exercise trials were completed on an electronically braked cycle ergometer. The MAOD was determined according to (Medbø et al., 1988). For the aoPP trials participants cycled maximally against a fixed resistance ( $0.7 \text{ Nm}/\text{kg}$ ) until power output declined to the power at  $\text{VO}_{2\text{max}}$ . For aoPP, energy outputs (KJ) were calculated by trapezia measurements of the area under the total power output (tPO) and aerobic power output (aPO) curves until their point of intersection, with anaerobic energy generation =  $\text{tPO} - \text{aPO}$ . Throughout all trials expired air was recorded on a breath-by-breath basis using a pre-calibrated metabolic cart. **Results:** The mean MAOD score was  $60.7 \pm 14.2$  ml/kg or  $22059 \pm 6445.0$  J with a duration of  $118.1 \pm 51.1$  s, which equated to a workload of  $465.1 \pm 80.9$  W. For the aoPP test the mean energy generation score was  $24.8 \pm 5.9$  KJ or  $332.0 \pm 74.0$  J/kg. The duration of the aoPP test was  $51.9 \pm 16.4$  s with a total energy cost of  $23087.3 \pm 7057.1$  J. There was a significant difference for both test duration ( $P = 0.00280$ ) and exercise intensity ( $P = 0.0013$ ) between MAOD and aoPP. There was however a non-significant difference between MAOD and aoPP (J) ( $P = 0.1621$ ). Test re-test analysis of the aoPP displayed a SEM of  $1.72$  KJ which equated to a CV of 5.7%. **Discussion:** The data suggests that the aoPP test may provide a valid means of estimating the anaerobic capacity. In all participants the power output declined from the instantaneous high to that associated with  $\text{VO}_{2\text{max}}$ , but then displayed a 'plateau like' response suggesting that the aoPP test has both exhausted the anaerobic capacity and factored in the aerobic contribution. **References** Medbø JI, Mohn AC, Tabata MI, Bahr R, Vaage O, Sejersted OM. (1988) *J Appl Physiol*, 64, 50-60

**INDIVIDUAL ANAEROBIC THRESHOLD ASSESSMENT IN FRONT CRAWL SWIMMERS**

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**Introduction** One of the most used methods for anaerobic threshold assessment is based on the fixed reference value of 4 mmol/l of blood lactate concentration ([La]). However, since 30 years ago, the anaerobic threshold has been reported to have great variability between athletes, particularly swimmers (Stegmann et al, 1981; Fernandes et al, 2008). In fact, a fixed value of [La] does not take into account considerable inter-individual differences and may frequently underestimate or overestimate real aerobic capacity. Thus, conversely to the use of an averaged [La] value, an individualized approach was suggested before, both for adult (Fernandes et al., 2008) and children swimmers (Fernandes et al., 2010). The purpose of the present study was to assess the individual anaerobic threshold in front crawl swimming. **Methods** In a 50 m swimming-pool, 13 international level swimmers ( $20.7 \pm 2.7$  years old,  $182.8 \pm 6.0$  cm,  $74.6 \pm 5.2$  kg and  $n > 8$  training units per week) performed a  $7 \times 200$  m individualized intermittent incremental protocol, with increments of  $0.1 \text{ m}/\text{s}$  for each 200 m step (1 min rest intervals), being the initial velocity established according to the individual level of performance on the 400



m front crawl (adapted from Fernandes et al., 2008). Capillary blood samples, collected during the intervals (Lactate Pro, Arkay Inc), allowed assessing individual anaerobic threshold through the [La]/velocity curve modelling method (assumed to be the interception point of a combined pair of regressions used to determine the exact point for the beginning of an exponential rise in [La], as proposed by Machado et al., (2006). Results [La-] and velocity values corresponding to individual anaerobic threshold averaged, respectively,  $2.32 \pm 0.68$  mmol/l and  $1.38 \pm 0.11$  m./s-1, being both significantly lower than the averaged 4 mmol/l of [La] and corresponding velocity values. Discussion Our results corroborate those previously observed for well aerobically trained swimmers (cf. Stegmann et al., 1981; Martin and White, 2000; Fernandes et al., 2008). These authors observed that the [La] corresponding to anaerobic threshold in groups of untrained subjects or athletes not especially aerobically trained was found near 4 mmol/l, but in aerobically trained subjects (especially in highly trained long-distance runners, triathletes and swimmers), it was found to be distinctively lower. Therefore, we confirm the fact that the 4 mmol/l and its corresponding velocity values do not represent the individualized lactate threshold in trained swimmers. References Fernandes RJ et al. (2008) Int J Sports Med 29(2) 145-50 Fernandes RJ et al (2010) Eur J Sport Sci 10(5) 311-317 Machado L et al (2006) Port J Sport Sci 6(supl 1) 142-144 Martin L and Whyte G (2000) Int J Sports Med 21 366-368 Stegmann H et al (1981) Int J Sports Med 2(3) 160-165 Acknowledgement FCT PTDC/DES/101224/2008

## RELIABILITY OF BLOOD LACTATE REMOVAL AND PERFORMANCE DURING SWIMMING

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Introduction During most of swimming competitions, the athletes are asked to participate of multiples bouts at the same day, turning important the recovery mode realized between these performances. Many studies have been made to investigate the best intensity of this recovery, and also the effects of different recovery modes (passive, active or combined) in lactate removal (Reaburn and Mackinnon, 1990; Toubekis et al., 2008). The purpose of this study was to investigate the reliability of the lactate removal rate in swimming using two different recovery modes (passive and active) and also of 200m-performance. Methods Nine competitive swimmers participated in this study. They performed a 200m swimming max effort, to induce acidosis, and recovered for 30min. All of recovery modes tests and retests, were randomized and realized with at least 24h between them. The blood lactate [La] was collected on minutes 1, 3, 5, 7, 9, 13, 17 and 30. During these tests the lactate parameters were observed: half time of blood lactate removal (t1/2); maximal blood lactate concentration ([La]max); time to reach maximal blood lactate removal (time to [La]max); 200m swimming performance time (T200m). Statistical Analysis was made by t-test, intra-class correlation and typical error of measurement (TEM), between test and retest for each mode of recovery (Hopkins, 2000). Results The mean $\pm$ s values of t1/2 during passive and active recovery were  $16.55 \pm 2.82$ min e  $10.92 \pm 4.65$ min, respectively, not showing significant difference between test and retest on each recovery mode. However, a weak correlation was found (passive:  $r=0.09$ ; active:  $r=0.45$ ), and also a high TEM for both mode of recovery (passive: 22%; active: 37%), thus not assuming the reliability of this index on swimming. All of other lactate indices analysed showed TEM higher than 10% (12-38%). Furthermore, the T200m could be considered highly reliable for both recovery modes, showing the mean $\pm$ s values of  $145.1 \pm 12.6$ s, correlation of 0.98, and TEM of 1,5% Discussion Although the mean values of the lactate parameters analysis (t1/2; [La]max; time to [La]max) did not show significant difference between test and retest, both analysis of correlation and TEM showed low reliability for two mode of recovery. The mechanisms involved in the lactate production and particularly on blood lactate removal, seem to vary from one day to another, when analyzing the intra-subject variations. Thus, we suggest carefulness when using the t1/2 of blood lactate removal in swimming, whether for research or practical applications. References Hopkins, W. (2000) Sports Med. 30, 1-15. Reaburn PRJ, Mackinnon LT. (1990). Eur. J. Appl. Physiol. 61, 246-250. Toubekis AG, Tsolaki A, Smilios I, Douda H, Kourtesis T, Tokmakids SD. (2008). Int. J. Sports Phys. Perform, 3, 375-386.

## RELATIONSHIP AMONG TRAINING LOAD, LACTATE MINIMUM AND PERFORMANCE IN TRAINED CYCLISTS DURING A FULL TRAINING PERIOD

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Introduction The correct distribution of load during period training is essential to improve physical capacity and performance of athletes. The main components to training load are volume and intensity, although the intensity appears to be most important to well trained athletes (Iaia and Bangsbo, 2010). Therefore, the aim of the study was to verify the relationship among training load, aerobic capacity and performance in trained cyclists. Methods Eight well trained road cyclists (age  $18 \pm 2$  years; weight  $64.9 \pm 8.6$  Kg) were submitted to the experimental protocol. The full training period was divided in three phases: preparatory (1st to 9th week), first competitive phase (10th to 18th week) and second competitive phase (19th to 29th week). The training load, considered as the product of the volume (Km) and intensity (km/h), was measured daily after each training session. The anaerobic threshold was determined by the lactate minimum test (LM) performed on a cycle ergometer using protocol modified by Pardonno et al. (2008). This protocol consisted in a hyperlactemia induction by Wingate test, followed by incremental test (six stages of 3 minutes) applied after 8 minutes of rest. The simulated time trials of 15 kilometers (TT-15km) were used to evaluate the performance. The LM and TT-15km were performed at the end of each training phase. Correlations among variables were obtained from Pearson Correlation test ( $P < 0.05$ ). Results There was no significant correlation among volume and training load with LM and TT-15km in all phases of training. However, significant correlation was obtained between intensity training and LM ( $r = 0.69$ ,  $P < 0.05$ ) in first competitive phase. The intensity training also showed significant correlation with TT-15km in first competitive phase ( $r = 0.76$ ) and second competitive phase ( $r = 0.70$ ). Discussion In elite athletes the training based in high intensity and low volume seems to be more efficient than high-volume and low intensity to increase anaerobic threshold and performance (Faude et al., 2008). Therefore, the significant correlations obtained among intensity, LM and performance suggest that the increase in the intensity during training appears to be efficient to improve aerobic capacity and performance in trained cyclists. References Faude O, Meyer T, Scharhag J, Weins F, Urhausen A, Kindermann W. (2008). Int J Sports Med, 29, 906-12. Iaia FM, Bangsbo J.(2010). Scand J Med Sci Sports, 20 (Suppl), 11-23. Pardonno E, Sotero RC, Hiyane W, Mota MR, Campbell CS, Nakamura FY, Simões HG. (2008). J Strength Cond Res, 22, 1073-80.

## EFFECTS OF STRAIGHTNESS KNEE KICK MAKES LACTATE ON 100 BUTTERFLY PERFORMANCE: A CASE STUDY USING THE MEN'S ASIAN AND JAPANESE RECORD HOLDER

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**INTRODUCTION** The stroke technique was focused on straightness the knees less (Maglischo, 2003). When comparing his 2005 stroke to his 2009 stroke, we found that the extent to the straightness of his butterfly kick improved (Ide et al, 2010) from 39% to 55% (of >170 degrees knee-bending). Lactate level of bending the knees at 4.3mmol/l, straightness knees at 6.4mmol/l. **METHODS** This study compared Kawamoto's performance in 2009 to his performance in 2005. Kawamoto performed 25 meter butterfly all out butterfly stroke. Swimming Speed Mater (Vine, VMS-003, AC100V, 1/500sec, 0.2mm/pulse) generated the data by an attached wire with movement place (Yoshimura et al., 2007). The wire then exports the analogue signals and RS232C signals. These signals calculated are then examined using Microsoft Windows Excel and a Wicoxon Signed Ranked Test. While swimming, the subjects were monitored from the side using an underwater video camera at a sampling frequency of 60Hz (Underwater monitor system 2, YAMAHA, Shizuoka, Japan). The subject strokes angle of degree was analyzed with DartTrainer in regards to the bending of the knee and upper body movement. The lactate test was 50seconds wall kick, tempo was 1.10sec/stroke by FINIS tempo machine. The subject lactate generated by the Lactate Pro™ (Kyoto, Japan) meter for on-farm determination of the blood lactate of teleost fishes. Blood lactate of farmed cod, caught by rod and line, was below detection limits of the meter (< 0.8 mM), and confirmed by laboratory assay as  $0.459 \pm 0.037$  mM (mean  $\pm$  SEM,  $n = 34$ ). **RESULTS** Swimming Speed Mater shows the 2009 and 2005 max speed was 2.5m/sec to 2.7m/sec at the second kick phase respectively. The distance pre stroke (DPS) results were different resulting in a,  $2.204m \pm 0.131$  for 2009 and  $1.894m \pm 0.062$  for 2005 (DPS (m) Wicoxon.:  $p=0.006061$ , 1 stroke (velocity) Wicoxon.:  $p=0.7748$ ) and DartTrainer showed the straight knee considered when the knee bend is 170 degrees to 180degrees (+170 degree), 55% use of straight knee kick for 2009 and 39% for 2005, in the one stroke. The lactate, bend knees test result at 4.3mmol/l, straightness knees test result at 6.7mmol/l. **DISCUSSION** Based on the above evidence it is clear the most preferred butterfly technique is to use a straight knee kick (Loebbecke et al., 2009). The other hand, straight knees kick makes more lactate. Next training plan (Yoshimura and Kosuge, 2008), we employed training plan for keep low lactate straight knee kick. **REFERENCES** Maglischo EW (2003). Swimming Fastest. Champaign: Human Kinetics. Takahisa Ide, Yutaka Yoshimura, Kohei Kawamoto, Masafumi Takise, Toshifumi Kawakami. (2010) 2010 Biomechanics and Medicine in Swimming, 270-273, Oslo, Norway

## CAN MAXIMAL LACTATE STEADY STATE BE ESTIMATED THROUGH CRITICAL VELOCITY IN HUMAN SWIMMING?

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**Introduction** Theoretically, critical velocity (CV) represents the highest velocity that can be sustained from aerobic energy reconstitution capacity in long duration events. Maximal lactate steady state (MLSS) has a real physiological meaning compared with CV but is associated with many difficulties related to his determination. The aim of the present study was to analyze the relation between MLSS and CV. **Methods** Seventeen well-trained male swimmers completed a maximal 400 m front crawl (mean performance 79% of world record) in order to use the average velocity between 50 m and the 350 m (V400) as an estimate of the maximal aerobic speed (Lavoie and Leone, 1988). For MLSS velocity (MLSSv) determination, athletes performed in random order and different days, 30-min at constant velocity at 85, 90 and 95% of V400. CV was calculated from the slope of the regression analysis between the velocity of maximal trials (100, 200, 400 and 800 m). CV2 corresponded to the relation of 200 and 400 m, CV3 to 200, 400 and 800 m and finally, CV4 to 100, 200, 400 and 800 m. Anaerobic Work Capacity (AWC) was represented by the y-intercept of the velocity-time relationship. Results MLSSv ( $1.34 \pm 0.06$  m.s<sup>-1</sup>) corresponded to 95% of CV2 ( $1.41 \pm 0.08$  m.s<sup>-1</sup>), 97% of CV3 ( $1.39 \pm 0.08$  m.s<sup>-1</sup>) and 96% of CV4 ( $1.40 \pm 0.08$  m.s<sup>-1</sup>). MLSSv, V400 and all critical velocities were highly correlated. T-test applied to MLSSv over CV determined from two, three and four swimming distances evidence that the designated "gold standard" was significantly lower when compared to any of the combinations to obtain CV ( $p < 0.01$ ). The linear regression relation between CV2, CV3 and CV4 lead us to conclude that CV can be determined for swimming through any of these swimming distances combination. AWC calculations were not related with any swimmer performance but we were able to verify that swimmers who performed faster in 100 m were those who present a higher AWC. **Discussion** In swimming, previous researches related to CV were quite conflicting with some authors arguing that represent the upper limit of heavy intensity exercise. We found that CV over-estimated MLSSv in well-trained swimmers as previous mentioned by Dekerle et al. (2005) in a study with eight trained competitive swimmers. Our results confirm that the direct determination of MLSSv remains the most accurate procedure for exercise prescription aiming at aerobic loading. We also verified that the inclusion of 800 m distances had no significant effect on CV determination that can result from the combination of 200 and 400 m maximal swims. Studies concerning CV have to be interpreted with caution, swimming CV is still a valuable tool to assess training adaptations and could be used as an estimator of the MLSSv. **References** Dekerle, J., Pelayo, P., Clipet, B., Depretz, S., Lefevre, T., Sidney, M. (2005). Int J Sports Med; 26: 524-530. Lavoie, J.M. and Leone, M. (1988). J Swim Res; 4 (4): 17-19.

## CAN AN INCREMENTAL TEST PROVIDE RELIABLE INDICATORS OF MAXIMAL LACTATE STEADY STATE?

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**Introduction** Maximal lactate steady state (MLSS) is widely used for aerobic training prescription and monitorization of swimmers evolution. Lactate threshold (LT) represents the point during an incremental exercise test where there is an abrupt increase in blood lactate concentration [La] above basal levels. The purpose of this research was to compare the results obtained from an incremental test for LT determination with MLSS. **Methods** Fourteen competitive male swimmers completed a maximal 400 m front crawl in order to use the average velocity between 50 m and the 350 m (V400) as an estimate of the maximal aerobic speed (Lavoie and Leone, 1988). For MLSS velocity (MLSSv) determination, subjects performed, in random order and different days, 30-min at constant velocity at 85, 90 and 95% of V400. Athletes also completed 7x200 m front crawl incremental step test for LT determination based on log-log methodology (Pyne et al., 2001). Vmax was assumed as the swimming velocity performed in the last repetition of the incremental test. V4 was the velocity associated to a [La] of 4 mmol.L<sup>-1</sup>. Results Vmax ( $1.53 \pm 0.07$  m.s<sup>-1</sup>), V400 ( $1.52 \pm 0.07$  m.s<sup>-1</sup>), V4 ( $1.36 \pm 0.07$  m.s<sup>-1</sup>) and LT velocity (LTv) ( $1.34 \pm 0.06$  m.s<sup>-1</sup>) corresponded, respectively, to 112% (both Vmax and V400), 100% and 99% of MLSSv ( $1.36 \pm 0.06$  m.s<sup>-1</sup>). Vmax, V400, V4, LTv and MLSSv were highly correlated. LTv was different from MLSSv ( $p < 0.05$ ). Mean [La] at MLSSv ( $4.8 \pm 1.6$  mmol.L<sup>-1</sup>) was not related with mean [La] at LTv ( $3.7 \pm 0.7$  mmol.L<sup>-1</sup>). Velocity, stroke rate and stroke length performed in the fourth repetition of the incremental test (85%

of V200) were highly correlated with the same swimming parameters evidenced at MLSSv (respectively  $r = 0.87$ ;  $r = 0.89$  and  $r = 0.92$ ;  $p < 0.01$ ). The relation between MLSSv and V4 was examined with Blant Altman methodology, the bias and limits of agreement were indicators of a good fit. Discussion V4 was the physiological concept that more consistently estimated MLSSv. From our results we can conclude that V400 can be determined with accuracy from Vmax. Dekerle et al. (2005) found a decrease in stroke length at intensities above MLSS. We found this boundary to be situated at 90% of V400 and 85% of V200. In our understanding, both the continuous and incremental tests provide useful indexes of aerobic potential, but they cannot be used interchangeably for MLSSv estimation. The direct determination of MLSSv remains the most accurate procedure for exercise prescription aiming at aerobic loading. References Dekerle, J., Nesi, X., Lefevre, T., Depretz, S., Sidney, M., Marchand, F.H., Pelayo, P. (2005). *Int J Sports Med*; 26: 53-58. Lavoie, J.M. and Leone, M. (1988). *J Swim Res*; 4 (4): 17-19. Pyne, B.D., Lee, H.E., Swanwick, K.M. (2001). *Med Sci Sports Exer*; 33: 291-297.

### MAXIMAL AEROBIC POWER AND LACTATE THRESHOLD IN NOVICE FEMALE ONE-DAY EVENT RIDERS IS AFFECTED BY ADDITIONAL UN-MOUNTED TRAINING

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**Introduction** The physical fitness requirements for participation in One Day Eventing (ODE) have received limited investigation (Westerling, 1983; Devienne and Guezennec, 2000; Meyers and Sterling, 2000; Roberts et al., 2009). Extant literature has, however, reported that equestrianism provokes a high aerobic demand, particularly in disciplines where jumping and galloping are involved (Wright and Peters, 2008). Marked blood lactate accumulation reported in equestrian sports where jumping is required also indicates that the anaerobic energy system supports the aerobic system in meeting the metabolic demands of the sport. There is limited research that has identified variables relevant to both maximal and sustained high intensity aerobic exercise in such samples. The aim therefore, was to investigate maximal aerobic power and lactate threshold in novice female ODE riders and identify if the levels required for competition were enhanced by further un-mounted exercise training. **Methods** VO2max and lactate threshold (LT) were determined using a continuous, incremental protocol on a cycle ergometer. Heart Rate (Polar RS800CX Multi, Polar Electro Europe) and blood lactate were recorded. Participants were assigned an additional non-mounted physical training category from interviews as PA1: equitation alone, PA2: moderate additional training and PA3: considerable additional training. Results Mean VO2max was  $41.8 \pm 8.1$  ml.kg<sup>-1</sup>.min<sup>-1</sup>, with a range of 28.5 to 55.7 ml.kg<sup>-1</sup>.min<sup>-1</sup> and mean LT was  $2.8 \pm 0.9$  mMol, with a range of 1.6 to 5.2 mMol. There were differences in VO2max (PA1  $38.0 \pm 7.3$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; PA2  $39.8 \pm 6.2$  ml.kg<sup>-1</sup>.min<sup>-1</sup>; PA3  $51.4 \pm 4.3$  ml.kg<sup>-1</sup>.min<sup>-1</sup>) and Watts at LT (PA1  $110 \pm 13.4$ W; PA2  $130 \pm 20.9$ W; PA3  $163.8 \pm 39.4$ W) between the PA categories ( $p < 0.05$ ). **Discussion** The mean VO2max data would suggest that this sample were at least comparable with or superior in aerobic fitness compared to previous studies. The range identified a wide spectrum of fitness in the novice category and that any fitness enhancement appears due to additional un-mounted training. Combined, the level of aerobic power and LT in the equitation only group (PA1) would suggest that participation in ODE equitation training and competition at this level alone does not result in a high level of aerobic fitness or anaerobic tolerance. References Devienne, M., Guezennec, C. (2000). *J Appl Physiol* 82 (5), 499-503. Meyers, M.C., Sterling, J.C. (2000). *J Sp Med Phys Fit* 40, 131-138. Roberts, M., Shearman, J., Marlin, D. (2009). *Comp Exercise Physiol* 6 (3), 129-135. Westerling, D. (1983). *Eur J App Phys Occu Phys* 50 (3), 373-382. Wright, R., Peters, D.M. (2008) *I J Perf An Sp* 8 (2), 76-81.

### ANAEROBIC THRESHOLDS FROM T-CAR TEST PREDICT MAXIMAL LACTATE STEADY STATE IN FUTSAL PLAYERS

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**Anaerobic thresholds from T-CAR test predict maximal lactate steady state in futsal players** Carminatti, L.J.; Costa, V.P.; Dittrich, N.; Guglielmo, L.G.A.; De-Oliveira, F.R. 1: UFSC / UDESC (Florianópolis, Brazil) 2: UFLA (Lavras, Brazil) **Introduction** Several methods of anaerobic thresholds (AT) determined from continuous incremental tests have been used as predictors of maximal lactate steady state (MLSS): heart rate deflection point by visual method (HRv) (Conconi et al. 1982); mathematical method Dmax (Kara et al. 1996); the predicted Dmax (Dmaxpred) determined by percentage of peak velocity (PV) (80.4%) and HRmax (91.4%) from Carminatti intermittent test (T-CAR) (Carminatti et al. 2005). Thus, the aim of this study was to verify the validity of these AT as predictors of MLSS in futsal players. **Methods** Eight futsal players ( $21.3 \pm 3.1$  years;  $177.4 \pm 7.7$  cm;  $79.4 \pm 21.2$  kg) performed the following field tests: 1) T-CAR to determine AT; PV and HRmax – Field test with multi-stages of 90s in shuttle system (repeated sets of 5 x 12s bouts with pauses of 6s). The initial velocity was set at 9.0 km•h<sup>-1</sup> (controlled by audio beep) with an increase of 0.6 km•h<sup>-1</sup> in each stage until volitional exhaustion; 2) Several constant load test lasting 32min in the T-CAR system (4 x 8min with 1min of pause to collect samples of 25µL of capillary blood) to determine the HR and the velocity at MLSS (HRMLSS and VMLSS). **Results** The blood lactate at MLSS was  $4.2 \pm 1.8$  mmol.l<sup>-1</sup> ( $1.4 - 6.7$  mmol.l<sup>-1</sup>). The HR of the predictors was: HRv ( $186 \pm 11$  bpm); HRDmax ( $178 \pm 10$  bpm) and HRDmaxpred ( $183 \pm 8$  bpm). The velocities were: VHRv ( $13.0 \pm 1.5$  km•h<sup>-1</sup>); VDmax ( $12.2 \pm 1.4$  km•h<sup>-1</sup>) and VDmaxpred ( $12.4 \pm 1.2$  km•h<sup>-1</sup>). The HRMLSS ( $182 \pm 4$  bpm /  $91.2 \pm 3.2$  %HRmax) and VMSS ( $12.5 \pm 1.6$  km•h<sup>-1</sup> /  $81.1 \pm 4.2$  %PV) were not significant different when compared to the several AT predictors ( $p > 0.05$ ). In addition, the correlations between these measures were high and significant: HRv (0.83), HRDmax (0.88), VHRv (0.83), VDmax (0.98) and VDmaxpred (0.91); except for HRDmaxpred (0.53;  $p = 0.176$ ). **Discussion** The blood lactate value at MLSS found in the present study is in agreement to others reported during traditional continuous protocol. The heart rate and the velocities determined by several AT predictors were similar and strongly correlated with HRMLSS and VMLSS, respectively. Therefore, we found evidence of validity of several AT predictors from T-CAR with MLSS in futsal players. References Carminatti L.J., Lima-Silva A.E., De-oliveira F.R. Dmáx em teste intermitente de campo: por % fixo da frequência cardíaca máxima e pico de velocidade (2005). *Rev Bras Ci Mov*. 13, 44-44. Conconi F, Ferrari M, Ziglio PG, Droghetti P, Codeca L. Determination of anaerobic threshold by noninvasive field test in runners (1982). *J Applied Physiol*. 52, 869-73. Kara M, Göbel H, Bediz C, Ergene N, Uçok K, Uysal H. Determination of the heart rate deflection point by the Dmax method (1996). *J Sports Med Phys Fitness*. 36, 31-34.

## Poster presentations

### PP-PM71 Soccer 5

#### PERFORMING SOCCER GAME AFFECTS THE VELOCITY, AGILITY AND PSYCHOPHYSICAL CONDITION IN PSYCHOTIC SUBJECTS

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**Introduction** Physical activity is an important aspect of good health for everyone and is even more important for psychiatric patients who usually live an unhealthy lifestyle and assume medications that tend to reinforce their metabolic syndrome (Kopp, 2009). The purpose of this study was to examine whether performing soccer game by psychotic subjects has effects on their velocity, agility and psychophysical perception. **Methods** Eighteen overweight male subjects, 8 no-trained psychotics (NTPs) (age: 35.00 $\pm$ 5.00 years; height: 163.00 $\pm$ 4.00 cm; BMI: 25.00-29.90) and 10 trained psychotics (TPs) (age: 36.00 $\pm$ 6.00 years; height: 164.00 $\pm$ 7.00 cm; BMI: 25.00-29.90) from Local Health of Palermo (Sicily, Italy) participated in this study. NTPs did not performed any sports activity during the experimentation; while TPs were trained for 8 weeks by two sessions/week. In particular, every trained session included a warm up pattern for 20 minutes (min), a training period of 50 min including soccer technical-tactical exercises and a short match; finally a cool down part for 10 min. We evaluated the physical condition of the subjects measuring their body weight (BW) and body mass index (BMI). The velocity and agility were estimated recording the time used to perform 30 meter sprint test (30mST) and slalom test running with a ball (STB) between 5 cones located 50 cm apart. Psychophysical perception of psychotics was studied using the SF-12 health status questionnaire that measures self-rated health (Faulkner G et al., 2007). It investigated the summary measures PCS-12 (physical domain of SF-12, scores ranging from 0 to 70) and MCS-12 (mental domain of SF-12, scores ranging from 0 to 70). All data were acquired before and after the experimentation. **Results** After the training period PCS-12, MCS-12 and performances of 30mST and STB were improved in TPs compared with NTPs. In contrast, BW and BMI were lower in TPs than NTPs. **Discussion** We showed that training sessions of soccer game can improve the psychophysical condition and sports performance in psychotic subjects. In agreement with Pringle (2009), this might be due to the organized social phenomenon of soccer game that promotes a sporting therapeutic and healthy antagonism. Integrating physical activity programs into psychiatric services can improve physical health outcomes of patients with serious mental illness and may produce improvements in psychological and social outcomes. **References** Kopp M: Physical activity in persons with severe mental illness: research-based clinical recommendations. *Neuropsychiatr*. 2009; 23(3):151-6. Faulkner G, Cohn T, Remington G, Irving H: Body mass index, waist circumference and quality of life in individuals with schizophrenia. *Schizophr Res*. 2007; 90(1-3):174-8. Pringle A: The growing role of football as a vehicle for interventions in mental health care. *J Psychiatr Ment Health Nurs*. 2009; 16(6):553-7.

#### PHYSIOLOGICAL DEMANDS OF TURN MOVEMENTS AT DIFFERENT RUNNING SPEEDS

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**Introduction** Turn movements are essential to evade or pursue an opponent in ball sports. Bloomfield et al. (2007) reported there were about 5,000 turn movements in an English Premier League soccer match. It is important to know the total energy expenditure (EE) of players in a match to determine an appropriate diet (Alberto et al 2008). The EE of turn movements contributes to the total EE during a soccer match. Although many previous biomechanics studies have been published regarding turn movements, research describing the physiological demands of turn movements is sparse. The aim of the present study was to investigate the effects of running speed on EE for a 180° turn using the "different frequency accumulation method". **Methods** Seven healthy young men participated in eight running sets at a constant speed. Each set was 5 minutes in duration. The participants turned 180° repetitively during the 5-minute running interval. The EE during running and turning was measured using a portable metabolic system (Meta Max 3B). Subjects ran at speeds of 75, 100, 125, and 150 m/min with turn frequencies of 10 and 20 turns/min for each speed. We calculated the EE of a turn at each speed from the slope of regression for EE against turn frequencies. After each set, ratings of perceived exertion (RPE) were surveyed using the Borg scale. **Results** The EE of a turn at 75, 100, 125, and 150 m/min was 5.9  $\pm$  2.2, 12.3  $\pm$  2.3, 18.7  $\pm$  6.6, and 24.7  $\pm$  8.3 J/kg, respectively. As the running speed increased, the EE of a turn increased. The correlation coefficient between the EE of a turn and running speeds was strong (mean  $r$  = 0.99), and the relationship appeared to be linear. At a speed of 150 m/min running with 20 turns/min, the RPE was very high (18.1  $\pm$  0.7). **Conclusion** In this study, we examined whether the EE of a turn movement was affected by running speed. The strong correlation between the EE of a 180° turn and running speed implies that the EE of a 180° turn can be calculated from running speed. The results of the present study indicate that as running speed increases, the energy consumption of a turn during running increases in a linear manner, and RPE is increased when the turn frequency is increased. **References** Bloomfield, J. et al. *Journal of Sports Science and Medicine* (2007), Suppl. 10, 9-10. Alberto, S. et al. *Journal of Sports Science*, (2008), 7, 327-334.

#### GENETIC DIVERSITY OF LITHUANIAN FOOTBALL PLAYERS ACCORDING TO THE POSITION OF PLAY ON THE FIELD

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**Introduction** Football is the most popular sport in the world. Our hypothesis is that genetic information might significantly influence a footballer's career. The purpose of this study was to assess the ACE I/D, PPARGC1A G/A and PPARA G/C polymorphisms' genotype and allele frequency distributions in Lithuanian football player groups. **Methods** The study involved 400 footballers (81 forwards, 124 defenders, 35 goalkeepers, 160 midfielders) and 167 controls (male non-athletes from the general Lithuanian population). Genotyping was performed by PCR-RFLP. Genotype and allele frequency differences between the groups were assessed by the chi-squared test with the expected values equal for all categories. **Results** Hardy-Weinberg equilibrium calculations of ACE, PPARGC1A and PPARA genotypes frequencies showed no deviation from expected frequencies in the Lithuanian footballers group. ACE I/D genotype frequencies of the footballers were different from those of the controls (II/ID/DD:24.0/46.5/29.5% vs. 24.6/29.9/45.5%;  $p$ <0.05). ACE D/D genotype and D allele were significantly less common among football players compared to controls ( $p$ <0.05). For the goalkeepers the ACE I allele (51.4%) was more frequent when compared to other football players (defenders-48.4%; midfielders-48.1%; forwards-42.0%) and controls (39.5%). We found no significant PPARGC1A G/A polymorphism genotype frequency differences between the footballers and controls

(GG/GA/AA:50.2/41.0/8.8% vs. 49.7/44.3/6.0%;  $p>0.05$ ). The frequency of the PPARGC1A G allele was higher for the midfielders (72.2%) and goalkeepers (75.7%) compared to the forwards (69.1%), defenders (68.5%) and controls (71.9%). Similarly for the PPARGC1A G/C polymorphism the footballers were not significantly different from controls (GG/GC/CC:67.5/29.5/3.0% vs. 72.5/24.5/3.0%;  $p>0.05$ ). The PPARGC1A C allele was slightly more common among the forwards (22.8%) compared to other footballers (goalkeepers-12.9%, defenders-16.5%, midfielders -17.2%) and controls (15.3%). However the PPARGC1A G allele had higher frequency among the goalkeepers (87.1%) compared to other footballers (forwards-77.2%, defenders-83.5%, midfielders-82.8%) and controls (84.7%). There were no PPARGC1A A/A or PPARGC1A C/C genotype athletes among the researched goalkeepers. Discussion It has been determined by other researchers that ACE I, PPARGC1A G and PPARGC1A A alleles enhance aerobic endurance while the ACE D, PPARGC1A A, and PPARGC1A C alleles are associated with speed and power. Our study shows that according to the ACE I/D, PPARGC1A G/A and PPARGC1A G/C polymorphisms footballers have mixed (speed/power and endurance) genotype combinations. These findings support our theory that footballers require both aerobic and anaerobic energy system balance as well as the stability of the regulatory mechanisms to be success in their sport.

### TEMPORAL PATTERNS ANALYSIS IN THE GOALS SCORED BY FOOTBALL TEAMS

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Introduction Studies that focus on simple frequency analysis cannot identify temporal patterns within a sport performance. The purpose of this study was to detect patterns of behavior, known as T-pattern (characterized by their temporal and sequential structure), in the goals scored by the teams of F.C. Internazionale Milano (IM), F. C. Barcelona (FCB), and Manchester United (MU) in the 2009/2010 sporting season. Methods Sixty-one goals (24 scored by FCB, 17 by IM and 21 by MU), resulting from thirty-six games (12 per team), were encoded using the observational instrument developed by Sarmento et al. (2010). The reliability of the data was calculated by the intraobserver agreement, and values above 0.95 for all criteria were achieved. For the detection of temporal patterns, we used the software THÈME 5.0., and the following criteria were used: the minimum number of events was set at 3 and the level of significance was set at 0.005. Results and Discussion In relation to the goals scored by FCB, we detected 578 T-patterns, of which 12 were complete patterns, because they contained all the codes present in the observational instrument, since the start until the end of the OP. The completed t-patterns found provide important information about the regularities of all game actions and the interactions that occur between players in the different phases of the OP. These regularities have a sequential structure that is repeated with the same interval of time in three different offensive sequences. For the IM and MU teams, we found 18 and 9 T-patterns, respectively. None of these T-patterns was complete, but the incomplete t-patterns detected provide important information about how the offensive sequences that end in a goal begin and develop. The more significant T-patterns will be later explained in a detailed way. Conclusion The detection of behavior patterns in offensive plays (T-patterns) proves to be particularly interesting. The number of detected T-patterns indicates that the structure of the game is much more complex than the "human eye" can detect. The difference of patterns found between these different teams, suggest that the FCB offensive sequences are more consistent in their temporal structure than those of other teams. This type of analysis provides important information for coaches that can be used in the training process. Sarmento, H., Anguera, T., Campaniço, J., & Leitão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina (Kaunas)*, 46(6), 401-407.

### DEVELOPMENT OF AN EXERCISE PROTOCOL THAT SIMULATES THE ACTIVITY PATTERN OF INTERNATIONAL TAEKWONDO COMPETITION

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Introduction Exercise protocols that simulate the activity pattern of competition have been devised for various sports. These simulations provide an ergonomic framework to permit more detailed examinations of the physiological responses to specific intermittent activity patterns. They also offer a controlled model to facilitate the study of interventions (Drust et al. 2007). The aim of this study was to devise an exercise protocol that serves to replicate the activity profile of international Taekwondo competition. Methods The exercise protocol devised in this study was modelled on the time-motion data obtained from international Taekwondo competition (Bridge et al. 2011). The regular fighting, preparatory, non-preparatory, and stoppage activity phases performed in competition formed the fundamental framework of the protocol. These activity phases were arranged into 36 individual cycles of movement. Each individual cycle of movement required the participants to perform either a single non-preparatory or stoppage activity phase followed by a preparatory and fighting activity phase. Each activity phase contained a collection of Taekwondo actions that were arranged into irregular sequences. The individual cycles of movement were assembled to formulate three two-minute blocks of exercise. A one minute rest interval separated each block of exercise. This configuration represented the three two-minute rounds of international combat. Eight male Taekwondo competitors performed each predetermined cycle of movement on a specifically design 1.7 m course and stationary kick bag. These actions were performed in time with an audio signal that provided specific activity instructions. Results The mean fighting time set in the exercise protocol was 1.3 s, preparatory time 7.0 s, non-preparatory time 4.0 s, stoppage time 1.6 s, fighting to non-fighting ratio (1:x) 6.0 and 32 exchanges and 35 kicks were included. These compare favourably with the mean  $\pm$  SD range of time-motion data measured in international Taekwondo competition. The mean  $\pm$  SD fighting time in the international competition was  $1.7 \pm 0.4$  s, preparatory time  $6.4 \pm 2.1$  s, non-preparatory time  $3.0 \pm 0.6$  s, stoppage time  $2.8 \pm 0.9$  s, fighting to non-fighting ratio (1:x)  $6.3 \pm 2.0$  and  $28 \pm 6$  exchanges and  $31 \pm 7$  kicks were performed. Conclusions The exercise protocol devised in this study provides a reasonable approximation of the activity pattern performed in international Taekwondo competition. This protocol may therefore serve as useful ergonomic model to permit more detailed study of the physiological responses to Taekwondo-specific intermittent exercise. References Bridge C.A. et al. (2011) Int J Sports Physiol Perform, in press. Drust B. et al. (2007) Sports Med, 37, 783.

### TIME-MOTION ANALYSIS OF ELITE HURLING MATCH-PLAY

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Introduction Time-motion analysis is a useful method for quantifying the work-rate of a sport and provides a conceptual framework for the development and prescription of specific training regimes. Therefore, the aims of the present study were two-fold, first to quantify the type and frequency of movement activity displayed by elite hurling players in competition and second, to examine the occurrence of high-

intensity activity during elite match-play to provide an insight into any fatigue related changes in performance. Methods Fifteen, male (age:  $27 \pm 4$  years) outfield hurling players (six defenders, three midfielders and six forwards) participating in the knock out stages of the All-Ireland hurling championships were video recorded throughout an entire game (70 mins). One camera was used per player to follow each of the players throughout the game. The camera was positioned above the half-way line to enable the players to be clearly monitored irrespective of position on the field of play. The player's activities were coded (SportsCode, Warriewood, NSW, Australia) into one of seven movement categories: stationary, walking, shuffling, cruising, run/sprint, backward motion and sideways movement. For each activity, the frequency, mean duration and percentage of total time were calculated. Activity was further classified as low-intensity (stationary, walking, shuffling, backward and sideways movement) or high-intensity (cruising, run/sprint). Data were analysed using a one-way analysis of variance and are presented as means and standard deviations. Statistical significance was set at  $p < 0.05$ . Utilizing Cohen's kappa the intra-observer reliability never exceeded 2.1% for the activity categories. Results Participants spent  $6.6 \pm 2.6\%$  of total match time standing stationary,  $43.8 \pm 4.3\%$  walking,  $14.8 \pm 4.4\%$  shuffling,  $9 \pm 2.8\%$  jogging,  $7.3 \pm 2.5\%$  run/sprint,  $3.3 \pm 0.8\%$  in sideways movement and  $15.1 \pm 2.5\%$  in backwards movement. On average, there was a transition every 3.7 sec between different activities. Of these transitions, the ratio between high-intensity activities to low-intensity activities was approximately 1:5.3. No significant difference in the percentage time spent performing low-intensity and high-intensity activity between the 1st and 2nd half was observed. Discussion Involvement in elite hurling requires intermittent bouts of complex high-intensity movement patterns interspersed with periods of low-intensity activity. These initial findings indicate that any field based fitness tests or training programmes devised should be both multi-modal and intermittent in nature to simulate the demands of match-play. The current data represent a valuable contemporary characterization of the activity profiles of hurling players and will be of interest to elite level coaches. References

### GAME DEMANDS IN ELITE FEMALE RUGBY SEVENS

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GAME DEMANDS IN ELITE FEMALE RUGBY SEVENS Suarez, L.1,2; Nuñez, J.1,2; Portillo, J.3 Molano, F.1,2 and Mendez-Villanueva, A.4. 1:UPO (Sevilla, Spain), 2:VFsport (Sevilla, Spain), 3:UCLM (Toledo, Spain), 4:Physiology Unit, ASPIRE, Academy for Sports Excellence (Doha, Qatar) INTRODUCTION Rugby Sevens was recently voted one of the new summer Olympic sports and will appear for the first time in the 2016 Olympic Games in Rio de Janeiro. While several studies have investigated the match play demands of rugby union to our knowledge no previous study has described the match activity profiles of female Rugby Sevens players. The purpose of the present study was to describe the match-play demands of professional female rugby players competing in Rugby Sevens matches. METHODS Time-motion analysis of running activity was performed on 12 elite female rugby players belonging to the same national team during 5 competitive matches in a 2-day international tournament. Portable global position system (GPS, 1Hz SPI Elite, GPSports, Canberra, Australia) technology and heart rate (HR) responses were used to assess match running demands and exercise intensity, respectively. RESULTS Mean total distance ( $\pm$  SD) covered over the whole match by all players was  $1556.2 \pm 189.3$  m. Low-intensity activities represented 62.9 % of total time, which consisted of 29.7% ( $462.6 \pm 94.6$  m) standing and walking and 33.2% ( $515.9 \pm 88.6$  m) jogging. Cruising, striding, high-intensity running and sprinting represented 11.6% ( $181 \pm 61.4$  m), 16.4% ( $255.7 \pm 88.3$  m), 3.7% ( $57.1 \pm 40.8$  m) and 5.4% ( $84.0 \pm 64.8$  m) of total time, respectively. The average maximal distance of sprints, number of sprints, minimum distance of sprint and mean sprint distance over the game were:  $25.8 \pm 16.1$  m,  $5.3 \pm 3.2$  sprints,  $6.5 \pm 2.0$  m, and  $17.2 \pm 8.8$  m, respectively. For over 75% of the game, players were exposed to heart rates above 80% of their maximal heart rate. DISCUSSION It has been previously reported that male rugby union (15-a side) players covered a total match distance ranging from 5408 to 6953 m (Cunniffe et al., 2009; King et al., 2009; Roberts et al., 2008). Extrapolating the women rugby 7's playing time to the 15-a side male rugby match duration ( $\sim 83$  min) (Cunniffe et al., 2009) the resulting figure would be a game coverage of  $\sim 8950$  m. Thus, overall running demands appear to be much higher in female rugby 7's than in the male a-15 rugby code. Collectively, these findings provide important information for prescription of training aimed at developing physiological qualities specific to the demands of competitive elite female rugby 7's. REFERENCES Cunniffe B., Proctor W, Baker JS, Davies, B. (2009). J Strength Cond Res, 23 (4), 1195-1203. King T, Jenkins D, Gabbett T. (2009). J Sports Sci, 27 (3), 213-219. Roberts SP, Trewartha G, Higgitt RJ, El-Abd J, Stokes KA. (2008). J Sports Sci, 26 (8), 825-833.

### COMPARISON OF MOVEMENTS DEMANDS OF MATCH PLAY AND TRAINING IN ELITE AUSTRALIAN FOOTBALL

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Introduction Specific training is important for preparing team sport athletes for competition, however, it is unknown if the training reflects current match demands in professional Australian Football (AF). One previous study has shown that during training, AF players spend a greater proportion of time standing, less time running, have similar high-intensity efforts and greater involvement with the ball compared to match play [1]. However since this study was completed, the match demands of professional AF have increased [2]. It is not known if current training practices reflect these increased match demands. Therefore, the purpose of this study was to compare the movement demands of match play and training in a professional AF club. Methods Twenty eight professional AF players (mean $\pm$ SD) age:  $23 \pm 3$  yr) from the same club participated in this study. Data was collected from 14 official AFL matches (132 files) and 70 skill-based training sessions (572 files) during the 2010 season. Player movement was quantified using 5-Hz GPS (MinimaxX, Catapult Innovations) and analysed for mean exercise intensity (m/min), high intensity running (HIR/min:  $>14$  km/h), and very high intensity running (VHIR/min:  $>23$ km/h). Training activities were classified as Kicking, Handball, Ball movement, Game sense, Defensive actions, Positional skill/strategy, and Skill acquisition drills. All training data was coded real-time for separate drills and analysed post hoc using proprietary software. Results The mean exercise intensity during match-play was  $129 \pm 9$  m/min,  $40 \pm 9$  HIR m/min and  $6 \pm 3$  VHIR m/min, respectively. The movement demands of the training sessions were lower than matches and had greater variability (games 9% vs. training sessions 42%). The most demanding training drills were Games Sense Drills ( $129 \pm 35$  m/min,  $24 \pm 13$  HIR m/min and VHIR  $12 \pm 7$  m/min), whilst Positional skill/strategy drills had the lowest movement demands ( $66 \pm 22$  m/min,  $7 \pm 5$  HIR/min and VHIR  $4 \pm 4$  m/min). 72.8%, 17.2% and 9.8% of training drills were lower, similar to, and greater than mean match intensity, respectively. Discussion In agreement with previous research [1], these findings show that most training drills completed by professional AF players were lower than typical match demands and have higher variability. The lower intensities in training drills was most likely due to the time spent coaching and/or the need to develop new technical/tactical abilities at these lower intensities. Coaches can use the present findings to prepare specific training sessions and better control the training process in professional AF. References 1. Dawson, B., et al., (2004) J Sci Med Sport 7: 292-301. 2. Wisbey, B., et al., (2010) J Sci Med Sport 13: 531-536.

## THE TECHNICAL PERFORMANCE OF TOP LEVEL SOCCER GOALKEEPERS DURING THE FIFA WORLD CUP 2010.

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**Introduction** In respect to other field positions, the individual goalkeeper's actions could have a key role in the match's final result. The goalkeeper's performance in soccer, can be associated with two main actions: positioning choices and defense technique selection. The aim of this study was to obtain detailed information about the technical actions and the performance of the top-level goalkeepers. The final purpose was to obtain information in order to organize and design specific training, which would simulate realistic game-like situations. Methods 17 goalkeepers playing in the last 16 matches in the FIFA World Cup 2010 were analyzed with recorded video. The goalkeepers' actions were divided in save (S) if the ball was directed towards the goal, and coming out (CO) if the ball was intercepted or not directed towards the goal. Each action was labelled: hand high (HH), hand low (HL), feet high (FH), feet low (FL). For ball and goalkeeper positions data, the goal was divided in eight rectangles (1.83x1.22mt), the goal area in ten squares (1.83x1.83mt) and the penalty area in five rectangles. Descriptive and statistical analysis were applied. Results 398 total actions (n°276 CO; n°122 S) were recorded (on average n°12.4 actions for each goalkeeper for each match). Saves were n°46 (37.7%) HH; n°66 (54.1%) HL; none FH and n°10 (8.2%) FL. Higher quantities for CO actions: n°135 (48.9%) HH; n°110 (39.9%) HL; n°1 (0.4%) FH and n°30 (10.9%) FL. Goalkeepers suffered 42 goals and in 28.6% of the cases they were positioned outside the goal area. The highest number of goals (n°11) was scored in the left-side-low-corner portion of the goal; and the highest quantity of saves (n°46) happened in the middle of the goal just in front of the goal line. Discussion This study attempted to understand those aspects related to the optimization of soccer goalkeepers' resources and to clarify competition demands. From those findings, goalkeeper performance appears to be particularly interested in catching every ball circulating in the goal zone (goal area or penalty area). This behaviour could enlighten the importance of coming out that represents an excellent solution for team ball possession. Therefore, goalkeepers should be trained with particular attention to catch the ball, also if it is not directed towards the goal, as well as to be able to move fast in short distances. When inside the goal, they should be trained to perform both low and angular saves. References Lamas, Ugrinowitsch, Barrera, (2010). De Baranda, Pilar Sainz, Ortega, Enrique and Palao, José M.(2008).

## QUANTIFYING THE GAP BETWEEN UNDER 18 AND SENIOR AFL FOOTBALL: 2003-2009

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**Purpose** A successful transition from elite Under 18 Australian Rules (U18) teams to professional senior competition depends on synergies among physical, tactical, psychological and maturational factors. The increasing use of notational analysis may assist in quantifying the demands of these two different levels of competition. No studies have compared individual players' movement rate, game statistics and ball speed in U18 and senior competition of the Australian Football League across time. This project compared differences in player movement and ball speed between matches from senior AFL competitive matches and U18 players in the 2003 and 2009 seasons. Methods TrakPerformance Software and Global Positioning System (GPS) technology were used to analyse the movement of players, ball speed and game statistics. Analysis of variance (ANOVA) compared the two levels of competition over time. Results Observed interactions for distance travelled per minute of play ( $p = 0.009$ ), number of sprints per minute of play ( $p < 0.001$ ), time spent at sprint speed in the game ( $p < 0.001$ ), time on field ( $p < 0.001$ ), and ball speed ( $p < 0.001$ ) were found. Subsequent analysis identified increases in movement patterns in senior AFL competition in 2009 compared with the same level of competition in 2003 and U18 players in 2003 and 2009. Conclusions Senior AFL players in 2009 were moving further, sprinting relatively more frequently, playing less time and playing at game speeds significantly greater than the same senior competition in 2003 as well as compared with both cohorts of U18 players.

## THE EFFECT OF RAPID DIRECTIONAL CHANGES ON GPS VALIDITY DURING INTERMITTENT HIGH-INTENSITY ACTIVITY

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**Purpose** Use of the Global Positioning System (GPS) for quantifying the movement demands of high intensity multi-directional activities is increasing. However, GPS device measurement validity has not been assessed using well-validated protocols that incorporate the frequent, rapid changes in direction encountered during intermittent team sports. This study aimed to evaluate the distance measurement precision and reliability of three GPS devices by contrasting protocols with identical speed profiles but dissimilar directional requirements. Method Team sport athletes completed two 90 min trials of the Loughborough Intermittent Shuttle Test activity pattern (Nicholas et al., 2000). One was completed on a 20 m shuttle running track (LIN), the other on a 200 m curvilinear running track (CUR). Distance measured by three GPS devices (position sampling frequency; Device A = 15Hz, Device B = 1Hz, Device C = 1Hz) was assessed for systematic measurement bias, absolute and relative reliability, and epoch error. Results GPS and criterion distance measures differed during both protocols in all devices (all  $p < 0.001$ ). Each device underestimated distance for LIN (relative distance =  $96 \pm 3\%$ ,  $91 \pm 2\%$  and  $50 \pm 1\%$ , for Devices A, B and C respectively) but not for CUR (relative distance =  $103 \pm 1\%$ ,  $104 \pm 2\%$  and  $99 \pm 4\%$ , for Devices A, B and C respectively). Absolute measurement reliability during LIN and CUR protocols was superior for Device A (CV = LIN 2.44%, CUR 2.16%; LOA = LIN  $\pm 453.4\text{m}$ , CUR  $\pm 223.2\text{m}$ ) compared with B (CV = LIN 7.52% CUR 2.65%, LOA = LIN  $\pm 742.7\text{m}$  CUR  $\pm 384.2\text{m}$ ), and C (CV = LIN 46.12% CUR 3.55%, LOA = LIN  $\pm 3474.8\text{m}$  CUR  $\pm 820.4$ ). Conclusion This study shows that rapid directional changes reduce GPS distance measurement validity. Complex multi-directional movement patterns that involve stop-start activities increase within-epoch divergence of scalar and vector movement quantities. The superior measurement validity provided by Device A supports this notion, as the greater measurement resolution provided by a 15Hz position sampling frequency reduced the within-epoch separation of actual device displacement and output distance measures. Therefore it may be inappropriate to use low sampling frequency GPS devices to quantify the movement demands of intermittent team sport and multi-directional physical activity. References Nicholas, C.W., Nuttall, F.E., & Williams, C. (2000). The Loughborough Intermittent Shuttle Test: a field test that simulates the activity pattern of soccer. Journal of Sports Sciences, 18(2), 97-104.

**PHYSICAL AND PHYSIOLOGICAL PROFILES OF TURKISH AMPUTEE FOOTBALL REFEREES**

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Introduction Amputee football is a kind of football whose players are one leg amputees. Although, "activity profiles and physical requirements of soccer referees (SR) have been examined in number of studies" (Krustrup et al, 2009), research for amputee football referees (AFR) were limited. For that reason of limited studies about AFR, this study aim to determined physical and physiological profiles of Turkish AFR. Methods There were 27 Turkish AFR participated to study. Age, height, body weight (BW), somatotype, body fat percentage (BFP), soft lean mass (SLM), flexibility (F), vertical jump (VJ), leg strength (LS) and anaerobic power (ANP) characteristics were determined. VO2max was estimated with BFP formula belonged Wier et al (2006). Descriptive statistic determined by SPSS (ver.13). Results Age of AFR was found  $33,81 \pm 8,50$  years, height  $176,83 \pm 6,33$  cm, BW  $77,77 \pm 10,68$  kg, BMI  $24,93 \pm 2,98$  kg/m<sup>2</sup>, endomorphy  $3,53 \pm 3,32$ , mezomorphy  $4,48 \pm 1,48$ , ectomorphy  $2,18 \pm 1,39$ , BFP  $21,16 \pm 5,57$  %, SLM  $56,43 \pm 5,67$  kg, F  $22,56 \pm 7,92$ cm, VJ  $50,93 \pm 6,09$  cm, LS  $154,46 \pm 21,80$  kg, ANP  $87,57 \pm 15,97$  kgm/sec, VO2max  $43,91 \pm 4,87$  ml/kg-min. Discussion It was not found any study about physical and physiological characteristics of AFR for that reason result of this study was compared with soccer referees. Although Kızılet et al (2010)'s study with Turkish elite SR and Casajus and Castagna (2007)'s study with Spanish elite SR' mean age, height and BW were similar of AFR but BFP of AFR were higher than elite SR. Additionally AFR have higher BFP and similar F and VO2max capacities when compared to Pulur and Yamaner (2004)'s study with lower level Turkish SR. References Casajus JA, Castagna C.(2007) Aerobic Fitness and Field Test Performance in Elite Spanish Soccer Referees of Different Ages. J of Sci and Med in Sport, 10, 382-389. Fox EL, Matthews DK.(1974) The Interval Training Conditioning for Sports and General Fitness, 257-258. Saunders, PHIL. Kızılet A, Kızılet T, Erdemir I, Acet M.(2010) To Determine Anthropometric Characteristics on Different Level Turkish Soccer Referees. Selcuk Univ. J. of PES Sci, 12(2),80-84. Krustrup P, Helsen W, . Randers, MB, Christensen JF, Macdonald C, Rebelo AN, Bangsbo J.(2004)Activity Profile and Physical Demands of Football Referees and Assistant Referees in International Games, J Sports Sci., 27(11): 1167-1176. Pulur A,Yamaner F. (2004) The evaluation of Physical and The Physiological Parameters of Turkish Soccer Classman Referees( Example of Malatya and Diyarbakır). Dumlupınar University J of Social Science, 10,175-182. Wier LT, Jackson AS, Ayers GW, Arenare B.(2006) Nonexercise Models for Estimating VO2max with Waist Girth, Percent Fat, or BMI, Med. Sci.in Sport and Exercise, 38(3), 555-561

**Poster presentations****PP-PM72 Swimming Related Activity****TECHNICAL VARIABLES, STROKE PHASES AND INDEX OF COORDINATION AT AND ABOVE THE INTERMITTENT MAXIMAL LACTATE STEADY STATE IN SWIMMING**

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Introduction In swimming, the prescription of aerobic training, even in long-distance athletes, is done mostly on an intermittent basis, which allows them to be made proportionately greater in intensity than if performed continuously (Maglisho, 1993). This improves performance in intermittent exercise has been attributed to factors such as the removal of lactate (passive and active recovery) and restoration of creatine phosphate (passive recovery). Thereby, the aim of this study was to analyze changes in stroke parameters (i.e., stroke length - SL and stroke rate - SR) and arm coordination (i.e., propulsive and non-propulsive phases and index of coordination - IdC) when swimming at (100%) and above (102.5%) intermittent maximal lactate steady state (MLSSI). Methods Nine male endurance swimmers ( $18.56 \pm 2.13$  yr;  $68.06 \pm 6.48$  kg;  $1.76 \pm 0.64$  m) performed in different days two to four tests of 12 repetitions of 150 s with 30 s (relation effort/rest 5:1) of passive recovery between repetitions to determine the MLSSI, with 2.5% at difference between velocities (Pelarigo et al., 2010). Video analysis was used to determine the SR, SL, stroke phases and IdC. The IdC was determined using the lag times between the propulsive phases of each arm (Chollet et al., 2000). Blood lactate and stroke technique variables were analyzed at 10th and 30th minute swim of each imposed speed test. Results There was significant difference between MLSSI ( $1.26 \pm 0.06$  m.s<sup>-1</sup>) and 102.5% MLSSI ( $1.29 \pm 0.06$  m.s<sup>-1</sup>). SR and SL maintained between the 10th and 30th minute of the test swim have modified significantly at 102.5% MLSSI (SR -  $32.66 \pm 3.42$  and  $33.85 \pm 2.84$  cycles.min<sup>-1</sup> and SL -  $2.40 \pm 0.24$  and  $2.30 \pm 0.17$  m.cycle<sup>-1</sup>, respectively), but there wasn't significant difference between MLSSI. In relation the time effect, all stroke phases maintained at 10th and 30th minute at MLSSI, however, the propulsive phase B increased significantly at 102.5% MLSSI ( $23.0 \pm 3.5$  and  $24.3 \pm 3.3$ %, respectively). In relation the intensity effect (MLSSI and 102.5% MLSSI), there was significant difference in Phase A at 10th and 30th minute ( $38.3 \pm 5.9$  and  $35.5 \pm 6.8$  and  $39.0 \pm 4.9$  and  $34.5 \pm 5.7$ %), in Phase B at 30th minute ( $21.7 \pm 2.8$  and  $24.3 \pm 3.3$ %) and in Phase C at 10th and 30th minute ( $23.0 \pm 2.3$  and  $25.1 \pm 2.7$  and  $23.3 \pm 2.3$  and  $24.8 \pm 2.6$ %), respectively. Conclusions Therefore, the intermittent exercise and the metabolic condition seem influence the stroke parameters (SR and SL) and stroke strategy to maintain the speed during swim intermittent tests lasting 30 min. References Chollet et al. (2000). Int J Sports Med, 21, 54-9. Maglisho EW (1993). Mayfield Publishing Company: 363-388. Pelarigo JG et al. (2010). J Sci Med Sports, in press. Acknowledgments This research was supported by grants from Capes Foundation, Ministry of Education of Brazil.

**FIRST SHOOTING CHOICE AND FINAL EXECUTION IN WATER POLO PENALTY**

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FIRST SHOOTING CHOICE AND FINAL EXECUTION IN WATER POLO PENALTY Papamargaritis, Th., Platanou, T. Department of Aquatic Sports, Faculty of Physical Education and Sport Science, University of Athens Greece Introduction Penalty is a very difficult situation for water polo goalkeepers as it is for all the goalkeepers of the other team sports in which this regulation applies. They have to face the opponent shooter without the aid of another defender player. An important factor for the goalkeeper to avert a goal is his ability to know the direction that he has to move in a relation to the angle chosen by the shooter. This must happened before the implementation of the shootout. The question is if the shooter changes the first decision about where he will direct the ball the time when the ball leaves from his hands. The purpose of the study was to examine whether the angle chosen by the shooter during the execution of penalty, when he is positioned at the penalty spot, coincides with the final angle shoot after the referee's signal. Methods For the purpose of the research took



part 18 water polo players who had at least 10 years' experience in this sport. All the participants were asked to shoot 5 penalties. When the player was positioned at the penalty spot, he informed the researcher about the angle he chooses to shoot. The researcher and the shooter were communicated by using two mobile phones. One of them was connected with a waterproof Bluetooth on shooter's ear. The researcher had the other mobile. Then, the players executed the penalty but they had the choice to change their first decision and shoot to another angle. The researcher noted the default angle that shooter had previously chosen and also he noted the final angle that the shooter directed the ball. All the instructions were given without the presence of the goalkeeper. Goalkeeper was given the direction to make any effort in order to save the goal. Finally, we measured the number of shoots which were executed to the same angle and those which were changed angle and we also measured the percentage relative to the total number of each case. Results Of the total 90 penalty which were executed by the 18 water polo players the 72 penalties (80%) were directed to the angle that the shooters had already chosen to shoot. 12 penalties (13, 3%) were directed at a different angle of this, that they first chose but in the same side of the terminal and 6 penalties (6,7%) were directed at a different side and angle of the terminal. Discussion The initial choice of the angle that the shooter aims to shoot the penalty rarely changes. Therefore, the predictability of goalkeeper to move in the right direction that the shooter has chosen before can avert the goal. Goalkeeper's predictability, in order to move in the right direction that shooter has already picked to shoot can finally avert the goal.

## VISUAL FEEDBACK AND MOTOR CONTROL IN SWIMMING AND WALKING

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Introduction In swimming, sensory-perception is strictly related to the so called "feel of the water" and to the ability in reducing the drag forces. Anyway the visual feedback, that has a basic role in the motor control and learning and that supports the swimmers in displacements along a straight direction when they swim in a lane, does not attend so easily in open water events. This study aimed to analyze the consequences of a visual deprivation both in walking exercise and in swimming. Methods 20 young swimmers, aged 8 to 11 years, participated to the study. After a familiarization to perform the trials at low to middle intensity, subjects underwent three tests both in visual feedback (VF) and in visual deprivation (VD) conditions: 25m front crawl and 25m backstroke in a double-wide lane set; 25m walking along a line in a gymnasium set. They were surveyed: i) stroke length (SL) and stroke rate in the first 10m of the swim tests (i.e. until no deviations were detected); ii) amplitude (PA) and frequency of the path in the first 10m of the walking test; iii) velocity (v) in the first 10m; iv) deviations of displacements from the straight direction; v) limbs dominance, vi) side of breathing in the 25m crawl. Results SL and PA significantly lowered ( $p < 0.05$ ) in VD (SL crawl:  $1.8 \pm 0.27$  vs  $0.97 \pm 0.26$ , m/stroke; SL backstroke:  $1.41 \pm 0.37$  vs  $1.16 \pm 0.25$ , m/stroke; PA:  $1.16 \pm 0.19$  vs  $0.76 \pm 0.17$ , m; VF vs VD, respectively). In VD the velocities also decreased (Crawl: from  $0.87 \pm 0.09$  to  $0.76 \pm 0.22$ , m/s; Backstroke: from  $0.87 \pm 0.17$  to  $0.75 \pm 0.16$ , m/s; Walking: from  $0.93 \pm 0.21$  to  $0.70 \pm 0.19$ , m/s; VF vs VD, respectively). Furthermore, subjects showed significant correlations between the side of the deviation and: 1) the side of breathing in the 25m crawl ( $p < 0.01$ ); 2) the lower limb dominance ( $p < 0.01$ ). Discussion There is evidence that visual deprivation significantly decreased the velocity of the displacements, both in swimming and in walking. The main effect of this deceleration is that the amplitude of SL and PA (i.e. the cinematic variables most related to the motor control and to the technical skills management) shortened. Visual deprivation probably induced subjects to displace more carefully, dropping the intensity of the actions in both the environments. The correlations between the side of the deviations and either the side of breathing in the 25m crawl and the lower limb dominance show that symmetry of the actions highly affects the spatial guidance. It can be concluded that in young swimmers, even in a simple task such as displacing at low to middle velocity for short distance, visual deprivation significantly modifies the output of the movements. References Novák, J. (1982). Swimming direction and visual control. V Congress in Biomechanics and medicine in swimming (Amsterdam, Netherlands). Champaign, IL: Human Kinetics, 345-347.

## GENDER, BLOOD LACTATE RESPONSE, BODY FAT AND AEROBIC PERFORMANCE IN SWIMMING.

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Introduction The performance in swimming, as in other cyclic sports such cycling and running, has been linked strongly to physiological, technical and physical capacities. But, as water locomotion demands more energy per unit distance than locomotion on land (Pendergast et al., 2003), the control of technical level may be important to increase propulsive force and reduce active drag (Kolmogorov & Duplischeva, 1992). Thus, the objective of this study was to verify the effect of gender on blood lactate response ([La]) and body fat percentage (%BF) in the relationship between anaerobic threshold (AnT) and maximal speed of 30 min (S30) in swimming. Methods Twenty-one male and thirteen females swimmers (age =  $15.35 \pm 2.18$  and  $15.33 \pm 1.56$  yr; bodyweight =  $63.40 \pm 12.61$  and  $57.32 \pm 9.64$  kg; stature =  $1.72 \pm 0.91$  and  $1.65 \pm 0.60$  m, respectively) with at least five years of experience in swimming were divided in male and female groups (GM and GF), respectively. GM and GF had similar aerobic performance levels (S30). S30 was determined through a maximal 30 min test, recording the distance in meters, calculating velocity by dividing the distance by time. Blood lactate was analyzed at 10th and 30th minute swim. The AnT was determined by linear interpolation between velocity and lactate concentration obtained in two sub-maximal repetitions of 400 m, assuming a fixed concentration of 3.5 mM lactate. Results The [La] in S30 was higher in GM than GF ( $3.97 \pm 1.46$  and  $2.68 \pm 0.82$  mM), but the %BF was lower in GM than GF ( $13.36 \pm 4.05$  and  $22.23 \pm 6.03$  %BF). There weren't difference between gender about AnT ( $1.19 \pm 0.09$  and  $1.19 \pm 0.06$  m.s<sup>-1</sup>) and S30 ( $1.14 \pm 0.09$  and  $1.13 \pm 0.09$  m.s<sup>-1</sup>) in males and females swimmers, respectively. Conclusion Therefore, some factors that might explain, at least in part, the different blood lactate response observed in female swimmers are muscularity and testosterone concentration, which might be higher in males (Keskinen & Komi, 1993). Moreover, the lower blood lactate response in swimmers could suggest that women may have different metabolic rates of carbohydrate and fat utilization during prolonged exercise. Thus, the blood lactate concentration during S30 seems to depend more of gender than aerobic performance level. References Keskinen KL, Komi PV (1993). J Appl Biomech, 9, 219-226. Kolmogorov SV, Duplischeva OA (1992). J Biomech, 25, 311-318. Pendergast D et al. (2003). Eur J Appl Physiol, 90, 377-386. Acknowledgments This research was supported by grants from Capes Foundation, Ministry of Education of Brazil.

## CHANGES OF THE STREAMLINE POSTURE BY A DIFFERENCE OF THE WATER DEPTH AMONG COLLEGE SWIMMERS

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**Introduction** Recently swimming techniques for competitive swimmers has been analyzed individually at four phases, i.e., the start phase, the stroke phase, the turn phase, and the finish phase. Those analyses provide the understanding of the importance for techniques at start and turn phases, e.g., the streamline and the dolphin kicking, in order to improve the swimming performance. However, those techniques have been usually assessed according to the subjectivity without evidence in many cases. In this study, we assessed the changes of the streamline and water resistance of swimmers according to the difference of the water depth during pulling by the mechanical steady force. **Methods** Subjects were eleven male competitive college swimmers who had reached the national and collegiate levels (two breaststroke, eight freestyle, and one individual medley swimmers). We used a pulling assist system, including the wire line to pull subjects who kept the streamline with the steady force of 65 N for 25 m. These trials were done at two water depths, i.e., from 25 cm to 45 cm (Shallow) and from 80 cm to 100 cm (Deep). At this time, subjects' moving velocity changes were measured precisely with a speed meter built-in the pulling system, and subjects' posture changes were analyzed with a video analysis system. **Results** The differences of mean velocities between at the two water depths were approximately zero for two subjects. However, for the other nine subjects the velocities were smaller at Shallow compared with at Deep. Additionally, the size of the velocity differences was related to the streamline change size because of the water depth change (Wilcoxon rank sum test,  $p < 0.01$ ). Namely, when the angles between the upper body and the legs were larger (the straight streamline changed to be V-shaped), the velocities were decreased ( $r = 0.53$ ). **Discussion** To keep the streamline was easier at Deep than at Shallow, because of the higher water pressure which assisted to keep the posture. It was suggested that the water resistance increased and therefore, the velocity decreased at shallow water for nine subjects. **Conclusion** Our results supported the importance for techniques to keep the streamline straight in start and turn phases, in order to improve the performance.

## INCREASING STROKE RATE IMPROVES ARM COORDINATION AND DECREASES INTRACYCLIC VELOCITY VARIATION IN FRONT CRAWL SWIMMING

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**Increasing stroke rate improves arm coordination and decreases intracyclic velocity variation in front crawl swimming** Yuji Matsuda. 1, Yosuke Yamada. 2, Yasushi Ikuta. 1,3, Shingo Oda. 1 1: Graduated school of Human and Environmental Studies, Kyoto university, Kyoto, Japan. 2: Fukuoka University, 3: Osaka Kyoiku university. **Introduction** Swimming velocity is not stable and fluctuating even in a stroke cycle, and the decreased intracyclic velocity variation (IVV) will lead to swimming efficiency (Barbosa et al., 1996). However, it is not well known what swimming techniques decrease IVV. The purpose of this study were 1) to examine whether manipulating stroke rate (SR) affects the arm coordination (Idc) and IVV and 2) to examine whether using kick affects IVV. **Methods** Eight collegiate male swimmers performed the following two tests (average age:  $21.6 \pm 2.3$  years). Test 1: The swimmers swam at their maximal swimming velocity with imposed stroke rate (SR) (35, 40, 45, 50, 55, 60 cycle min<sup>-1</sup> and ad libitum). Test 2: The swimmers swam at maximal velocity with arm only (A), arm and kick (AK), and arm and fin kick (AF) at imposed SR (45 and 55 cycle min<sup>-1</sup>). Two cameras were used to film the swimmers from the right and left side views with panning. Idc was calculated as the lag time between the propulsive phases of each arm (Chollet et al., 2000). IVV was determined from the coefficient of variation of the head horizontal velocity within one stroke cycle. **Results** Idc significantly increased (Idc: from  $-9.27 \pm 3.68\%$  at SR35 to  $3.03 \pm 0.90\%$  at SR60) and IVV significantly decreased (from  $8.52 \pm 1.22$  at SR35 to  $4.72 \pm 1.63$  at SR60, by 45%) with increased SR. Moreover a highly significant correlation was found between Idc and IVV ( $r = 0.965$ ,  $p < 0.01$ ), suggesting that IVV decreased with increasing Idc. In contrast, there was no difference in Idc and IVV among A, AK, and AF. **Discussion** With increasing SR, Idc was increased and IVV was decreased. The high correlation between Idc and IVV suggest that decreased IVV was induced by increasing Idc. When Idc was higher, there was less non-propulsive phase in a stroke cycle, and the velocity would be maintained in a stroke cycle, which leads to lower IVV. In contrast, there was no difference in IVV among three kick conditions (A, AK and AF). It is confirmed that using kick and fin improved average swimming velocity, but do not affect IVV. The results suggest that the changing arm coordination, but not kicking, affects IVV in front crawl swimming. **Reference** Chollet D, Challes S, Chatard JC. (2000). New Index of coordination for the crawl: description and usefulness. *Int J Sports Med*, 20, 54-59. Barbosa TM, Keskinen K, Fernandes R. (2005). Energy cost and intracyclic variation of the velocity of the center of mass in butterfly stroke, *Eur J Appl Physiol*, 93, 519-523.

## EVALUATION OF STARTING REACTION TIME OF TURKISH SWIMMERS

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**Gumus, M.1, Akalin, T.C.1 1: ZKÜ (Zonguldak, Turkey)** **Introduction** It is well known that race time of winner or loser in swimming competitions sometimes change in a few milliseconds. Starting reaction can play a major role in race time as it is an influential component of swimming. The aim of study was to evaluate of starting reaction time of Turkish swimmers participated to Turkish National Championships. **Methods** In this study, 2328 official competition times of 532 swimmers (218 female, 314 male) who participated in Turkish National Championships 2010 performed in Istanbul, Turkey by permission of Turkish Swimming Federation. Championship was performed in 50 m indoor swimming pool of Istanbul Technical University and the data of starting time -elapsed from the electronic start signal to the moment of last contact- measurements were obtained by SWISS TIMING (OMEGA) that is official partner of FINA. Data were evaluated by using SPSS for Windows 16.0 software and mean values were represented as "arithmetic mean  $\pm$  standard deviation". ANOVA test, student t test, posthoc Bonferroni test and pearson correlation analysis were used for the comparisons between the measurements. **Results** of analysis were evaluated with 95% confidence interval. **Results** Mean starting reaction time (SRT) of all swimmers was  $0.78 \pm 0.07$  seconds. SRT was  $0.81 \pm 0.09$  seconds for female,  $0.79 \pm 0.09$  seconds for male and there was a significant difference between groups ( $p = 0.001$ ). There was a positive and significant correlation between SRT and race distance ( $r = 0.249$ ,  $p = 0.001$ ). In free style swimmers, SRT was significantly lower than the others ( $p = 0.001$ ). SRT was  $0.81 \pm 0.12$  seconds for 13 years old,  $0.81 \pm 0.09$  seconds for 14 years old,  $0.80 \pm 0.09$  seconds for 15 and 16 years old,  $0.79 \pm 0.09$  seconds for 17 and 18 years old,  $0.78 \pm 0.08$  seconds for 19 and over years old swimmers, and there was a negative and significant correlation between SRT and age groups ( $r = 0.101$ ,  $p = 0.001$ ). In championship, there was a significant difference between competition categories by SRT ( $p = 0.001$ ) and SRT was  $0.81 \pm 0.09$  seconds for elimination races,  $0.78 \pm 0.09$  seconds for semi-finals and  $0.79 \pm 0.09$  seconds for finals. **Discussion** In this study mean SRT was  $0.78 \pm 0.07$  seconds. SRT

was reported between 0.6-0.8 seconds in several studies. Accordingly, SRT of Turkish swimmers may be determined as relatively longer than the others. STR is related with performance and success. This study is the first research about SRT of Turkish swimmers and will provide the basis for improving the training techniques and programmes for Turkish swimmers and their trainers. Furthermore, Turkish swimmers and trainers can evaluate their performance for international competitions and monitor their performance improvement by using these measurements regularly. References Mason, B. & Cossor, J. (2000). What we can learn from competition analysis at 1999 pan Pacific Swimming Championships. In proceedings of XVIII Symposium on Biomechanics in Sports, HongKong, 75-82.

### **SOME REMARKS ON THE ACTIVE DRAG IN SWIMMING: AN APPROACH USING SIMPLIFIED MODEL**

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SOME REMARKS ON THE ACTIVE DRAG IN SWIMMING: AN APPROACH USING SIMPLIFIED MODEL Matsuuchi, K.1 1: University of Tsukuba (Tsukuba, Japan) Introduction In human swimming, the drag is equivalent to the propulsion in the averaged meaning. In this context the drag means not static but active drag. Several approaches to measuring the active drag have been proposed (Hollander et al., 1986; Kolmogorov et al., 1992; Xin-Feng et al., 2007). However, it is not clear how to define the active drag or to measure it correctly. Therefore it is impossible to compare the results obtained by the various methods. Our aim is to obtain an understanding on the basic characteristics of the drag. The force exerted on hand affects the motion of trunk, or the center of gravity. The response of the trunk is investigated using a simplified mathematical model. The solutions are obtained both numerically and analytically. Swimming speed and the work done by the force are considered. Methods For establishing the equation of motion it was supposed that the direction of motion is unidirectional, and no rotation of the trunk is taken into account. Moreover the drag is supposed to be proportional to the square of swimming velocity. The equation including the propulsive and drag forces on the right-hand side is derived. The two forces on the right-hand side are both functions of time. The equations are solved numerically and analytically. In the analytical method the variables are expanded into Fourier components. To verify the numerical results the analytical solutions are compared and investigated the time dependence of the drag variations. Results Multiplying the velocity and integrating once the equation with respect to time over a period, we can show that the work done by propulsive force is equal to that by the drag. In other words, the work done by the propulsive force is equivalent with that by the drag. Numerical results show that the active force is strongly dependent on the amplitude of velocity fluctuation. It was found that the numerical results agree fairly well with the analytical result. It is then concluded that in understanding the drag correctly the contribution of fluctuations has to be taken into account. Discussion Estimating the magnitude of active drag in a correct manner has been a main concern in biomechanics in swimming. Confining ourselves to the translational motion, the response to the functional form of propulsive force was considered using a simplified model equation. It was found that the center of gravity can be sensitively responded by the variation of force fluctuation, or velocity variation. References Hollnder AP, De Groot G, Van Ingen Schenau GJ, Toussaint HM, De Best H, Peeters W, Meulemans A, Schreurs AW. (1986). J Sports Sci, 4, 21-30. Kolmogorov SV, Duplishcheva OA. (1992). J Biom, 25, 311-318. Xin-Feng W, Lian-Ze W, Wei-Xing Y, De-Jian L, Xiong S. (2007). J Sports Sci, 25(4), 375-379.

## **Poster presentations**

### **PP-PM73 Artistic and Martial Sports**

#### **THE EFFECTS OF STATIC AND DYNAMIC STRETCHING ON COMPETITIVE GYMNASTS' SPLIT JUMP PERFORMANCE**

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THE EFFECTS OF STATIC AND DYNAMIC STRETCHING ON COMPETITIVE GYMNASTS' SPLIT JUMP PERFORMANCE Harper, E.N., Walsh, M.S., Baldwin, C.C. Miami University (Oxford, Ohio, USA) Introduction In the past researchers, such as Power et al. (2004), have reported that static stretching preexercise has a negative effect on performance variables. Other researchers have since investigated the differing effects on performance between static and dynamic stretching preexercise. Commonly, dynamic stretching proves to have different effects on performance variables than static stretching (for example see Hough et al., 2009). Currently, little research has looked beyond general performance measures, such as running, jumping, and force production. More research studies are needed, particularly those that are sport-specific. The purpose of this study was to evaluate the effects of no stretching (NS), static stretching (SS), and dynamic stretching (DS) on competitive gymnasts' split jump performance. Methods Twelve female competitive gymnasts completed three split jump trials on a force plate with simultaneous motion capture following each stretching protocol. The stretching protocols were preceded by a 5 minute walking warm-up on a treadmill. Each of the stretches were performed on both the right and left leg. The SS protocol consisted of performing a split for 1 min and three modified split stretches for 45 seconds each. The DS protocol consisted of standing forward, backward, and forward-backward combined leg swings (3 sets of 10 each) and a dynamic stretch for the plantar flexors. Results Repeated-Measures ANOVAs were used to access differences between stretching protocols for each of the dependent variables (flight time, max split angle, and change in center of mass height). No statistical significance between the three stretching protocols was found. Discussion This study is one of few to measure the effects of stretching preexercise on sport specific performance variables. These findings conflict with previous research comparing acute dynamic and static stretching, suggesting that both static and dynamic stretching produced negligible differences in split jump performance. It is important to note that the stretches performed by the gymnasts and the amount of stretching was selected specifically to mimic what is commonly done in gymnastics training and to be sensitive to the allocated time athletes typically have to devote to preexercise routines. This is of interest to those presented with the question of what to incorporate into a preexercise warm-up routine to optimize performance. References Hough P, Ross E, Howatson G. (2009). Effects of dynamic and static stretching on vertical jump performance and electromyographic activity. J Strength Cond Res, 23(2), 507-512. Power K, Behm D, Cahill F, Carroll M, Young W. (2004). An acute bout of static stretching: Effects on force and jumping performance. Med Sci Sports Exerc, 36(8), 1389-1396.

## ENERGY EXPENDITURE DURING ARTISTIC GYMNASTIC TRAINING SESSION OF ELITE YOUNG MALE ATHLETES.

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**Introduction** The qualities necessary to achieve high levels of performance in artistic gymnastics are today well defined: power, strength, speed, flexibility and coordination (Jemni et al. 2001). Although a lot of studies evaluated the gymnasts' anaerobic power by means of laboratory tests, such as Wingate, only few studies have been focused on the blood lactate formation or heart rates monitoring during sport-specific situations (Jemni et al. 2003). To our knowledge, there are no studies that had quantified the Energy demands during a typical training session of artistic gymnastic in young elite athletes. The aim of the present study was to quantified the intensity of physical activity (PA) and the Energy Expenditure (EE) of young elite gymnasts during a typical pre-competition training session (TS) and for each gymnastic routines [Vault (V), Pommel Horse (PH), Rings (R), Parallel Bar (PB), Horizontal Bar (HB) and Floor Exercise (FE)]. **Methods** Ten elite Italian young male gymnasts (age  $11.8 \pm 1.6$  yr; stature  $144.1 \pm 1.6$  cm; weight  $38.9 \pm 10.7$  kg) competing in Artistic Gymnastic at the National level were examined in this study. The EE (kcal) was measured continuously during the different phases of the TS and during each gymnastic routines using the SenseWear Pro Armband (SWA). Paired-sample t-tests were used to determine differences in the metabolic equivalent (MET) and EE (Kcal) values between each routines. Results The total time of TS was  $3.2 \pm 1.6$  hours (16% warm up and flexibility, 17% power and strength training; 16% HB; 15.5% FE; 11% PB; 10% PH; 9.5% R and 5% V) and the EE for the entire TS was  $882.2 \pm 155.8$  kcal. The intensity of PA during the different phases of TS ranged from moderate (3–6 METs) to very vigorous (>9 METs). The PA intensity was vigorous for 52.2% of the total time of TS. Among all the gymnastic routines the PH (59.7 s; 8.5 METs; 30.8 kcal) and the FE (78.1 s; 8.4 METs; 32.7 kcal) showed the highest MET and EE values. **Discussion** Physiological studies during artistic gymnastic performance are regrettably few due to its peculiarities in duration and nature of activities. Our results demonstrate that typical pre-competition TS of young elite male gymnasts is a very heavy exercise that required a high intensity level of PA for the most of TS time. This finding could also reflect the high heart rate values reported in previous studies on gymnastic routines (Goswami and Gupta, 1998). The possibility of monitoring variables during normal training by mean of SWA can improve training protocols and control the gymnasts' fitness levels. **References** Goswami A, Gupta S. (1998). J Sports Med Phys Fitness 38, 317-322. Jemni M, Friemel F, Sands W, Mikesky A. (2001). Can J Appl Physiol 26, 442-456. Jemni M, Sands WA, Friemel F, Delemarche P. (2003) Can J Appl Physiol 28, 240-256.

## SPEED AND POWER IN FENCERS OF DIFFERENT LEVELS

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**Introduction** A fast and explosive footwork is regarded as an important precondition for the competition success in fencing, however data have rarely been published. The speed and power especially of the lower limbs should be excellent and better in fencers of higher levels. The aim of the study was the determination of speed and power in fencers of international and national level. **Methods** 8 male German top-level epee fencers (TLE), 17 junior epee fencers of international (JIN) and 30 junior epee fencers of national level (JNA) took part in the study. The measurements were focused on speed at footwork forward (FW\_F), footwork backward (FW\_B), footwork forward and backward with change of direction (FW\_F+B) and 3m-Sprint (3mS). To determine power Counter-Movement Jumps (CMJ) and Squat Jumps (SJ) were performed on a force plate (Quattro Jump, Kistler). Reactive strength index (RI) was determined by Drop Jump (Opto Jump, Microgate). Performance of groups was compared by oneway analysis of variance (ANOVA). Results Fencing-specific movement speed of TLE was higher (FW\_F:  $1.01 \pm 0.07$ s, FW\_BW:  $1.06 \pm 0.02$ , FW\_F+B:  $2.18 \pm 0.08$ s) than in JIN ( $1.08 \pm 0.08$ s,  $1.16 \pm 0.08$ ,  $2.28 \pm 0.13$ s, n.s.) and JNA ( $1.13 \pm 0.09$ s,  $1.23 \pm 0.11$ s,  $2.41 \pm 0.14$ s,  $p < .05$ ), whereas differences in 3mS were not significant. Jumping performance of TLE (SJ:  $49.2 \pm 2.9$  cm, CMJ:  $52.4 \pm 3.5$  cm, DJ (RI):  $3.0 \pm 0.4$ ) was better than for JIN ( $47.2 \pm 5.2$  cm,  $49.7 \pm 5.5$  cm,  $2.8 \pm 0.4$ , n.s.) and for JNA ( $43.3 \pm 5.2$  cm,  $45.8 \pm 5.1$  cm,  $2.7 \pm 0.4$ ,  $p < .05$ ). SJ and CMJ correlate with FW\_F+B ( $r = -.63$ ,  $p < .01$ ,  $r = -.65$ ,  $p < .01$ ). **Discussion** Results emphasize the importance of a fast and explosive footwork for success in fencing. For determining speed in fencers, specific tests that take special requirements (e.g. footwork, change of direction, weapon) into account are more suitable than sprints. Jumping performance correlates with movement speed in fencing which points to significance of power in lower limbs for acceleration, fast change of direction and performing lunge. **References** Felder H (2003). Biomechanische Aspekte und leistungsbestimmende Faktoren beim Fechten, dargestellt am Beispiel des Ausfalls. Sportorthopädie Sporttraumatologie 19, 263-267. Roi GS & Bianchedi D (2008). The science of fencing: implications for performance and injury prevention. Sports Med 38, 465-481. Tsolakakis C & Katsikas C (2006). Long term effects of a combined physical conditioning and fencing training program on neuro-muscular performance in elite fencers. Int J Fitness 2, 35-42.

## 2009 PORTIMÃO RHYTHMIC GYMNASTICS WORLD CUP.SCORES ANALYSIS.

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The performance in rhythmic gymnastics (RG) is evaluated in competition by a final score that includes 3 sub-scores: Difficulty, Artistic and Execution scores. The level of RG performance has been continuously improved in the last years. Those improvements were always ruled by the modifications in FIG (International federation of gymnastics) code of points (Ávila-Carvalho et al., 2008b). The difficulty score represents the body and apparatus difficulty level that the gymnast or the group can achieve (Ávila-Carvalho et al., 2008a). The artistic score main goal is the evaluation of the emotional message projection to the public (and judges) and to display the choreographic idea with an expressive interpretation guided by the following three aspects: music accompaniment, artistic image and expressivity (FIG, 2009). According Lebre, (2007) the main liability of the final score depends on the artistic score. The execution score represent the quality of the performance that the gymnasts can do. In order to understand some of the consequences of the use of the present code of points in RG we analyzed the Difficulty score (D1 and D2) and of the Artistic and Execution score some in the 2009 Portimão RG World Cup Series. All forms and scores from the 47 gymnasts present in 2009 Portimão RG World Cup general competition were analyzed. The departure scores (Ds) for D1 and D2 were registered, as well as the final score (Fs) achieved by the gymnast. The analysis was made for the entire sample in one group, and for the entire sample divided in 3 groups: 1st, 2nd and 3rd part of the final ranking for each apparatus. The descriptive statistics were performed using the average as a measure of central tendency and standard deviation as measures of dispersion. We present also the minimum and the maximum value of data. We also apply a correlation test between D2 and D1 scores and artistic and execution scores. Results: In D1 and D2 scores: a) There was a big difference between the scores proposed by the coaches in the competition forms and the difficulties that judges could identify; b) As lower is the position of the gymnast in the ranking, higher was the difference between the departure and final score, nevertheless those differences are shorter in D2 scores. In execution and artistic

scores: a) The execution and the artistic scores were almost the same for each group of gymnasts (1st, 2nd and 3rd part of the final ranking) for all groups and for all apparatus; b) These results might show one of two situations: or the judges were not evaluating what they suppose to do or the code of points made the judges evaluate twice the same aspects.

### UCHI KOMI VS NAGE KOMI IN A JUDO SPECIFIC TEST AMONG MALE ATHLETES

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**Introduction** There is some lack of scientific information about the utility of technical skills repeated stereotypically in judo training (eg. Uchi Komi & Nage Komi). Notwithstanding, these skills are included in any proposal of Judo valuation. Almansba et al (2007) focused the assessment on UK; while Franchini et al. (2010) have worked on the NK "Judo Special Fitness Test" since 1995. However, to our knowledge, no one has analyzed the relationship between them. In 2009 we developed the Blasco Judo Test, combining UK and NK with some specific RFD-Strength skills (eg. pull-ups, gripping up and down a rope and a final TUM isometric pull-up). The test has already shown to be valid, reliable (Blasco et al. 2010) and able to discriminate regarding the Performance. Our purpose now is to analyze the relationship among UK, NK and other conditional demands, under fatigue, within a time-line structure similar to the contest. **Methods** 24 male Spanish Judo competitors (national e international level,  $10.15 \pm 3.4$  years in competition) age  $21.14 \pm 3.26$ ;  $74.53 \pm 9.79$  kg,  $11.36 \pm 2.10\%$  fat;  $175.78 \pm 6.66$  cm) were tested close to their main competitions. Partial correlations, controlling for age and weight, were used to analyze the relationship between the maximum number of UK achieved in the three series comprising the test vs. the maximum number of NK, Pull-ups, repetitions in the rope, and TUM Isometric Strength. (UK and NK were played twice: techniques for a symmetric and asymmetric opponent). **Results** T Blasco total score (ti):  $211.29 \pm 28.62$  rep; TUM isometric pull-up:  $22.66 \pm 8.61$  s; NKt:  $42.29 \pm 5.61$ ; UKt:  $50.58 \pm 8.26$ ; Rope Gripping-t:  $78.67 \pm 14.24$ ; Pull-ups-t:  $25.54 \pm 8.35$ . While Partial correlation showed significant moderate to big correlations among NK (symmetric, asymmetric, and the addition of both) and all the strength exercises in the test, UK (symmetric, asymmetric and their addition) showed no correlation with NK, pull-ups or the rope exercise. **Discussion** In previous studies, Blasco total score, jointly with total pull-ups, rope ( $p < 0.001$ ), and NK ( $p < 0.005$ ), showed significant differences with regard to Performance. Meanwhile, UK did not show any statistical significance. Partial correlations match the idea of a closer relation among NK and the strength requirements in competition, while UK shows again a different trend. We need further studies to deepen in the meaningful and application of these differences. **References** Almansba R, Franchini E & Sterkowicz S. (2007). *Science & Sports*, 22, 216–223. Blasco-Lafarga C. (2009). Thesis. <http://www.tdx.cat/TDX-0929109-141838>. University of Valencia, Spain. Blasco-Lafarga C, Baydal E, López S, Martínez-Navarro I, Pablos C & Carratalá V. (2010). *Ciencia, Cultura y Deporte* (5), 13 Supl. Franchini E, Takito MY, Kiss MA & Sterkowicz S. (2005). *Biol Sport*; 22(4):315–328.

### CHANGES OF POWER-VELOCITY RELATIONSHIP IN JUDO ATHLETES

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**Introduction** Success in judo requires perfect physical and tactical preparation (Franchini et al., 2005). Professional literature includes a number of works on exercise physiology of male and female judoists (Callister et al., 1991), but there are very few studies concerned with judoists' biomechanics (Buško and Nowak, 2008). The aim of the study was to examine changes of power-velocity relationship of lower extremities during training. **Methods** The study was conducted on eight judo athletes (age  $15.5 \pm 0.8$  years, body height  $173.3 \pm 9.7$  cm, body mass  $69.2 \pm 14.0$  kg and training experience  $7.5 \pm 1.9$  years). Force-velocity (F-v) and power-velocity (P-v) relationship were determined from five maximal cycle ergometer exercise tests, 10 s each, with increasing external loads amounting to 2.5, 5.0, 7.5, 10.0, 12.5% of body weight (BW). There were 2-min breaks between the tests. Three measurements were carried out: before the second preparatory period (I), after the second preparatory period (II) and after the second starting period (III). The results were statistically processed using analysis of variance (ANOVA) with repeated measures (post-hoc Tukey test). **Results** The absolute power output at the load of 2.5, 7.5, 10.0 and 12.5% BW were statistically significant increase after the second preparatory period (II,  $p < 0.05$ ) and after the second starting period (III,  $p < 0.05$ ). The relative power output at the load of 2.5% and 5.0% BW insignificant increased between the measurements I and III by 3.7% and 2.0%, respectively. The relative power output at the load of 7.5% BW increased from  $10.11 \pm 1.10$  W/kg (I) to  $10.58 \pm 0.94$  W/kg (II) and  $10.41 \pm 0.94$  W/kg (III). The relative power output at the load of 10.0% BW was observed from  $10.49 \pm 1.37$  W/kg (I) to  $11.14 \pm 1.04$  W/kg (II) and  $11.06 \pm 1.26$  W/kg (III). The relative power output at the load of 12.5% BW increased from  $9.01 \pm 1.98$  W/kg (I) to  $10.55 \pm 1.60$  W/kg (II,  $p < 0.05$ ) and  $10.43 \pm 0.87$  W/kg (III,  $p < 0.05$ ). **Discussion** The measurement of the maximal static muscle torque and maximal power output of legs yields valuable information that can be extremely useful in judo training planning (Häkkinen, 1989). In our study absolute power output has increased significantly during the analyzed period. When the values of power output are divided per kilogram of body weight significant differences were observed only for the load of 12.5% BW. **Acknowledgements** The study was supported by Ministry of Science and Higher Education (Grant No. AWF - Ds.-134). **References** Buško K, Nowak A. (2008). *Human Movement*, 9(2), 111–115. Callister R, Callister RJ, Staron RS, Fleck SJ, Tesch P, Dudley GA. (1991). *Int J Sports Med*, 12(2), 196–203. Franchini E, Takito MY, Kiss MAPDM, Sterkowicz S. (2005). *Biol Sport*, 22(4), 315–328. Häkkinen K. (1989). *J Sports Med Phys Fitness*, 29(1), 9–26.

### EVALUATION OF TRAINING AND PERFORMANCE IN THAI BOXE

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**Introduction** It is assessed that in the combat sports the best performance highly depends on technical-tactical and energetic features. Therefore particular attention have to be paid in fully understanding this assumption, questioning about the simplest but equally relevant ways to evaluate the peculiarities of the combat actions and to improve the planning of the training and its outcomes. Lehmann's test (1994), analysis of [La] and perceived exertion can be useful methods to exploit. The aim of this study was to examine these pointers and their relations with the performances in Thai-boxers at different level. **Methods** 10 non-competitive (NC) and 10 competitive (C) Thai-boxers volunteered in the study. The Lehmann's test (LT, 4 series of consecutive Jab punches for 6 s, 1 min rest) was twice repeated in two consecutive days. The number of Jab punches (JP), the [La] (by a fingertip blood sample, 3 min post-test) and the perceived exertion (RPE, by the Borg scale, 0–10) were collected. The outcomes of the matches performed by C athletes were also surveyed (victories,  $8 \pm 2.3$ , mean  $\pm$  SD). The reliability of LT, the differences between athletes by level and correlations of results after LT and the performances of the C athletes were accomplished. **Results** In NC, the ICC of JP, [La] and RPE were 0.89, 0.96 and 0.49, respectively. In C, the ICC of JP, [La] and

RPE were 0.87, 0.82 and 0.94, respectively. LT is then reliable both in NC and in C. C performed a significantly higher number of JP than NC ( $43.26 \pm 2.01$  vs  $48.05 \pm 2.95$ ,  $p < 0.01$ ), as well as they showed a lower [La] ( $6.93 \pm 0.92$  vs  $5.63 \pm 0.46$ , mM,  $p < 0.01$ ). No differences were found in RPE. In C, a significant negative correlation was found between [La] and JP ( $\rho = -0.98$ ,  $p < 0.01$ ). Positive correlation was found between the outcomes (victories) in the competitions and JP ( $\rho = 0.86$ ,  $p < 0.01$ ). Discussion In Thai boxers, the Lehmann's test is a proper and useful method to evaluate the ATP-PC System. The results showed that LT is directly related to the training level, then it can be easily employed by coaches as a training support. Furthermore, competitive athletes perform the test better than the non-competitive also thanks to the enhanced economy that their actions allow as a consequence of a more fully-developed technical skills. This economy also combines with the energetic outcomes of the training. The positive correlation between JP and the results (victories) in the competitions confirms that the high intensity of the punches combinations is an essential element in Thai boxe. References Lehmann G., Mosch N., Lilge W., 1994, Untersuchungen zur Struktur der Leistungsvoraussetzungen des Taekwondokämpfers, *Leistungssport*, 24, 3, 21-26. Lehmann G., 1997, L'allenamento della resistenza negli sport di combattimento, *SDS-Rivista di Cultura Sportiva*, 38, 16, 19-25.

## WATER TRAINING IN COMBAT SPORTS

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*UIPASC*

**WATER TRAINING IN COMBAT SPORTS** Distaso, M., 1; Invelito, G., 1; Villani, R., 1 1:Italian Union Trainers of Combat Sports (UIPASC) Introduction The aim of this research was to test a new training method of the rapidity action of the roundhouse kick in combat sports, using the natural resistance of water. Materials and Methods To determine whether the performance of technical movements in the water, could be beneficial also on the rapidity of the technique on the mat, we organized a standardized protocol administered to 20 male athletes practicing kick boxing (years 18/30; height 1,67/1,85 cm; weight 67/90 kg), divided into two homogeneous groups: 10 athletes formed the experimental group, and 10 the control group. Then, to know the initial speed of each athlete, we administered to both groups, the SOK test (Speed of Kick), a system composed of photocells and ergotester that allows us to know the real speed of execution of the roundhouse kick. The experimental group played 12 training sessions in the pool, for a period of one month, in which they performed the technique as quickly as 6 times for 8 series, with both legs. The recovery time between repeats was 2 seconds and 3 minutes between sets. Instead, the control group, continued for the duration of the 12 sessions, only and exclusively the traditional punching bag training. At the end of training in the pool, was administered to two groups, the SOK initial test, to show the actual speed increase. Results After the training period in water, the experimental group showed, in executing the roundhouse kick, times lower than in the control group. The speed improvement obtained in the post-training is to be considered significant. Experimental group (mean: 0.18 sec pre-training, post-training 0.14 sec, difference 31.30%), control group (mean: 0.19 sec pre-training, post-training 0.18 sec; 14.30% difference). Discussion Given the scope for improvement in the experimental group of the speed action of the roundhouse kick, we can say that this training method, based on the water resistance, has given excellent results in terms of increased of speed action, an essential component for the explosive kick in kick boxing. References Villani R., Distaso M., (2003), 8<sup>th</sup> Annual Congress of the ECSS, 233, Salzburg Lehmann, G. (1999). *Leistungssport*, 29, 30-33.

## DIFFERENCES IN THE USE OF TECHNICAL AND TACTICAL ELEMENTS BY WINNERS AND DEFEATED K-1 SUPER HEAVY-WEIGHT FIGHTERS, JAPAN 2010

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**Introduction** What this article aims to do is to identify K-1 fighters' situational efficiency parameters by registering the use of a group of tactical and technical elements applied by the winners and defeated fighters in the Final K-1 Grand Prix Tournament in Japan in 2010. **Methods** The sample consisted of eight top-level K-1 super heavyweight fighter specialised in different contact sports (boxing, kick boxing, karate, muay thai, etc.) fighting according to K-1 rules. Data were collected on the basis of video recordings of seven fights, based on which the K-1 tournament analysis was performed. The collected data were processed using descriptive statistics. Variables were processed using the formula for the technical and tactical elements application efficiency in K-1 fights  $K - 1 = x / Ny \times 100$  %. **Results and discussion** Basic descriptive parameters of technical and tactical elements indicate that the total frequency of punches in the winners at this tournament is 732 or 56.5 %, whereas that frequency in the defeated K-1 fighters is 562 or 43.5 % of the total number of hand techniques used. The winners were dominant in the use of all hand techniques with regard to the defeated fighters. The most frequent punches were the direct punches 414 or 32 % and hooks to the head 257 or 19.8 %. The winners also more frequently used kicks than the defeated fighters. They used them 358 times or 57.4 %, whereas the defeated fighters used them 267 times or 42.6%. The winners most frequently used low circular kicks 204 or 32.5 %, and their application of a large number of technical and tactical elements was more diverse than that of the defeated fighters. The use of basic and advanced defence techniques is more frequent with the defeated fighters 764 or 53.5 %. The same frequency for the winners was 663 or 46.5 %. The winners used offensive tactics and attacking techniques 5 or 71%, which resulted in their victory, whereas the defeated fighters used a defensive and combined tactics. That suggests that they used defensive techniques more than the offensive ones. The manner in which the victory was achieved 4 or 57.1 % by decision, 2 or 28.6% by knock-out, 1 or 14.2 % by forfeit due to injury. That suggests that the offensive and attacking techniques are essential for fighting efficiently in K-1. **Conclusion** The gathered statistical indicators suggest that success in K-1 is determined by the level and structure of a large number of abilities, skills, and characteristics that can be measured and analysed, as well as improved with appropriate means and methods through a fighter's career. References Kapo, S. (2006). Structural Analysis and Model of K-1 Top Level Fighters. Dissertation (In Bosnian). Faculty of Sports and Physical Education, BiH. Valera, D. (1973). (1973). *Karate la competition Paris*: Ed Serdirey

## EFFECTS OF FATIGUE ON TRUNK STABILITY IN ELITE-GYMNASTS

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**Introduction** Training of (factors underlying) trunk stability has been suggested as a means to improve performance and reduce injury risk in athletes. However, up to date there is limited evidence on factors that determine trunk stability in athletes. The aim of the present study was to test the hypothesis that fatigue induced by a series of exercises that represent a normal training effort would lead to a decrement of trunk stability in elite, female gymnasts. Nine girls, all national top-level gymnasts, participated in the study. Participants mean  $\pm$  standard deviation age, height and mass were  $12.4 \pm 2.3$  yrs,  $1.47 \pm 0.12$  m and  $39.0 \pm 12.92$  kg, respectively. Participants and their parents

provided informed consent before participation. **Methods** As a measure of core stability the participants were subjected to a series of balancing tasks before and after a fatigue protocol. The fatigue protocol consisted of four series of five dump handstand exercises on the bar were performed. This set of exercises is comparable to efforts in normal training and competitive events. One balancing task (three trials) was sitting as motionless as possible on a seat, with a feet rest and hands on lap, fixed over a hemisphere to create an unstable surface (Dieën et al., 2010b). The hemisphere was placed on a force plate to track the location of the contact point (CP) of the hemisphere on the force plate. In addition, nine sudden release trials were performed in which the seat was backward inclined over a set angle and suddenly released after which the subject had to regain balance. The sway amplitude and sway frequency in unperturbed sitting were determined from the CP time series and were averaged over the three trials. In addition, the maximum displacement and the exponential rate of recovery of the CP location after the sudden release were determined and averaged over nine trials. **Results** After the fatigue protocol, sway amplitude in the fore-aft direction was significantly increased ( $p=0.03$ ), while sway frequency was decreased ( $p=0.005$ ). In addition, the maximum displacement after the sudden release was increased ( $p=0.009$ ), while the rate of recovery after the perturbation was decreased ( $p=0.05$ ). **Conclusions** Fatigue induced by series of exercises representing a realistic training load caused a measurable decrement in dynamic stability of the trunk in elite-gymnasts. The results of this study suggest that endurance training of trunk muscles is indicated to maintain trunk stability during training sessions and competitive events even in well-trained athletes. DIEËN, J. H. V., KOPPES, L. & TWISK, J. 2010b. Postural sway parameters in seated balancing; their reliability and relationship with balancing performance. *Gait & Posture*, 31, 42-46

## PHYSIOLOGICAL AND HORMONAL RESPONSES TO PERFORMING SIMULATED AND CHAMPIONSHIP TAEKWONDO COMBATS

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**Introduction** Simulated Taekwondo combats have tended to elicit reduced physiological load than equivalent championship Taekwondo combats (Bridge et al. 2009; Butios and Tasika, 2007). The mechanisms that govern this response have not been elucidated. There is evidence to suggest that this phenomenon may be a function of dissonant stress hormone responses in these combat settings (Obminski, 2008). The aim of this study was to compare the physiological and stress hormonal responses to performing Taekwondo combats in simulated and championship settings. **Methods** Ten male Taekwondo black belts (mean  $\pm$  SD, age  $18 \pm 1$  years, body mass  $64.5 \pm 11$  kg, height  $1.77 \pm 0.08$  m) were examined during the first combat in an international championship event and during a simulated combat. The championship combats comprised three two-minute rounds of full-contact combat with one minute separating each round. In the simulated combats, participants performed an exercise protocol that replicated the structure and activity profile (physical workload) performed in the championship Taekwondo combats. The championship and simulated combat trials were separated by a period of two weeks. Participants were instructed to replicate the same warm up and nutritional practices for each combat. Heart rate (HR) was recorded at 5 s intervals during the combats. Venous blood samples were obtained before and after each combat to determine the plasma metabolite and hormone concentrations. **Results** Significantly higher ( $P < .05$ ) HR ( $136 \pm 13$  vs.  $116 \pm 10$  beats.min<sup>-1</sup>), plasma lactate ( $2.6 \pm 0.9$  vs.  $1.2 \pm 0.7$  mmol.l<sup>-1</sup>), and glucose ( $6.7 \pm 0.9$  vs.  $5.6 \pm 1.2$  mmol.l<sup>-1</sup>) concentrations were evident before the championship combats than before the simulated combats respectively. The championship combats also induced higher ( $P < .05$ ) HR during combat than the simulated combats ( $188 \pm 8$  vs.  $172 \pm 4$  beats.min<sup>-1</sup>). Significantly higher ( $P < .05$ ) plasma lactate ( $12.2 \pm 4.6$  vs.  $3.6 \pm 2.7$  mmol.l<sup>-1</sup>), glucose ( $10.3 \pm 1.1$  vs.  $5.9 \pm 0.8$  mmol.l<sup>-1</sup>), glycerol ( $143 \pm 49$  vs.  $78 \pm 21$   $\mu$ mol.l<sup>-1</sup>), epinephrine ( $2.7 \pm 1.7$  vs.  $0.6 \pm 0.2$  nmol.l<sup>-1</sup>) and norepinephrine ( $14.3 \pm 9.4$  vs.  $3.0 \pm 1.1$  nmol.l<sup>-1</sup>) concentrations were evident after the championship combats than after the simulated combats respectively. **Conclusions** The findings of this study demonstrate that championship Taekwondo combats augment the physiological and hormonal responses in comparison to simulated combats. These contrasting physiological and hormonal profiles seem to be mediated primarily by the different stress responses to these combat settings. **References** Bridge C.A. et al. (2009) *Int J Sports Physiol Perform*, 4, 485. Butios S. and Tasika N. (2007) *J Sports Med Phys Fit*, 47, 179. Obminski Z. (2008) *Res Yearbook*, 14, 103.

## Poster presentations

### PP-PM74 Physiology: High Intensity Training

#### EFFECTS OF MAXIMAL AND SUBMAXIMAL TRAINING ON COAGULATION TIME OF NONATHLETE FEMALE STUDENTS

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The aim of the current investigation was to determine of the effects of maximal and submaximal training on coagulation factors (platelet, hematocrite, coagulation time, tromboplastin partial time, and trombine time) of nonathlete female students of college. The reason of this study was lack of adequate information about coagulation in compare of training rates. For this purpose, 10 volunteer students have performed two maximal training (Bruce protocol, running on treadmill until exhaustion) and submaximal training (Bruce protocol, running on treadmill until reaching to 75% of predicted maximal heart rate), separated by 10 days. Blood samples of four situations including fasting, before, immediately and 30 minute after both training has acquired and analyzed. Data has analyzed by analysis of variance (ANOVA) and post hoc test of tukey in significant level of .05. The least significant value is computed and reported by SPSS statistical package. Results have shown that both maximal and submaximal training has no effects on protrombine time and coagulation time. Hematocrite increased significantly after both training. Partial tromboplastin time increased after maximal training and platelet increased significantly after submaximal training. The difference between research results is probably attributed to different training protocol, method and time of coagulation factors measurement, and subjects. It is concluded that special load may be effective in process of coagulation, but also we need to more studies for clear results.

## EFFECTS OF 3 WEEKS OF HIGH INTENSITY INTERVAL TRAINING WITH LOW VOLUME ON SPRINT PERFORMANCE AND PLASMA URIC ACID

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**INTRODUCTION** It has been shown that low volume sprint training on a cycle ergometer increases peak but not mean power output during four all-out 30 s sprints (Burgomaster et al. 2005) after only six sessions. This study investigated whether performing this type of training with a predetermined constant "optimal" pace may improve the effectiveness of this training method. It was also hypothesized that this type of training would reduce purine loss from the muscle, as indirectly indicated by plasma uric acid. **METHODS** Eight university students trained 3 times per week with 1-2 days rest between training sessions for 3 weeks. In every training session the subjects performed four to six 30s bouts on a cycle ergometer at a constant pace of 100 rpm against a resistance equivalent to the mean power output of a baseline Wingate test with 4 min rest between bouts. In the last training session subjects completed four constant pace 30 s sprints against a new resistance equivalent to the mean power output generated in a Wingate test performed 24 hours before that session. Venous blood samples were taken at rest, 0.5h, 24h and 48h after first and last training sessions for uric acid analysis and capillary arterialized samples were taken at rest and 2 min after 2nd and 4th sprint, at the first and last training sessions for lactate determination. Two-way analyses of variance for repeated measures ( $p < 0.05$ ) and a Tukey post-hoc test were used for data analysis. **RESULTS** Mean power output (MPO) during the Wingate test increased significantly by 6.4%,  $p < 0.05$  ( $663.4 \pm 15.3$  vs.  $705.7 \pm 20.3$  W). Also, MPO during each of the repeated four 30 s bouts increased by 6-12%. Blood lactate 2min after the last sprint was significantly higher post-training ( $20.7 \pm 1.2$  vs  $18.3 \pm 1.0$  mmol/L,  $p < 0.05$ ). Repeated sprints caused elevation of uric acid 0.5 and 24 hours after the four sprints and returned to baseline 48 hours after exercise. Training caused a 13-15% decrease in plasma uric acid 0.5 and 24 hours after the repeated sprints ( $p < 0.01$ ). **DISCUSSION** The present study demonstrated that nine sessions of high intensity training at constant pace induced a relatively large increase in mean power output during single and repeated bouts. Furthermore the reduction of uric acid likely represents a training-induced adaptation to minimize the loss of purines from skeletal muscle (Stathis et al., 2006). **REFERENCES** Burgomaster, K. A., Hughes, S. C., Heigenhauser, G. J. F., Bradwell, S. N., Gibala, M. J. (2005). *J Appl Physiol*, 98, 1985-1990. Stathis, C. G., Carey, M. F., Hayes, A., Garnham, A. P., Snow, R. J. (2006). *J Appl Physiol Nutr Metab*, 31, 702-708.

## ACUTE PHYSIOLOGICAL RESPONSE TO INTENSIVE AEROBIC INTERVAL TRAINING

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Training at high running speed improves running economy but yields no effect when training is performed highly anaerobic too frequently (Billat et al., 1999). Intensive aerobic interval training (IAEIT) results in accumulated high running speed with only a small contribution of anaerobic glycolytic energy supply (Christmass et al., 1999). Aim of the study was to analyse the response of heart rate (HR), blood lactate concentration (La) and oxygen uptake (VO<sub>2</sub>) to IAEIT of different running speeds. Only a slight contribution of anaerobic glycolytic energy supply was aimed to mimic the characteristics of slow continuous runs. **Method:** Eight trained male runners (VO<sub>2</sub>max:  $55.5 \pm 3.3$  ml/kg/min) participated in the study. They performed an incremental exercise test (increments: 0.75 km/h very minute) and three randomly assigned IAEIT of 30 min on a treadmill. In SAET work periods of 10 s were separated by 20 s of passive rest. Running speed of work periods was set to gain a mean running speed of 50%, 55% and 60% of velocity at the first lactate turn point (vLTP1). HR and VO<sub>2</sub> were measured continuously. La was analysed every minute during the first 10 min and subsequently every 5 min till the end of IAEIT. For warm up a slow continuous run was performed for 10 min at 0.5 km/h below vLTP1 in all tests. **Results:** Mean running speed at LTP1 and velocity at VO<sub>2</sub>max (vVO<sub>2</sub>max) was  $12.3 \pm 0.4$  km/h and  $19.8 \pm 0.9$  km/h. Running speed of work periods was  $18.7 \pm 0.7$  km/h,  $20.2 \pm 0.6$  km/h and  $22.3 \pm 0.7$  km/h for the different IAEIT. There was no significant difference between vVO<sub>2</sub>max and running speed of work periods at 55%vLTP1. Significant differences were found for HR, La und VO<sub>2</sub> between all three IAEIT ( $p < 0.01$ ). The different IAEIT intensities resulted in La of  $1.09 \pm 0.31$  mmol/l,  $1.57 \pm 0.52$  mmol/l and  $2.09 \pm 0.99$  mmol/l, respectively. La at 50%vLTP1 showed no significant difference to La at the end of warm up and vLTP1 ( $p > 0.05$ ). Depending on IAEIT intensity, VO<sub>2</sub> reaches 71.1%, 80.4% and 85.6% of VO<sub>2</sub>max at the end of very work period. Mean VO<sub>2</sub> was 54.0%, 58.5% and 64.0%, respectively. **Conclusion:** In IAEIT with work periods of 10 s separated by 20 s of passive rest and a mean running speed of 50%vLTP1 gave an overall aerobic metabolism similar to slow continuous runs despite almost maximal aerobic running speed during work periods. **References:** Billat et al. (1990) Interval training at VO<sub>2</sub>max: effect of aerobic performance and overtraining makers. *Med Sci Sports Exerc* 31 (1), 156-163 Christmass et al. (1999) Effect of work and recovery duration on skeletal muscle oxygenation and fuel use during sustained intermittent exercise. *Eur J Appl Physiol Occup Physiol* 80 (5), 436-447

## EFFECTS OF LOW CADENCE INTERVAL TRAINING ON FREELY CHOSEN CADENCE AND GROSS EFFICIENCY IN CYCLING

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**Introduction** Low cadence interval training is a common training method for cyclists. The effect of low cadence training on endurance-performance, and muscle strength is to our knowledge, not investigated. Some studies indicate that the freely chosen cadence (FCC) is decreased and efficiency is increased after strength training. The aim of the present study was to investigate the effects of low cadence training in on freely chosen frequency and gross efficiency during sub-maximal and maximal cycling **Methods** Twenty four highly trained male cyclists' with a VO<sub>2</sub>max  $59.1$  ml·kg<sup>-1</sup>·min<sup>-1</sup> volunteered in the present study. Subjects were randomised into one low cadence training group (Lctg) and one control training group (Ctg). Low cadence training was performed as 5 x 6 min work periods at 40 RPM between 72-82 %HRmax and was performed twice a week for 12 weeks in addition to their usual training programme. Ctg performed their usual training programme and in addition an equal amount of extra training (at FCC) per week as Lctg with a heart rate of 72-82 % of HRmax. At pre and post-test 5 sub-maximal work rates, a 30 minutes time-trial test was performed using a Velotron ergometer (DynaFit Pro, Racermate, USA) in addition to measurements of maximal leg strength. Oxygen consumption was measured using a Jaeger Oxycon Pro in mixing chamber mode (Jaeger, Germany). Gross efficiency was calculated as the ratio between external work rate and metabolic rate. **Results** There were no significant improvements in maximal leg strength in any of the groups. At the 30 min time-trial test average FCC was 100.3 RPM and gross efficiency was 20.0 % at an average work rate of 284 W. By the use of this test, there was no significant change in FCC or gross efficiency. At the sub-maximal workloads, average FCC was 94.7 RPM (stable with increased work rate) and gross efficiency 19.7 % (increasing with increased work rate). Ctg significantly increased FCC from 94.2 RPM to 95.2 RPM and the



gross efficiency was decreased from 19.9 % to 19.6 %. Lctg showed no significant changes. Discussion The present study demonstrates that 12 weeks of low cadence cycling seems to have no effect on FCC or gross efficiency during submaximal cycling and during a 30 min time-trial test. The same training load performed at FCC seems to increase FCC and decrease gross efficiency during sub-maximal cycling which might be negative over long distances. Thus, low cadence training might prevent an energy consuming higher FCC over time in the training process and energy saving results over time compared to only FCC training.

#### FAT OXIDATION RESPONSES TO HIGH-INTENSITY AEROBIC EXERCISE IN ADULTS.

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Introduction: Intensity is an important factor when considering the dose of aerobic physical activity required for gaining a certain health benefit. The purpose of this study was to investigate what effects high intensity aerobic training (HIT) have on maximal oxygen uptake (VO<sub>2</sub>max), total energy expenditure during 30 min at 70% VO<sub>2</sub>max (kcal/30min), fat oxidation (fatox) at 70% VO<sub>2</sub>max and percent body fat (fat%) in adults. The results are presented as preliminary data, as the testing of a control group is in progress. Methods: 9 individuals (age: 44 ± 12, VO<sub>2</sub>peak: 2.98 ± 0.73 L · min<sup>-1</sup>, BMI: 27.3 ± 3.0) volunteered for this study. All subjects were approved to participate in the study after a medical examination. The subjects agreed not to change their diet habits, and the diet was registered before and during the intervention period. The HIT protocol consisted of 4x4 min cycling workouts at intensity between 90-95% Hfmax 3 times per week for 6 weeks. The following pre- and post tests were performed; anthropometrics (weight, height, BMI, body fat percentage), blood samples (blood lipid profiles), and measurements of HR and VO<sub>2</sub> in sub maximal and maximal tests. All physical tests were carried out using a test bike ergometer. The first test was a graded exercise test consisting of 3 x 5 min at a submaximal intensity with increasing workloads for each period. Immediately after this test, a VO<sub>2</sub>peak test was performed using an incremental protocol. After 1 hour of rest the subjects completed 30 min cycling at 70% VO<sub>2</sub>peak, where fatox was measured using indirect calorimetry. Results: After 6 weeks of HIT the subjects had increased their VO<sub>2</sub>peak (9.4%), kcal/30min (6.9%) and fatox (15.6%). Fat% was decreased (8.6%) and bodyweight was unchanged. Practical applications: An important issue in health related research is how physical activity can give health benefits. The results in this study indicate that the effects of training can be influenced by the intensity of work. Further research about more precise intensity-response relationship for a number of specific health outcomes is needed. Helgerud J, Høydal K, Wang E, Karlsen T, Berg P, Bjerkaas M, Simonsen T, Helgesen C, Hjørth N, Bach R, Hoff J. Aerobic high-intensity intervals improve VO<sub>2</sub>max more than moderate training. *Med Sci Sports Exerc.* 2007 Apr;39(4):665-71. Nordby P, Saltin B, Helge JW. Whole-body fat oxidation determined by graded exercise and indirect calorimetry: a role for muscle oxidative capacity? *Scand J Med Sci Sports.* 2006 Jun;16(3):209-14.

#### EFFECTS OF LOW CADENCE INTERVAL TRAINING IN CYCLING

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Introduction Low cadence interval training (40-60 RPM at 72-82 %HRmax) is a common training method for cyclists. The effect of low cadence training on endurance-performance, and muscle strength is to our knowledge, not investigated. The aim of the present study was to investigate the effects of low cadence training in highly trained veteran cyclists on 30 min cycling performance, lactate threshold, VO<sub>2</sub>max and muscle strength. Methods Twenty four highly trained male cyclists age 47.1 ± 5.9 years with a VO<sub>2</sub>max 59.1 ± 4.03 ml·kg<sup>-1</sup>·min<sup>-1</sup> volunteered in the present study. A pre-to post-test experimental design was applied, with a twelve week training intervention. The subjects were randomised into two groups, one low cadence training group (Lctg) and one control training group (Ctg). For the Lctg group, low cadence training was performed as 5 intervals of 6 minutes work periods at 40 RPM and between 72-82 %HRmax, which was performed twice a week in addition to their usual training programme. The Ctg group performed their usual training programme and in addition an equal amount of extra training (at freely chosen cadence) per week as the Lctg with a heart rate of 72-82 % of HRmax. At pre and post-tests; VO<sub>2</sub>max, lactate threshold, 30 minutes time-trial test and maximal leg strength, was tested. Tests were performed on a Velotron bike (DynaFit Pro, Racermate USA). Heart rate was measured using a Polar RS 800 CX, (Kempele, Finland). Oxygen consumption was measured using a Jaeger Oxycon Pro in mixing chamber mode (Jaeger, Germany). Lactate was measured using a Lactate Scout (Biosen, Germany) device. Results There were no significant improvements in maximal leg strength. The Ctg had a significantly improvement in VO<sub>2</sub>max, lactate threshold work rate and VO<sub>2</sub>. The 30 minutes maximal cycling test revealed that the Ctg increased the average performance significantly from 278 W to 295 W and the VO<sub>2</sub> utilisation during this test from 52.8 to 54.7 ml·kg<sup>-1</sup>·min<sup>-1</sup>. Thus, the Lctg group showed no effect of the training period on any parameter. Discussion The present study demonstrates that 12 weeks of low cadence cycling seems to have no effect on 30 min maximal cycling, VO<sub>2</sub>max, lactate threshold or muscle strength. In fact, an equal amount x intensity (training load) of endurance training at freely chosen cadence seems to have more beneficial effects on VO<sub>2</sub>max, lactate threshold parameters and a 30 min time-trial performance test. The higher muscular forces during low cadence training might be fatiguing and negative for the quality of the endurance training at higher intensities.

#### EFFECT OF INTENSE INTERVAL TRAINING ON BLOOD PRESSURE AND HEMODYNAMICS IN SUBJECTS WITH ESSENTIAL HYPERTENSION

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Introduction Roughly 1 billion people worldwide suffer from hypertension and extensive work has been done to evaluate pharmacological and non-pharmacological interventions. Regular physical activity of moderate intensity is known to reduce blood pressure but the effect of high intensity intermittent exercise on blood pressure is less clear. Moreover, the mechanisms behind the blood pressure lowering effects of exercise remain unsolved. Nitric oxide (NO) and vasodilator prostanoids (PGs) are potent vasodilators that contribute to blood pressure regulation. The present study examined the effect of intensive interval training on blood pressure and the role of the NO/PG system in this response. Methods Ten subjects diagnosed with essential hypertension (47±4 years, 171±11 cm, 80±24 kg (S.E.)) and ten normotensive control subjects (46±3 years, 177±8 cm, 76±9 kg), performed 8 weeks of high intensity intermittent exercise training (1 hour cycling sessions 3-4 times per week, ~40% of training time > 80% of heart ratemax). Before and after the training period, the subjects participated in an experiment in which intra-vascular blood pressure and leg hemodynamics were measured at rest and during low, medium and high intensity one-leg knee-extensor exercise. The measurements were performed with and without inhibition of NO and

PGs by infusion of L-NMMA and Indomethacin into the femoral artery. Results Training increased ( $P<0.05$ )  $\text{VO}_2\text{max}$  by  $\sim 10\%$  in both groups and decreased ( $P<0.05$ ) mean arterial pressure by 7 mmHg in the hypertensive group only. The reduction in blood pressure was present both at rest and during all exercise intensities. Blocking the NO/PG system fully reversed the training induced reduction in resting and exercising blood pressure. Discussion The finding of a reduction in blood pressure in individuals with essential hypertension highlights that high intensity interval training is an efficient non-pharmacological intervention. The finding of full reversal of the blood pressure reduction by NO and PG blockade strongly indicates that one or both of these systems is up regulated with training in hypertensive subjects and contribute to the training-induced reduction in blood pressure. Funding: Danish Medical Research Council

## **PRACTICAL MODELS OF HIGH-INTENSITY INTERMITTENT EXERCISE DESIGNED TO DECREASE MUSCLE GLYCOGEN LEVEL**

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**Introduction** The decrease of muscle glycogen contributes to subsequent glycogen supercompensation and enhances exercise-induced gene expression involved with mitochondrial biogenesis. Since reduced muscle glycogen may contribute to the improvement of endurance performance, it is important to establish a simple method for achieving a low muscle glycogen level. Muscle glycogen decrease per unit time was greater in consecutive intense exercise bouts (e.g. repeated Wingate test) compared with low-intensity continuous exercise (LCE). However, because the Wingate test requires extreme physical exertion, such a protocol is difficult to complete, even for athletes. The purpose of this study was to examine the degree of glycogen decrease and physical demand in several practical models of high-intensity intermittent exercise (HIE). **Methods** Nine young subjects participated in three experimental sessions conducted in random order. In two of these sessions, the subjects performed HIE. One of the HIE sessions consisted of 60-second cycling bouts at  $\text{VO}_2\text{max}$  (HIE\_  $\text{VO}_2\text{max}$ ) and another session consisted 75-second cycling bouts at 80%  $\text{VO}_2\text{max}$  (HIE\_80% $\text{VO}_2\text{max}$ ). In both sessions, 12 bouts of exercise were completed with a 4-minute rest between each bout. In the last session, subjects performed LCE, cycling at lactate threshold. The exercise duration of the LCE session was adjusted to match the total work performed during the HIE sessions. Heart rate (HR) was measured during all experiments. The RPE and blood lactate concentration were measured after each bout. To assess muscle glycogen content, muscle biopsies were obtained from vastus lateralis muscle before and after experimental sessions. Result Muscle glycogen decrease was greatest during HIE\_  $\text{VO}_2\text{max}$  ( $57.9 \pm 15.9\%$ ), followed by the HIE\_80% $\text{VO}_2\text{max}$  ( $43.0 \pm 7.4\%$ ), and finally, LCE ( $22.4 \pm 20.4\%$ ). Both HIE protocols were significantly superior to LCE in reducing muscle glycogen ( $p<0.05$ ), but were not different from each other. Blood lactate concentration after each session was highest during HIE\_  $\text{VO}_2\text{max}$ , followed by HIE\_80% $\text{VO}_2\text{max}$ , and finally, LCE ( $7.2 \pm 1.1$ ,  $3.9 \pm 0.9$ ,  $1.1 \pm 0.3$  mmol/L, respectively;  $p<0.05$  for all comparisons). RPE ranged between 13–16 during the HIE\_  $\text{VO}_2\text{max}$  and 11–14 during the HIE\_80% $\text{VO}_2\text{max}$ , while maximal HR corresponded to 79.5 and 71.3% of HR reserve, respectively. **Discussion** The muscle glycogen level after both HIT protocols was similar to that reported after consecutive Wingate tests in previous studies. Thus, both HIE protocols may be effective at decreasing muscle glycogen level. The HR and RPE data during exercise suggest that both HIE protocols may be less strenuous compared with a repeated Wingate test. **In conclusion**, HIE\_  $\text{VO}_2\text{max}$  and HIE\_80% $\text{VO}_2\text{max}$  are practical models of high-intensity intermittent exercise that can decrease muscle glycogen level.

## **Poster presentations**

### **PP-PM75 Physiology: Acute Exercise Response**

#### **VARIATION OF INTRAOCULAR PRESSURE UNDER TWO DIFFERENT INTENSITIES AND VOLUMES OF RESISTANCE TRAINING**

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**Introduction** The association between Intraocular Pressure (IOP) and Physical Exercise has been discussed for several years. However, few studies have been conducted regarding to the association between IOP and Resistance Training (RT). Therefore, the aim of this study was to verify the influence of two different intensities and volumes of resistance training on IOP. **Methods** A population of 19 volunteers ( $21.8 \pm 3.28$  years old) who were athletes and practiced boxing, underwent to two different RT sessions: (S1) 3 sets of 15 repetitions with 60% of one repetition maximum (1RM) using an interval of 30 seconds between the sets, and (S2) 4 sets of 8 repetitions with 80% of 1RM using an interval of 120 seconds between the sets. The IOP measurement was taken by Perkins tonometer before, during and after the RT sessions. All data were described by descriptive tests. The statistical analyses were performed by Shapiro-Wilk Test and ANOVA with Tukey post-test. **Results** There was a reduction in IOP during both RT sessions. However, S1 had a significant reduction in IOP when compared with S2. At the end of session IOP returned to the initial scores, in both sessions. **Discussion** According to metabolic pathway for performing the exercises, it is suggested that in S1 there is greater involvement of the glycolytic metabolism for energy demand due to higher number of repetitions associated with the short time interval between the sets. Whereas, in S2, almost producing energy is of the phosphogen system, due to the short duration of the exercise and long period of recovery of interval between sets. Due to the exercise conditions in S1, there was a higher lactate production than in S2. The increase of lactate and consequent reduction in blood pH has been considered one of the main factors associated with the IOP reduction in anaerobic exercises. Thus, a RT session performed with lower intensity and higher volume can promote greater reduction in IOP. **References** American College of Sports and Medicine. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc.* 2009; 41(3):687-708. Conte M, et al. Variação da pressão intraocular após teste submáximo de força no treinamento resistido. *Arq Bras Oftalmol.* 2009; 72(3):351-4. Kiehl RA, et al. Standardized aerobic and anaerobic exercise: differential effects on intraocular tension, blood pH, and lactate. *Invest Ophthalmol Vis Sci.* 1975;14:782-5. Risner D, et al. Effects of exercise on intraocular pressure and ocular blood flow: a review. *J Glaucoma.* 2009; 18(6):429-36. Vieira G, et al. Intraocular pressure variation during weight lifting. *Arch Ophthalmol.* 2006; 124:1251-4.

**VENTILATORY RESPONSE DURING REPETITION OF SHORT-TERM MAXIMAL EXERCISE**

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Ventilatory response during repetition of short-term maximal exercise Yamanaka R. 1, Yunoki T. 1, Arimitsu T. 1, Afroundeh R. 1, Lian C.S. 1, Matsuura R.2, Yano T. 1 1: Hokkaido University (Sapporo, Japan), 2: Kyushu Kyoritsu University (Kitakyushu, Japan) Introduction Ventilation (VE) increases during intense exercise and remains at a higher level than the pre-exercise value for a period of more than 10 min during recovery from exercise. The increase in VE during and after intense exercise is considered to be a homeostatic function for compensation of acidosis (decline in pH) induced by exercise. Although the decline in pH itself is known to be one of the factors driving breathing, the effect of pH on the ventilatory response during and after short-term maximal exercise (SME) remains unclear. Therefore, in the present study, to determine the effect of pH on the ventilatory response during and after SME, we examined the ventilatory response during and after repeated SME in which the increase in lactate and consequently the decline in pH are attenuated with decrease in muscle glycogen content. Methods Eight subjects performed three SME tests that consisted of SME (100-105%  $\dot{V}O_{2peak}$ -work rate, 120 sec) using a cycle ergometer and subsequent 20 min of recovery. Between SME tests, the subjects also performed 40 min of moderate intensity exercise (ventilatory threshold) with a subsequent 40-60-min period of recovery. Results At the end of SME and during subsequent recovery, blood pH was significantly higher in the 3rd test than in the 1st test. VE during SME and the first 60 sec of recovery was increased by repetition of SME, and VE in the 3rd test was significantly higher than that in the 1st test. During recovery after the first 60 sec, there were no significant differences in VE between the tests. Perceived exertion of legs (PEL) during SME was increased by repetition of SME, and PEL in the 3rd test was significantly higher than that in the 1st and 2nd tests. Although perceived exertion of the whole body tended to be higher in the 3rd test than that in the 1st test at 3 min and 10 min of recovery, there were no significant differences throughout the recovery period. Integrated EMG (IEMG) in the vastus lateralis (VL) during SME was significantly lower in the 3rd test than in the 1st test. MPF of the EMG in the VL during SME was significantly higher in the 2nd and 3rd tests than in the 1st test. Discussion Although the decline in blood pH was attenuated, VE increased with an increase in PEL by repetition of SME, suggesting that VE during SME is affected by PEL rather than by blood pH. Moreover, the increase in recruitment of type II fibers during SME, which was estimated from the increase in MPF of the EMG, could increase VE via a central mechanism that is associated with perceived exertion other than general central command (IEMG). However, VE during the recovery period except for the first 60 sec did not seem to be related to blood pH and perceived exertion.

**SHORT TERM TREADMILL RUNNING ENHANCE BRAIN PLASTICITY**

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Introduction It is well known that physical exercise has an important role for improvement of brain functions, such as mental states and cognitions. Because several studies have reported that alteration of brain functions are closely related to the neuronal plasticity, physical exercise may induce enhancement of brain functions via induction of neuronal plastic changes. However, little is known about the relationship between physical exercise and brain plasticity. In this study, we examine the effects of short term treadmill running on expression of  $\Delta$ FosB protein, which is known to mediate neuronal plasticity, in rats. Materials and Methods Male Wistar rats were used in this study. The rats performed low intensity treadmill running for 30mins per day during 1 day, 3, or 5 straight days. Running speeds were progressively increased from 15m/min to 20m/min. Control rats were placed on non-driven treadmill on equal durations with treadmill running group. We assessed the expression of  $\Delta$ FosB using immunohistochemistry in various brain regions. Results Two way ANOVA revealed the significant main effects for the number of  $\Delta$ FosB expression in striatum between control and treadmill running. Multiple comparison showed that 3days treadmill running induced a significant increase in the number of  $\Delta$ FosB positive cells in the striatum, which have important role for motor activity, compared to that in 1 day treadmill running ( $P < 0.05$ ). 5 days treadmill running also significantly increase  $\Delta$ FosB expression in striatum compared to 1 day, but not 3days treadmill running. Two way ANOVA revealed the significant main effects for the number of  $\Delta$ FosB expression in hippocampus between control and treadmill running. The expression of  $\Delta$ FosB in hippocampus in rats performed treadmill running were significantly higher than that in control rats in all exercise duration. Treadmill running during 5days induced a significant increase in the number of  $\Delta$ FosB positive cells in the hippocampus compared to 1 day and 3 days treadmill running. Discussion The results of the present study showed that treadmill running enhance  $\Delta$ FosB expression in striatum and hippocampus in despite of relatively short exercise duration. The increasing levels of  $\Delta$ FosB with repeated stimulation would result in the gradual induction of significant levels of a long-lasting AP-1 complex, which is hypothesized to underlie persisting forms of neuronal plasticity in the brain. Taken together with the results of this study, it is suggested that even short term physical exercise could improve brain functions via increasing neuronal plasticity, and that  $\Delta$ FosB may play a key role in controlling physical exercise-induced neuronal plasticity in the brain.

**DOES EXERCISE INTENSITY ALONE PROMOTE RUNNING-INDUCED INCREASES IN MUSCLE SPECIFIC CALPAIN-LIKE ACTIVITY AND INDICES OF MUSCLE INJURY?**

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Introduction Despite the link between increased muscle calpain activity and indices of muscle damage with exercise; controversy exists as to which exercise factor(s) may be important in mediating this relationship. Exercise intensity is considered the primary factor in inducing the "calcium-calpain and muscle damage" relationship. Whether total energy expenditure and specific muscles also contribute to the exercise response is not in the literature. The purpose of this study was to determine the effect of low and high energy expenditures at three exercise intensities on rat plasma CK, and muscle activities of calpain-like protease and myeloperoxidase. Methods Male rats ( $306 \pm 24$ g) were assigned to a control and six run exercise groups; each having a different intensity (15m/min, 25m/min and 35m/min) and equated to two different energy expenditure (EE) levels (high or low). Following exercise, muscle calpain-like and myeloperoxidase activities were assayed for soleus (S), plantaris (PL), and v. lateralis (VL) muscles. Blood creatine kinase (CK) activity was also assessed post-exercise. Results Blood CK and muscle protease activities on average increased in a dose-dependent manner in response to intensity ( $r^2 = 0.66$ ), with calpain-like activities being muscle specific. PL calpain-like activities increased ( $p < 0.05$ ) from  $14.1 \pm 4.2$  to  $22.5 \pm 5.5$  U/g wet wt for the 15 m/min group, while the 25 m/min group went from  $17.6 \pm 4.4$  to  $33.8 \pm 7.2$  U/g wet wt ( $p < 0.05$ ). Comparable results were found with the vastus lateralis muscles. In contrast, the responses to EE varied with PL having larger (33%) increase to HEE, while the response for VL was greater to LEE (44%). The S did not respond to exercise conditions in any systematic manner ( $p > 0.05$ ). Discussion

Skeletal muscle protease (calpain-like) activity increased with exercise: a) at both EE but the magnitude of the response at LEE and HEE was muscle specific; and b) at all intensities with  $PL > VL > S$ . Skeletal muscle protease activity and plasma creatine kinase activity were positively related across all energy expenditure and exercise intensities. Skeletal muscle protease and myeloperoxidase activities were generally not related across all energy expenditure and exercise intensities, although responses were muscle specific  $VL > PL > S$ . In summary, any studies examining the "calcium-calpain and damage" framework must consider not only the intensity of the loading but also its EE before definitive conclusions about the relationship between muscle protease activity and muscle damage can be offered. Supported by NSERC Canada

### EXERCISE INFLUENCE ON THE AMPHETAMINE-DEPENDENT BEHAVIOUR AND DOPAMINE IN STRIATUM, FRONTAL CORTEX AND HIPPOCAMPUS

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**Introduction** The dopaminergic mesocorticolimbic and nigrostriatal systems are considered to be involved in drug addiction. However, there is little information about the effect of exercise on addiction and on the synthesis, metabolism and action of dopamine (DA) in the central nervous system, in the presence of amphetamines (Marques et al., 2008). Therefore, this work aimed to verify the influence of exercise on addiction using an amphetamine (AMPH)-induced conditioned place-preference (CPP) in rats, and to determine DA and respective metabolites (DOPAC, HVA) in striatum, frontal cortex and hippocampus. **Methods** Adult male Sprague-Dawley rats were randomly separated in two groups: one with and another without exercise, which consisted in a 8 weeks running program in a treadmill, with increasing intensity. The group with exercise trained 5 days per week, beginning with 6 cm/sec and finishing with 50 min (warming + 45 min at 54 cm/sec and 15% of slope). The CPP test was performed in both groups using the procedure and apparatus previously described. There were three phases: 1st phase - Pre-conditioning: free access to both compartments, 20 min sessions with registration of the time spent in each compartment; 2nd phase - Conditioning: 8 consecutive days (45 min sessions) in the alternated compartments (4 days of 2 mg/kg AMPH alternated with saline injections); 3rd phase - Test day: free access to both compartments, 20 min sessions with registration of the time spent in each compartment. Animals were sacrificed 24 h after the last AMPH or saline, and striatum, hippocampus and frontal cortex were dissected for DA and metabolites measurement by HPLC with coulometric detection. **Results** Since in the pre-conditioning phase none of the animals presented preference for a compartment, all the animals were used in the study. The group without exercise showed preference for the compartment associated with AMPH ( $p < 0.05$ ), being the opposite observed with the animals with exercise. In the striatum and frontal cortex, AMPH decreased DA content; training and AMPH reduced DA and metabolites, whereas training alone did not induce significant changes. However, training increased DA and metabolites in the hippocampus, inhibiting the AMPH-induced DA reduction. **Discussion** According to these results, chronic exercise may prevent the AMPH-seeking behaviour in this animal model but not significantly changes the impact of AMPH on striatal and frontal DA synthesis. Data also suggest that exercise may correlate with changes in DA dynamics in hippocampus. **References** Marques E, Vasconcelos F, Rolo M R, Pereira F C, Silva A P, Macedo TR, Ribeiro C F. (2008). *Ann N Y Acad Sci*, 1139, 222-231.

### INFLUENCE OF EXERCISE ORDER ON THE ACUTE HORMONAL RESPONSES TO CONCURRENT TRAINING

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**Introduction** Rises in the levels of circulating cortisol (COR) and the consequent imbalance in anabolic hormones due to large training volumes can produce an unfavorable environment for the development of muscle mass, becoming a cause for the interference effect of concurrent training (CT). This study analyses the influence of exercise type order on the acute response of total testosterone (TT) and COR during and after a CT session. **Methods** Ten strength-trained men ( $23.5 \pm 0.9$  years;  $174.8 \pm 4.9$ cm;  $77.5 \pm 4.8$ kg;  $15.8 \pm 2.7\%$  fat mass) randomly performed two different CT sessions separated by 1 week: aerobic exercise (AE) following strength exercise (SE) (SE-AE) or AE preceding SE (AE-SE). SE lasted about 30 minutes and consisted of three sets of eight repetitions at 70% of 1 maximal repetition (90s resting between sets) for four exercises: bench press, squat, lat pull down and knee extension. AE consisted of 30 minutes of continuous exercise on a cycle ergometer at 75% of maximal heart rate. Blood samples were obtained before (pre), in between AE and SE and after (post) the training sessions to determine TT and COR concentration. **Results** There were no significant differences in the TT and COR resting levels between the different experimental days. TT increased after the first exercise type in both exercise orders, but post-TT remained significantly higher than pre-TT only in AE-SE ( $P < 0.01$ ). The TT variation after the first exercise type was higher than the observed after the second (SE-AE: 22.3 vs. -12.9%; AE-SE: 31.8 vs. 7.6%;  $p < 0.05$ ) and TT total variation (after the CT session) was significantly higher in AE-SE than in SE-AE (41.4 vs. 3.3%;  $p < 0.01$ ). COR levels increased after the first exercise type and returned pre-levels after the second exercise type in both situations. No significant differences between exercise orders were found in total variation of COR (AE-SE: 12.6%; SE-AE: 8.2%) and the variation during the first exercise type was significantly higher than during the second (SE-AE: 10.6 vs. -2.1%; AE-SE: 11.5 vs. 1.1%;  $p < 0.05$ ). **Discussion** The results showed that the order in which the types of exercise are performed during a CT session can influence the acute testosterone response, with the AE-SE session showing a greater relative increase after the training session, which was not observed in COR. Based on the relationship between acute hormonal responses and chronic neuromuscular adaptations to strength training suggested in the literature, this could be positive for the optimization of muscle hypertrophy in the long term. However, the extent of the importance of this response in chronic adaptations to CT remains speculative.

### COMPARISON BETWEEN ENDURANCE AND STRENGTH EXERCISE EFFECTS ON TISSUE TRIGLYCERIDES IN RATS

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**COMPARISON BETWEEN ENDURANCE AND STRENGTH EXERCISE EFFECTS ON TISSUE TRIGLYCERIDES IN RATS** MELLO, M.A.R., BOTEZELLI J.D., DALIA, R.A., GHEZZI, A.C., CAMBRI, L.T., MOURA, L.P. 1: UNESP (Rio Claro-Brazil) **Introduction** Physical exercise is a powerful weapon used to reduce adiposity in human beings and in rats (Gaesser; Brooks, 1975). However, few studies address the effects of different exercise protocols on tissue triglyceride content. The aim of this study is to analyze the effect of strength and endurance training on the triglyceride content in the liver and in the adipose tissue of different regions, in rats. **Method** Twenty four male Wistar (120 days old) rats were randomly separated into three groups with eight rats per group: C (control sedentary), S (strength exercise) and E (endurance exercise). The animals of E group performed a minimum lactate test (ML) (Voltarelli et al., 2002) to identify the individual aerobic/anaerobic metabolic

transition during swimming exercise and were subjected swimming endurance training at 80% of ML intensity, one hour/day, five days/week. The S group was subjected to a strength training protocol consisting in four series of 10 jumps in the water separated by 10 minutes of rest, five days/week (Rogatto et al.). The animals were trained during 7 weeks. At the end of the experiment, they were killed by sodium thiopental administration to evaluate the triglyceride content (mmol/mg) in the liver and in the mesenteric, retroperitoneal and subcutaneous adipose tissue (Nogueira et al., 1990). The results were statistically analyzed by one-way ANOVA and the significance level was set at  $p \leq 0.05$ . Results Liver triglyceride content was higher in E group compared to C group: C =  $6.4 \pm 1.9a$ , S =  $9.2 \pm 2.7ab$ , E =  $9.9 \pm 1.5b$ . Mesenteric triglyceride content was lower in E and S groups compared to C group: C =  $15.6 \pm 0.6a$ , S =  $11.9 \pm 1.2b$ , E =  $10.1 \pm 2.4b$ . Retroperitoneal triglyceride content was lower in E and S groups compared to C group: C =  $20.3 \pm 5.4a$ , S =  $11.1 \pm 2.1b$ , E =  $10.9 \pm 4.0b$ . Subcutaneous triglyceride content was lower in E and S groups compared to C group: C =  $28.4 \pm 5.9a$ , S =  $16.5 \pm 1.5b$ , E =  $16.7 \pm 2.0b$ . Different letters indicate statistical difference. Conclusion: Both exercise protocols had beneficial effects on fat tissue depots of rats, since they equally reduced the triglycerides content in the adipose tissue. However, rats trained by the endurance protocol showed high values of triglycerides in the liver. Further studies are required in order to understand the alterations imposed by different exercise protocols on body fat distribution. Support: Fapesp, CAPES and CNPq. References: Gaesser GA, Brooks GA (1975). *Journal of Applied Physiology* 1975; 38 (6): 1132-1139. Nogueira DM (1990). *Clinical Biochemical methods*. Pancast, editor. São Paulo 1990. Rogatto GP et al. (2004). Acute metabolic responses of Wistar rats to the intermittent jump exercise. *Motriz*, 10 (2), 61-66. Voltarelli FA, et al. (2002). *Br J of Med Biol Res*, 35(11), 1389-94.

## ACUTE METABOLIC RESPONSES ASSOCIATED WITH STRENGTH AND HYPERTROPHY-TYPE WORKOUTS CORRECTED FOR PLASMA VOLUME CHANGES

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Introduction Information on the acute metabolic responses to resistance exercise (RE) may provide valuable information regarding peripheral fatigue factors. However, most studies have examined a relatively narrow range of metabolic responses to different RE workouts. In addition, much of the research has not accounted for plasma volume (PV) changes. This study compared a wider profile of metabolic responses following strength (STR) and hypertrophy-type (HYP) back squat workouts, when corrected for PV changes. Methods Following one repetition maximum (1RM) testing, seven trained males ( $23.6 \pm 2.7$  years) completed a STR workout (4x6 repetitions, 85% 1RM, 5 min rest intervals), a HYP workout (4x10 repetitions, 70% 1RM, 1.5 min rest intervals) and a control condition (CON) in a randomised cross-over design separated by at least 48 hours. Capillary blood samples were taken pre- (-20min, -10min, 0min) and post-exercise (+0min, +10min, +60min) in order to measure concentration of blood lactate (BL), electrolytes, haemoglobin (Hb) and haematocrit (Hct). The samples were analysed using a blood gas CO-Oximeter and electrolyte analyser (GEM Premier 4000). Following calculation of PV changes from Hb and Hct, variables were corrected using the method of Kraemer & Brown (1986). A two-factor within subjects ANOVA was employed for statistical analysis. Results Average PV changes were  $-8.05 \pm (11.45\%)$ ,  $-8.02 \pm (6.54\%)$  and  $-3.32 \pm (6.97\%)$  for the STR, HYP and CON conditions respectively. Repeated contrast tests revealed a significantly ( $p < 0.05$ ) greater increase (at +0min) in BL concentration following the HYP condition ( $1.40 \pm 0.32$  mmol/L-1 to  $12.16 \pm 3.74$  mmol/L-1) than the STR ( $1.66 \pm 0.44$  mmol/L-1 to  $8.31 \pm 2.95$  mmol/L-1) or CON ( $1.55 \pm 0.80$  mmol/L-1 to  $1.15 \pm 0.59$  mmol/L-1) conditions, this was also evident at +10min. In addition, the HYP workout resulted in significantly greater ( $p < 0.05$ ) gains in sodium (10.96%), chloride (6.32%) and calcium (12.27%) at +0min than the CON condition. Discussion PV changes were similar to those reported previously following RE (Wallace et al. 1990). The significant increase in BL concentration following the HYP workout is consistent with previous observations (McCaulley et al. 2009); however, the novel finding was the increase in the concentration of a number of electrolytes following the HYP condition. In this respect, the data highlight the need to consider electrolyte responses for a better understanding of the peripheral fatigue factors and long-term changes associated with HYP workouts. References Kraemer, R.R. & Brown, B.S. (1986) *Eur J App Phys*, 55, 579-584 McCaulley, G.O., et al. (2009) *Eur J App Phys* 105(5), 695-704 Wallace, M. et al. (1990) *J of App Sport Sci Res* 4(4): 154-159

## ENERGY COST DURING LEG PRESS AND CURL SCOTT EXERCISES

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Magalhães N.1; Vencesbrito A.1,2; Brito J.1,2 1 Sport Sciences Research Laboratory of Sport Sciences School of Rio Maior (Rio Maior, Portugal) 2 Center of Research in Sports, Health and Human Development (CIDESD, Vila Real, Portugal) Introduction Strength training has had an exponential increase in the number of practitioners. Consequently, it has become essential to research more about its physiological effects, since several scientific communities support the need for strength training to improve health and functional capacity. The aims of this study were to assess the energy cost (EC) in Leg Press (LP) and Curl Scott (CS) exercises through the relationship between oxygen consumption (VO<sub>2</sub>) and external load, and to determine the aerobic and anaerobic contribution for the intensities of 60% and 85% of 1 maximum repetition strength test (1RM). Methods Twelve trained subjects (6 male, 6 female mean  $\pm$  SD age  $24.67 \pm 3.55$  years, height  $1.68 \pm 0.09$  m, weight  $66.87 \pm 14.11$  kg) performed the LP and CS exercises for a 5-minute period at the intensities of 20%, 25%, 30% and 35% of 1RM. For the 60% and 85% of 1RM the subjects performed their maximum number of repetitions. VO<sub>2</sub> was assessed with a portable gas analyser and the maximum value of lactate post-exercise (Lacmax) at 60% and 85% 1RM was also determined. Equations to predict EC for both exercises were calculated using linear regression. Results EC can be estimated in CS and LP exercises, respectively, by the following equations:  $Y = 12.101 + 1.541X$ ,  $R = 0.617$ ,  $R^2 = 0.380$ ,  $S_{xy} = 4.52$ ;  $Y = 13.048 + 0.795X$ ,  $R = 0.636$ ,  $R^2 = 0.405$ ,  $S_{xy} = 4.24$ , where Y corresponds to VO<sub>2</sub> and X is the percentage of 1RM. The predicted EC for CS at 60% and 85% 1RM was 15.86 and 20.64 ml-1kg-1min-1, respectively, with an accumulated VO<sub>2</sub> (AcVO<sub>2</sub>) of 13.72 and 13.69 ml-1kg-1min-1, respectively. This corresponds to an anaerobic contribution of 13.4% and 33.6%, respectively. The predicted EC for the LP exercise at 60% and 85% 1RM was 32.43 and 43.70 ml-1kg-1min-1 with an AcVO<sub>2</sub> of 20.15 and 18.06 ml-1kg-1min-1, respectively. This corresponds to an aerobic contribution of 37.8% and 58.4%, respectively. There was a significant difference in Lacmax between both exercises and between the different intensities, but no significant relationship between defO<sub>2</sub> and Lacmax were verified. Discussion The results imply that this method of extrapolation has the tendency to indicate higher EC values than those actually measured. However, there are some possible limitations due to the lack of linearity between work and VO<sub>2</sub> at higher intensities, in the repetition rate of each subject, which fatigue may alter (Robergs et al. 2007). It was also observed that the subjects would hold their breath while performing the exercises at the highest loads (mainly at 85% of 1RM), which may consequently alter the data collected by the gas analyser. References Robergs RA, Gordon T, Reynolds J, Walker TB, (2007). *J Strength Cond. Res.*, 21(1):123-130.

**AEROBIC WORK CAPACITY IN JAPANESE MIDDLE-AGED RECREATIONAL CYCLISTS**

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**Introduction** Recently, the recreational cycling becomes increasingly popular to prevent to lifestyle related disease such as diabetes and improve physical fitness in Japan. Cycling is one of the representative non-impact type exercise, and many people can cycle over prolonged duration irrespective of age and sex. However, the available data of the aerobic work capacity in Japanese recreational cyclists are only few. Therefore, we aimed to clarify the aerobic work capacity of Japanese middle-aged recreational cyclists. **Methods** Subjects were thirty-three healthy Japanese recreational cyclists aged 18-63 years old (29 males and 4 females). They usually enjoyed cycling 2-3 days/week over 120-240 km/week. Age and physical characteristics of male and female subjects were  $42.8 \pm 11.1$  and  $38.0 \pm 10.3$  yr,  $171.8 \pm 4.7$  and  $154.7 \pm 5.9$  cm,  $64.9 \pm 6.7$  and  $48.0 \pm 4.7$  kg, respectively. The male subjects were divided into 4 groups by ages; less than 30yr (U30, n=4), 30-39 yr (30G, n=5), 40-49 yr (40G, n=12), above 50 yr (50G, n=8). They performed a maximal exercise test using a cycle ergometer at 60 rpm. During the exercise test, heart rate (HR), oxygen uptake (Vo2) and blood lactate (La) were measured. Vo2 peak obtained individual during the exercise test was considered as Vo2 max. **Results** The mean Vo2max and HRmax of male and female subjects were  $52.1 \pm 7.2$  and  $46.5 \pm 4.8$  ml  $\cdot$  kg $^{-1}$   $\cdot$  min $^{-1}$ ,  $185 \pm 10$  and  $183 \pm 9$  bpm respectively, and declined with aging (56.6, 54.2, 51.3, 49.7 ml  $\cdot$  kg $^{-1}$   $\cdot$  min $^{-1}$  and 194.8, 191.0, 185.3, 177.5 bpm for each group). Vo2 at lactate threshold (LT) was also declined with aging (34.8, 30.7, 30.6, 30.7, 28.3 ml  $\cdot$  kg $^{-1}$   $\cdot$  min $^{-1}$ ), but there was no age-related changes in %Vo2max at LT (60.7, 56.5, 59.1, 61.2, 60.3%). **Discussion** Previous studies demonstrated that Vo2max declines with aging and the lack of physical activity. In this study, however, Vo2max of 40G and 50G was 38.5 % higher compared with the reference values that of age-matched Japanese people<sup>1)</sup> and the same level as joggers in 40-60yr<sup>2)</sup>. Vo2 at LT was 63 % higher than that of sedentary Japanese in 50yr and equivalent to joggers in 40-60yr<sup>2)</sup>. Especially, Vo2max and HRmax in 50G were comparable to that of Japanese adolescents on treadmill running. These results indicate that regularly cycling of 2-3 days/week over 120-240km in middle-aged men might stimulate their cardiorespiratory functions and contribute to improving their aerobic work capacity to higher level. **Reference** 1) Exercise and Physical Activity Reference for Health Promotion 2006 (EPAR2006) J Epidemiol. 17(5): 177, 2007 2) Takeshima, N et al. Maximal oxygen uptake and lactate threshold in middle-aged and older runners: with special reference to aging. Jpn J Phys Fit Sports. 38(5): 197-207, 1989.

**Poster presentations****PP-PM76 Sports Medicine: Injury****DEVELOPMENT OF A METHOD OF MEASURING AMOUNT OF TAPE LOAD DURING SIDE-STEP AND LANDING MOVEMENTS**

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**Introduction** Taping is a common practice to prevent sports injuries. Although there have been several studies done on taping, a method to quantitatively measure the effect of ankle taping during sports tasks remains not to be established. The purpose of this study was to develop a method of measuring the amount of mechanical load on one stirrup tape strip for braking foot inversion during side-step and landing movements, and to evaluate the usefulness of this method. **Methods** The subjects were 5 basketball players, who had on average 9.2 years' experience. For the measurement protocol, a KFG5-120 strain gauge (Kyowa Electronic Instruments Inc.) was bonded to 38 mm widths of white tape (Johnson & Johnson Inc.). One calibrated tape strip was applied to the player's lower limb, opposite the dominant leg, passing over each center of the lateral and medial malleoli as stirrup tape. For the sports tasks, side-step and landing movements were selected because they are responsible for 30% and 45% of ankle injuries, respectively. The players carried out the side-step, plus a 3 m run-up and lateral landing from 20 cm in height on a force plate (AMT Inc.). The force plate and strain force on the taping were set to a sampling frequency of 1000 Hz. The timing for the tape strip during sports tasks was identified from the phase of ground reaction force in a horizontal direction, as measured using a force plate. **Results** The amount of tape load while winding the tape strip on the lower limb reached a maximum force of 6.4 (4.8-10.7) kg, and then stabilized at 3.5 (2.9-5.0) kg. The tape load during the side-step was 5.3 (2.8-10.1) kg. The tape strip was timed as working 0.017 (-0.005-0.074) seconds later than the ground reaction force in a horizontal direction. The amount of tape load during lateral landing was 4.3 (2.0-9.2) kg. The tape strip was timed as working 0.017 (-0.246-0.148) seconds sooner than the ground reaction force in a horizontal direction. **Discussion** This study measured the amount of mechanical load on one stirrup tape strip during sports tasks. The timing of the tape strip working during sports tasks followed the phase of ground reaction force in a horizontal direction. Therefore, this method should prove useful as a method for measuring the amount of mechanical tape load. In further studies we hope to measure the braking force and the sustaining force during appropriate ankle taping using this method. It is thought that this will help to develop an effective taping method for the prevention of ankle inversion sprains in sports activities.

**COMPARISON OF PRE AND POST EXERCISE ANTERIOR TIBIAL COMPARTMENT PRESSURES ON NATURAL GRASS AND ASPHALT**

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**Introduction** Different running terrains seem to have an influence on the prevalence of developing musculoskeletal injuries. Previous experimental studies have attempted to examine the type of surface, its impact on the locomotor system correlated to the type and incidence of injuries, without being conclusive so far. Comparison of the pre- and post- exercise anterior tibial compartment pressures in two different types of surface (natural grass and asphalt) in asymptomatic recreational athletes. **Methods** Forty-five healthy male participants, aged 28  $\pm$  5 years old, with 5  $\pm$  2 years of running experience underwent the experimental procedures. The participants were evaluated before and immediately after a 5km distance, while running at 10 km/h for the whole distance. The speed was fixed because its control was essential for the reproducibility of the results. All participants were free from injuries of the lower leg for the last 12 months.

The athletic equipment was the same for every participant during the experimental procedures. Intra-compartment pressure measurements were recorded 1 minute before and at the first minute after the onset of exercise. The wick catheter technique was the method of choice for measuring intracompartmental pressure values. All pressure values were compared by ANOVA for repeated measures. Results Statistical analysis of the data indicated that all participants, both those on natural grass (pre- 8.17mmHg, post-15.4mmHg) as well as those on asphalt (pre- 8.75mmHg, post-18.3mmHg), presented statistically higher ( $p < 0.05$ ) intra-compartment pressures immediately after the completion of exercise respect to the values of the pre- exercise measurements. Special concern should be given on the participants exposed on the asphalt terrain where values of 18.3mmHg were recorded after the completion of the exercise, illustrating a statistical significant difference ( $p < 0.05$ ) compared to the values of those who exercised on natural grass. Discussion The results confirm that running on a rigid surface, such as asphalt, may be an additional factor of increased risk for presentation of pathological anterior tibial compartment values and possible exertional compartment syndrome (CECS) development. References Baltopoulos P, Papadakou E, Tsironi M, Prionas G. (2008). Pre, during, and post exercise anterior tibial compartment pressures in long distance runners. *Journal of Sports Science and Medicine* 7, 96-100. Blackman, P.G. (2000). A review of chronic exertional compartment syndrome in the lower leg. *Medicine and Science in Sports and Exercise* 32(Suppl. 3), 4-10. Pedowitz R, Hargens A, Mubarak, S, Gershuni D. (1990) Modified criteria for the objective diagnosis of chronic compartment syndrome of the leg. *American Journal of Sports Medicine* 18(1), 35-40.

### THE IMPACT OF TYPE OF GROUND ON POST-EXERCISE CPK LEVELS AND HEMATURIA IN ATHLETES

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Introduction Literature advocates that athletes present higher incidence of hematuria than general population. However, various parameters distinguish the sports related hematuria with one of those being the spontaneously resolve after physical exercise whereas hematuria in nonathletic general population is usually chronic. Exercise characteristics, such as exercise duration and most predominantly intensity influence exercise-induced hematuria. Increased body temperature, hemolysis, increased production of free radicals, and excessive release of catecholamines are among the mechanisms underlying the exercise induced hematuria. The aim of the current study was to investigate a) the impact of type of terrain (natural grass and asphalt) on post-exercise CPK levels and hematuria in recreational athletes, b) possible statistical significant correlation between post-exercise CPK levels and hematuria. Methods Thirty five healthy male recreational athletes aged  $23 \pm 4$  years were tested before, immediately after, and 1h after the completion of 5 km running on natural grass and asphalt. Participants were asked not to participate in any intense exercise 3 days before the experiment. Five days of rest separated the two experimental sessions. Participants ran a distance of 5 km at 10km/h. The speed was fixed because its control was essential for the reproducibility of the results. Blood samples were collected from an antecubital vein for creatine phosphokinase (CPK) determination. Hematuria, urinary pH, and proteinuria were measured by re-agent strips for urinalysis using an automated reagent strip analyzer. Urine that was positive for hematuria was centrifuged for 5 min at 1500 rpm before examination of RBC distribution. RBCs are commonly found in urine, however, three or more cells per high power field is considered unusual and is used as a marker of hematuria in the current study. Urine specimens of at least 10 ml each were collected 5 min pre-exercise, immediately after, and 1h post-exercise. The study employed a 3x2 (time by type of ground) within-subjects design for the statistical analysis. The level of significance for the multivariate analysis of variance (MANOVA) was set at  $P < 0.05$ . Results Natural grass running produced increased CPK levels in both post-exercise measurements (pre- 341 g/l, straight after 408g/l, 1h post 382 g/l). A significant part of the participants (12/35) presented sport hematuria. Asphalt running revealed higher CPK values in respect to those of natural grass running (pre- 348 g/l, straight after 458g/l, 1h post 394 g/l). Interestingly, correlation between CPK levels and hematuria prevalence became apparent after the post-exercise measurements. Discussion The results confirm that running on a rigid surface (asphalt) may be an additional factor of sport hematuria increased risk.

### SCREENING PARTICIPANTS FOR EXERCISE INDUCED BRONCHOSPASM PRIOR TO A PERFORMANCE RELATED STUDY

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Background: Exercise induced bronchoconstriction (EIB) is defined as a bronchoconstriction occurring during or directly after exercise. Failure to recognize EIB amongst athletes is common (Dickinson et al., 2010). It therefore may be useful to screen potential participants for EIB, prior to them taking part in performance related studies. The aim of this study was to screen participants for EIB using the eucapnic voluntary hyperpnoea (EVH) challenge. Methods: A total of 69 participants were recruited (mean $\pm$ SD age  $22.84 \pm 4.51$  years, stature  $173.9 \pm 8.6$  cm, body mass  $71 \pm 9.1$  kg). They provided written informed consent. Each participant completed an EVH challenge test (Anderson et.al. 2001) involving 6 min hyperventilation at approximately 85% of maximal voluntary ventilation (30x baseline FEV1). Maximal flow volume loops were measured at baseline and at 3, 5, 7, 10 and 15min following completion of the challenge and a fall of 10% in FEV1 from baseline was deemed positive. An Independent T-test was conducted to compare FEV1 at baseline and maximal change following the EVH challenge between EVH-positive and EVH-negative participants. Significance was assumed if  $p < 0.05$ . Results: Nine (13%) of 69 participants presented EVH positive. There was no significant difference in baseline FEV1 between EVH negative and EVH positive subjects ( $4.0 \pm 0.9$  vs positive  $4.1 \pm 0.7$ ;  $p = 0.5$ ). However, there was a significant difference on largest FEV1 change and second largest FEV1 change between EVH negative and EVH positive participants ( $-5.6 \pm 2.7\%$  vs  $-18.7 \pm 6.7\%$ ;  $p < 0.01$ ) Conclusion: Thirteen percent of participants with no previous diagnosis of EIB tested positive using the EVH challenge test. The results indicate the prevalence of EVH positive participants is lower when compared to elite athletes (Dickinson et al. 2010). Screening volunteers prior to recruitment to intervention studies investigating exercise performance may be useful in eliminating EIB as a possible confounding variable. References Dickinson J, McConnell A, Whyte G. (2010). *British Journal Sports Medicine*, doi:10.1136/bjism.2010.072510 Anderson S, Argyros G, Magnussen H, Holzer K. (2001). *British Journal Sports Medicine*, 35, 344-7

### THE COMPRATION OF RUDENESS OF LOWER LIMB AND SPINAL COLUMN IN KARATE ATHLETIC

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**INTRODUCTION** Sport can have betterment and remedy effect in patient , but sport activity may be come one of factor of causing illness or coarseness.Of course it happens in condition that sport techniques are performed in wrong shape and use from organs in non principle way and use more of body. **METHOD** for true gatering of information, has been used pusture screen, digital scale, tape line and podescope. And for gatering personal information and sport record used quationnair. for recognizing different and rudeness of spinal column and lower limb in man and woman kata and kumite pearson chi-square statical exame used 95% in certainly level that result of research is difference of incidence lordosis radeness between men kata and kumite athletes. **FINDINGS** The age, weight and tallness average of research is 1/70 cm. 67/67 kg and 22/36 age. That 41/3% activity in kata range and 58/7% in kumite range. For true gatering of information, has been used pusture screen, digital scale, tape line and podescope. And for gatering personal information and sport record used quationnair. For recognizing different and rudeness of spinal column and lower limb in man and woman kata and kumite Pearson chi-square statical exame used 95% in certainly level that result of research is difference of incidence lordosis radeness between men kata and kumite athletes. **DISCUSSION & RESULT** In incident of lordosis rudeness between kata and kumite athletes there is difference. In incident of Genu varum radeness there is difference between kata and women kumite athletes. In incident of kyphosis rudeness, scoliosis rudeness, Genu valgum, posture rudeness, Genu varum rudeness, there is no difference between men cata and kumitist. In incident of kyphosis rudeness, scoliosis rudeness, Genu valgum rudeness, there is no difference between woman cata and kumitist.So we must recognize causing of rudeness in cumite range that it may cause in contact of this range an anable in complete controlling of all techniques in training and match. By prevention of these we can help to athletes to be thrown away of sport accident of this range. **References** 1: Keith H. Brridwell T , Paul A. Anderson , Scott D. Boden , Alexander R.Vaccaro , and jack E. Zigler , what is new in spine surgery , the journal of bone and joint surgery 2004. 2: Peter A.Rives , MD and Alam B.Douglass, MD, Evaluation and treatment of low back pain in family practice, The journal of the American. Board of Family practice. 17:s23- s31-2004

### MULTISENSORY TRAINING PROGRAM REDUCES RISK OF INJURIES IN PROFESSIONAL FOOTBALLER

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**Introduction** There is evidence in literature suggesting that balance, agility and coordination training techniques can induce changes in lower-extremity muscle activity patterns that result in improvement in dynamic joint stability. The mechanoreceptors present in and around the joints are responsible for maintaining postural control and joint position sense. These receptors are integrated in order to compose the somatosensorial system. In combination with visual and auditory inputs, which improve our spatial perception even further, the systems are able to maintain a dynamic stable body posture. Increasing this ability is a concrete mean to the prevention of sport injuries. **Methods** 20 player professional footballers received 2 months of balance and postural training, 2 sessions per week, with the use of a multisensory training approach (I-moove), . Before and after the training program, and again 2 months later, subjects performed stabilometry test. At the same time, the isometric lower limb test was measured by dynamometer. The athletes' health condition was monitored all the season, injuries were registered and classified. **Results** Results show a decrease of sway area and ellipse surface. Muscular strength increase statistically correlated with equilibrium ability. **Discussion** The multisensory training approach, which reduces the risk of injuries, yields a balance improvement in athletes. **References** Bellomo RG, Iodice P, Savoia V, Saggini A, Vermiglio G, Saggini R. (2009) Int J Immunopathol Pharmacol. Jul-Sep;22(3 Suppl):37-44. Silva KN, Mizusaki Imoto A, Almeida GJ, Atallah AN, Peccin MS, Fernandes Moça Trevisani V. (2010) Cochrane Database Syst Rev. May 12;(5):CD007648.

### SPORTS INJURIES IN JAPANESE BLIND FOOTBALL PLAYERS

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**Introduction** Blind football is an adaptation of football 5-a-side for athletes with visual impairments including blindness. This sport is one of the Paralympic games and is governed by the International Blind Sports Federation (IBSA). The game is played with modified FIFA (Fédération Internationale de Football Association) football 5-a-side rules. Football 5-a-side players are assigned to varying sports classes based on their level of visual impairment. Class B1 players are totally or almost totally blind, and Class B2 /3 have partial vision. For Class B1 games, teams consist of 4 field players with visual impairments, using eye shades to ensure fairness, and one goalkeeper who may be sighted. Teams may also use one guide, who is positioned behind the opponent's goal, to assist in directing players. The ball is equipped with a noise-making device inside to allow players to locate it by sound. During the game, players have to say clearly and audibly the word "voy" or "go", or any similar word, which prevents collisions between players, when seeking the ball and approaching the opponent. As little research has been performed on the athletes with disabilities relative to sports injuries (Ferrara and Peterson, 2000), especially in blind football players, the objective of this study is to find the features of sports injuries in blind football. **Methods** In this retrospective study, 15 male Japanese national team blind football players (all Class B1, mean (SD) age 29.8 (6.9) years) were interviewed and recorded, according to the FIFA standardized injury report form (Junge A, Dvorak J, et al., 2004). This study documented injury type and location caused by football during their respective careers as blind football players until June of 2010. An injury is defined as an absence from training or game for at least a week followed by diagnosis of anatomic tissue damage and medical treatment. **Results** The mean (SD) career as blind football player was 4.9 (2.3) years. During their careers, there were 31 total injuries among 9 players. The body parts injured were head / face (39%), trunk (19%), upper extremity (13%) and lower extremity (29%). The majority of injuries were diagnosed as fracture (32%), sprain (22%) and laceration / abrasion (13%). **Discussion** According to many studies of football-related sports injuries, the major locations of injury are lower extremities, especially in thigh, ankle, knee and lower leg (Junge A, Dvorak J, et al., 2004). In this study, head / face represented the major locations of injury in blind football players. Collisions between players predominantly caused head / face injuries. As players are completely unable to see during the game, they have to say clearly and audibly words like "voy" while approaching the opponent with a ball. Collisions seemed to happen, even between teammates, when they could not say the words instantly or properly. **References** Ferrara MS, Peterson CL (2000). Sports Med, 30, 137-143. Junge A, Dvorak J, et al. (2004). Am J Sports Med, 32 (1 Suppl), 80S-87S.



## RISK OF ACL INJURY IN SIDE CUTTING IN FOOTBALL: HALF-TIME RECOVERY IS MOSTLY INCOMPLETE AND DEPENDENT ON THE INDIVIDUAL

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**Introduction** Non-contact ligament or muscle injuries at the knee remain a significant problem in sports involving manoeuvres which consist of rapid decelerations and changes in direction. In football most injuries occur in the last 15 min of each playing half, and more in the second half (Hawkins et al, 2001). The purpose of this study was to examine which exact changes occur in joint kinetics, kinematics and neuromuscular control of the stance limb during side cutting manoeuvres following 45 min football specific fatigue, and whether these changes returned to pre-fatigue level after half time rest. **Methods** Following ethical approval, 8 male recreational players in dynamic team sports volunteered to take part in the study (mean age  $21.1 \pm 2.0$  yr, height  $184.0 \pm 3.2$  cm, mass  $82.1 \pm 12.7$  kg). Each subject completed five side cutting manoeuvres pre-fatigue, immediately post-fatigue and 15 min post-fatigue. Approach speed was standardized at  $4.5 \text{ m.s}^{-1}$  and cutting angle at  $45^\circ$  from a straight run. A 45 min version of the SAFT90 football specific fatiguing protocol was used to elicit fatigue (Small et al., 2010). IR cameras (Qualysis, Sweden) were used to collect motion data at 250 Hz in synchrony with ground reaction force (Kistler, Switzerland) and wireless EMG (Noraxon, USA) at 1500 Hz. Joint kinematics and kinetics were computed for the stance limb based on a lower limb and trunk segmental model with functional hip and knee joints (Vanrenterghem et al., 2010). Muscle activity of rectus femoris, biceps femoris, gastrocnemius lateralis and soleus lateralis of the stance limb were measured. Results ANOVA tests showed increased ACL loading risk with fatigue due to  $5.2$  degrees reduced average knee flexion angle ( $F_{1,15}$ ,  $8.06 = 5.62$ ,  $P = 0.04$ ), a  $33.2 \text{ Nm}$  reduced maximum knee external rotation (internal muscle) moment ( $F_{1,17}$ ,  $8.20 = 8.77$ ,  $P = 0.02$ ), and reduced average biceps femoris activity ( $F_{2,14} = 17.97$ ,  $P = 0.000$ ). Post-hoc testing indicated that all of these variables were still reduced following the 15 min rest period, although the average knee flexion angle had partially returned to its pre-fatigued level. **Discussion** The fact that fatigue resulted in reduced knee flexion, decreased external rotation muscle moment, but similar knee internal rotation, suggests that after fatigue the ACL is at greater risk of injury, which remains after half time. While some participants did partially recover their joint kinetics and kinematics, others did not. Importantly, there was never neuromuscular recovery. **References** Small et al. (2010) J Sc Med Sport, 13, 120 - 125 Vanrenterghem et al. (2010) Gait & Posture, 31, 517 – 521 Hawkins et al (2001) Br J Sports Med, 35, 43-47

## COORDINATION VARIABILITY AND ACUTE INJURIES: A CASE STUDY

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**Introduction** Dynamical systems theorists deem that a functional role of coordination variability (CV) in human movement is its potential to decrease the risk of injury. While this relationship is still uncertain, changing the frequency, magnitude, or site of application of an applied force that is undergoing repetitive loading has possible benefits in the prevention and treatment of overuse injuries. While runners experience chronic, repetitive injuries due to the body suffering exposure to a recurring force, most hamstring injuries that befall sprinters are acute and caused by a traumatic event. With the different etiology involved, an acute injury may have a different relationship with CV. **Methods** A 27yr old male sprinter participating in an investigation to assess CV under fatiguing conditions over multiple 80m sprinting trials, pulled up with a grade one hamstring strain. The sprinter had performed six 80m repetitions at maximal speed on a 400m athletic track. Kinematic data of the last 40m of the 80m distance were collected by five digital video cameras (frame rate 50Hz). Timing gates situated at 10m intervals recorded sprinting speed throughout each trial to ensure any coordination changes were due to fatigue and not a change in speed. Skin markers were attached to the athletes' greater trochanter, lateral epicondyle, and lateral malleolus. Angle-angle plots, phase planes and continuous relative phase (CRP) illustrated the coordination dynamics between the knee and hip joints, and mean ensemble CRP values were used to compare differences in coordination on a trial-by-trial and stride-by-stride basis. Variability was determined by standard deviation (SD) between the trials while significance was determined as changes greater than  $\pm 2$  SD. **Results** Trial-by-trial comparisons of knee phase plane data show a significant increase in CV by trial six, particularly during the mid- and late-swing phases of the stride. Stride-by-stride, the injured sprinter showed similar patterns in CV to other sprinters, with lower limb CV decreasing from 40-50m to 70-80m. **Discussion** While there are many potential causes of hamstring injuries, most occur during the late-swing phase when the hamstrings are activated eccentrically to decelerate the knee extension before switching to extend the hip joint concentrically. The observed increase in CV at the knee across the trials may have been an adaptation to avoid further injury by finding new ways to coordinate the muscle fibres, particularly during the mid- to late-swing phase of the stride. While the exact reason why knee joint CV increased in this athlete is not known, it seems possible that while a decrease in CV is linked to chronic injuries in runners, perhaps a large increase in CV is related to those injuries which are acute.

## THE INFLUENCES OF THE TWELVE-WEEK FALL PREVENTION EXERCISE ON THE BALANCE ABILITY OF THE ELDERLY IN COMMUNITIES

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**Introduction** Aging is complex and inevitable natural phenomenon. Speaking of the human body structure, as years go by, body's each function and organization will degenerate gradually and the balance ability is the most obvious one. The balance ability refers to the ability that the body center of gravity to maintain stably on the base of support, and it is also the most essential role for human body to maintain and operate each movement. Since the balance ability drops, fall will occur and tremendous medical fees will come along as well. Fall prevention exercise is one of the newly-developed exercises during recent years. Designers expect that the fall prevention exercise can enhance flexibility and strength, postpone degeneration of strength, promote the balance control ability of human postures, and then prevent the elderly from tumbling. **Methods** The subjects were 54 senior citizens in communities from Dajia District, Taiping District, and Shalu District in Taichung City, Taiwan, and they were evenly divided into the common exercise group, fall prevention exercise group, and control group. Kistler force platform (100Hz) and 3-meter walking were employed to measure the parameters of the static balance, dynamic balance, and lower-extremity strength. Then the fall prevention exercise group took the 12-week fall prevention exercise training and it took the posttest after the training was finished. The data were analyzed by the paired sample t test and one-way ANOVA to compare the results of the pretest and posttest and difference among groups and then examine whether the fall prevention

exercise training promotes the balance ability. Results The result indicated that the fall prevention exercise enhanced the performance of the time of right or left foot standing, average moving speed, 3-meter walking time, and the rate of develop force of lower-extremity strength ( $p < .05$ ). Discussion The fall prevention exercise is adequate for the elderly to take and it is also a preventive exercise for everyone to popularize. References Cao, Z. B., Maeda, A., Shima, N., Kurata, H., & Nishizono, H. (2007). The effect of a 12-week combined exercise intervention program on physical performance and gait kinematics in community-dwelling elderly women. *Journal of Physiological Anthropology*, 26(3), 325-332. DiBrezza, R., Shadden, B. B., Raybon, B. H., & Powers, M. (2005). Exercise intervention designed to improve strength and dynamic balance among community-dwelling older adults. *Journal of Aging and Physical Activity*, 13, 198-209. Takeshima, N., Rogers, N. L., Rogers, M. E., Islam, M. M., Koizumi, D., & Lee, S. (2007). Functional fitness gain varies in older adults depending on exercise mode. *Medicine and Science in Sports and Exercise*, 39(11), 2036-2043. Tsang, W. W. (2004). Effect of 4-and8- week intensive Tai Chi training on balance control in the elderly. *Medicine & Science in Sport & Exercise*, 36(4), 648-657.

## THE IMPACT OF LEISURE TIME PHYSICAL ACTIVITY ON MUSCULOSKELETAL COMPLAINTS IN YOUNG ADULTS THE NORWEGIAN NORD-TRØNDELAGE HEALTH STUDY

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Abstract A major part of the population in Norway is affected by musculoskeletal complaints (MSC) and low back complaints (LBC). Due to occupational disability and days of sick leave, this entails great negative economical consequences (Ihlebaek og Lærum 2010; Andersen et al. 2009). Findings indicate that physical activity may have positive impact on MSC as well as on LBC (Hildebrandt, Bongers, Dul, et al. 2000; Heneweere H, Vanhees L, Picavet HS 2009; Schneider S, Zoller S 2009). However, little research has been conducted to investigate whether leisure time physical activity ("friluftsliv") has general impact on MSC or more specifically on LBC. The definition of Vet et al. (2002) is used in this study on the concepts MCS and LBC including pains, problems or dislike in the neck, the upper part of the back and the shoulders and the lower part of the back. The model and the theory of Horgen (2001) and Odden (2008) identifies several hallmarks of "friluftsliv" like physical activity, leisure time, nature, the open air, culture, experience and change of environment. The aim of the study was to investigate the associations between gender, age, "friluftsliv" and MSC and LBC. Data from the Norwegian Nord -Trøndelag Health Study (HUNT 3-2006-2008) were used in the study. Young adults (20-29 years, N=4242) participated in the study. Associations between gender, age, "friluftsliv" and MSC and LBC were assessed by analysis of variance (ANCOVA) and logistic regression. Gender and "friluftsliv" associated significantly with MSC and LBC. Moderate participation in "friluftsliv" had positive impact on MSC and LBC with reduced complaints. Male subjects reported less MSC and less LBC than female subjects. References Andersen, I., Frydenberg, H., Mæland, J. G. Musculoskeletal complaints and future sick leave. *The Journal of the Norwegian Medical Association*; 2009, 12;129. 1210-3. De Vet, H., C., Heymans, M., W., Dunn, K., M., Pope, D., P., van der Beek, A., J., Macfarlane, G., J., et al., Episodes of low back pain: a proposal for uniform definitions to be used in research. 2002. *Spine*; 27:21 - 16 Heneweere H, Vanhees L, Picavet HS. Physical activity and low back pain: a U-shaped relation? *Pain*. 2009; 143(1-2):21-5. Hildebrandt, V. H., Bongers P. M., Dul, J., et al. The relationship between leisure time, physical activities and musculoskeletal symptoms and disability in worker populations. *Int Arch Occup Environ Health*; 2000. 73: 507-18. Ihlebaek, C., Lærum, E., Rammer flest, koster mest og får minst. *The Journal of the Norwegian Medical Association*; 2010; 21:130:2106. Odden, A., 2008. Hva skjer med norsk friluftsliv: en studie av utviklingstrekk i norsk friluftsliv 1970-200. Norwegian University of Science and Technology, Trondheim. Schneider S, Zoller S. [Physical movement - is it good for the back? Nationwide representative study on different effects of physical activity at the workplace and in leisure time]. *Der Orthopäde*. 2009;38(10):943-55.

## Poster presentations

### PP-PM77 Anthropometry 2

## RELATIONSHIP OF ANTHROPOMETRIC WITH PHYSICAL AND MOTOR FITNESS FEATURES IN IRANIAN ELITE SOCCER PLAYERS

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The purpose of this research was to determine the relationships between selected anthropometric with physical and motor fitness measures in elite Iranian soccer players. Among the players of national team, 60 elite men were selected voluntary as an overall sample. The anthropometric measures included, body mass index (BMI), fat %, weight, lean body mass, height and also chest, leg and thigh circumferences and body composition from total of 60 elite players. Also measurements (sectioned as: skinfolds, girths, lengths, and breadths) were made for each player. The procedure involved three measures at each site to calculate a mean value and used to relate with fitness variables. The physical and motor fitness tests used were: ergo jump, vertical jump, agility, flexibility, speed and reaction time. Mean calculated scores for all players were obtained. Regression analyses indicated significant correlation between certain variables of Fitness tests and variables of anthropometric estimation statistics. Knowing these relationships provides us with valuable predictive information about player's Capabilities in sport. Results showed between have less body mass index (BMI), less fat%, greater lean body mass, great leg and thigh circumferences were significantly related to better speed, agility, ergo jump and vertical jump. Also observed greater height with vertical jump ( $p < 0.05$ ) and relationships between agility and flexibility to less fat observed too. Regression analysis for all variables demonstrated a significant relationship between some parameters. These findings suggest that we can predict some variables of anthropometric or physical and motor fitness by other parameters.

## A SYSTEMATIC REVIEW AND META-ANALYSIS OF THE EFFECT OF AEROBIC AND RESISTANCE EXERCISE TRAINING ON VISCERAL FAT

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**Introduction** The increased risk of cardiovascular and metabolic morbidity and mortality as result of obesity has been well described. However, it is increasingly recognized that the location of excess adiposity, particularly increased deposition of visceral adipose tissue (VAT), is of greater importance in determining the adverse health effects of overweight and obesity. A systematic review of the available randomized control trials to 2006 suggested that interventions involving increased aerobic exercise (AEx) can benefit abdominal fat (Kay and Fatarone Singh, 2006). Although there are currently no guidelines for progressive resistance exercise training (PRT) in the management of obesity, there is evidence that PRT may result in VAT reduction (Kay and Fatarone Singh, 2006). **Methods** A systematic review and meta-analysis was performed to assess the efficacy of exercise interventions on VAT content/volume in overweight and obese adults. Relevant databases were searched to November 2010. Included studies were randomised controlled designs in which AEx or PRT in isolation or combination was employed for 4 weeks or more in adult humans. Studies were selected if computed tomography or magnetic resonance imaging was used for quantification of VAT fat area/volume pre- and post-intervention. Results Of the 12,196 studies from the initial search, 35 were included. After removal of outliers there was a significant pooled effect size (ES) for the comparison between AEx therapy and control (-0.29, 95% CI: -0.42 to -0.17;  $P < 0.01$ ), but not for comparison between PRT therapy and control (-0.03, 95% CI: -0.21 to 0.14;  $P = 0.71$ ). Of the available nine studies which have directly compared AEx with PRT, the pooled ES did not reach statistical significance (ES = 0.19, 95% CI: -0.04 to 0.41;  $P = 0.105$  favouring AEx). The pooled ES did not reach statistical significance for interventions that combined AEx and PRT therapy versus control (-0.15, 95% CI: -0.35 to 0.04;  $P = 0.12$ ), for which only seven studies were available. **Discussion** We aimed to evaluate the independent and synergistic effects of aerobic exercise and progressive resistance therapies and to directly compare the efficacy of aerobic exercise and resistance training interventions for beneficial VAT modulation. These data suggest that aerobic exercise may be a superior training modality for achieving reductions in VAT but further investigation is needed regarding the efficacy and feasibility of multi-modal training as a means of reducing VAT. **References** Kay S and Fatarone Singh, M. (2006). *Ob Rev*, 7, 183-200.

## EFFECT OF A 6-MONTH DEPLOYMENT TO AFGHANISTAN ON PHYSICAL FITNESS AND BODY COMPOSITION OF CROATIAN ARMED FORCES

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**INTRODUCTION** Engagement in military operations is considered an extremely physically demanding job. To meet these hard physical requirements soldiers are engaged in everyday physical training. However, during deployments soldiers are often deprived of such training routines and can experience significant decrements in physical fitness (PF). The main goal of the study was examining the change in PF and body composition (BC) after a 6-month military deployment to Afghanistan. **METHODS** The research was conducted on a sample of 59 professional soldiers of the Croatian Armed Forces. PF and BC were assessed prior and post deployment with the battery of 12 motor and functional tests and 2 morphological measures respectively. Pre-deployment to post-deployment changes in PF and BC were analysed using ANOVA. **RESULTS** Result showed significant decrement in percentage of body fat (14.66;  $p = 0.00$ ), while body weight (BW) did not change at all. Decrements in PF were registered in most variables (coordination, sprinting power, jumping power) with significant changes in agility, abdominal and upper body repetitive strength, aerobic and anaerobic endurance. The only improvement in PF was registered in flexibility, but this change was not statistically significant. **DISCUSSION** After a 6-month deployment to Afghanistan soldiers reduced their body fat without changing their BW and also experienced overall decrement in PF. Body fat loss is probably related to the changes in dietary habits and food selection while PF decrements are mostly related to the lower physical requirements of the deployment and the lack of scheduled exercise. In order to maintain optimal PF level during deployments, soldiers should be encouraged to continue with their exercise programmes as conducted prior to deployment. **REFERENCES** Sharp, M.A. (2008). *Med Sci Sport Exer*, 40(9), 1687-1692. Lester, M.E. (2010). *Mil Med*, 175(6), 417-423.

## ANTHROPOMETRIC AND BODY COMPOSITION PROFILES OF ELITE IRANIAN MALE CANOE POLO PLAYERS

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This study is supported by National Canoeing, Rowing & Sailing Academy (Tehran, Iran) **Introduction** Canoe Polo is a strength-power type of sport and competition performance depends on factors such as strength and anaerobic power, physical power, canoe polo technique and tactics. A vast amount of research has been conducted on water sports similar to dragon boating, and it has been found that there are major differences in the anthropometric and body composition characteristics between rowers, kayak paddlers and canoeists. However, there is not information available on the anthropometric and body composition characteristics of canoe polo players. **Methods** The subjects were fifteen elite male canoe polo players from the Iranian National team who competed at the 2011 Asian canoe polo championships in Tehran, Iran. Anthropometric and body composition measures were included weight, height, arm span, sitting height, Body Mass Index (BMI), Present Body Fat (PBF), Basal Metabolic Rate (BMR). Anthropometric measurements: A total of anthropometric variables were directly and indirectly measured according to the methods of standard International Society for the Advancement of Kinanthropometry (ISAK). For all the anthropometric measurements, standards of ISAK procedures were followed (Agha-Alinejad et al., 2010). Body Composition measurements: Their body composition was analyzed using Inbody 520 (Korea). Statistical analysis: Descriptive statistics were calculated for all variables. All statistical analyses were conducted using SPSSv16.0. **Results** Anthropometric variables (Mean  $\pm$  SD: age  $24.6 \pm 3.1$  years, height  $179.4 \pm 5.1$  cm, arm span  $185.7 \pm 5.5$  cm, sitting height  $94.3 \pm 4.0$  cm) and body composition variables (Mean  $\pm$  SD: weight  $82.9 \pm 7.6$  years, BMI  $25.7 \pm 2.0$  kg/m<sup>2</sup>, PBF  $14.4 \pm 2.8$  %, BMR  $1901.7 \pm 110.2$  Kcal in Day). **Discussion** This is the first study to present a detailed analysis of the anthropometric and body composition characteristics of canoe polo players. Descriptive anthropometric characteristics offer a unique wealth of information that can be used to analysis the size, proportionality, and body composition of athletes. This athlete profiling can be used by health and sports science practitioners in canoe polo for the design of exercise and nutrition interventions to improve health and performance (Ackland et al., 2009), for talent detection purposes and in the analysis and modelling of physical aptitude characteristics specific to the sport (Holway and Garavaglia., 2009) **References** Ackland TR, Elliott BC,

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### SOMATOTYPE AND SIZE OF ELITE IRANIAN MALE SWEEP ROWERS

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**Introduction** Identification of the unique aspects of physique that may contribute to success in sport has long interested sports scientists and coaches. Within a sport such as rowing, tallness is an obvious competitive advantage. Rowing is a weight-supported sport and anthropometric data of elite adult rowers emphasize the importance of the body mass and size. Successful open class rowers are as lean, but much heavier and taller, with long arms and a tall sitting height compared with athletes in other endurance sport disciplines. Long arms are helpful in obtaining an adequate stroke length. Because rowing is a strength endurance sport, in which body mass and body size are performance-related factors. Sweep rowers in open class are consistently taller and heavier than scullers, amounting to 2 cm and 4 kg for men, and 3 cm and 3 kg for women. The reason why sweep rowers are heavier, taller and more muscular than scullers may be a result of the dynamics of boat movement (Secher and Volianitis, 2007). **Methods** The subjects were thirteen (4 male lightweight and 9 male heavyweight) elite male Sweep rowers from the Iranian National team (Mean  $\pm$  SD lightweight: age  $19.7 \pm 0.5$  years, height  $187.7 \pm 4.1$  cm, body mass  $71.6 \pm 1.3$  kg and Mean  $\pm$  SD heavyweight : age  $22.0 \pm 1.5$  years, height  $194.5 \pm 4.0$  cm, body mass  $90.3 \pm 6.4$  kg ) who competed at the 2010 Asian Games in Guangzhou, China. Anthropometric measurements: A total of anthropometric variables were directly and indirectly measured according to the methods of standard International Society for the Advancement of Kinanthropometry (ISAK). For all the anthropometric measurements, standards of ISAK procedures were followed. Descriptions of measurement techniques are given later (Agha-Alinejad et al, 2010). Somatotype was calculated using the Heath-Carter protocol (Eston and Reilly, 2009). **Results** The mean somatotype for the male lightweight rowers (2.3-2.3-3.9) demonstrates that these athletes were predominantly ectomorphic. The mean somatotype for the male heavyweight rowers (2.8-5.0-3.3) demonstrates that these athletes were predominantly mesomorphic. **Discussion** Boats with sweep oars on average involve more athletes and a coxswain in the coxed pair, four and eight. The weight of the coxswain imposes a greater deceleration of the boat at the catch of the stroke, where the blade enters the water and force is applied to the oar, because of the change of the direction of the bodies in the boat and a high force is required to accelerate the boat. Thus, tall, muscular and heavy rowers are favored (Secher and Volianitis, 2007). **References** Agha-Alinejad H, Donyamali A, Bayati M, Mirakhori Z, Yousefi V, Farzad B (2010). 11th International Sport Sciences Congress, 1009-1011. Antalya / Turkey. Eston R, Reilly T (2009). Kinanthropometry and Exercise Physiology Laboratory Manual (3th edn.). Routledge. Secher NH, Volianitis S (2007). Rowing Olympic Handbook of Sports Medicine. Wiley-Blackwell.

### BODY COMPOSITION AND PHYSICAL PERFORMANCE IN ELITE SPANISH BASKETBALL PLAYERS

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Team sport performance is determined by a diverse range of qualities including body size, fitness, sport-specific skills, team tactics, and psychological attributes. The game of basketball requires big body size and physical. A player's size has a large influence on the position in the team, while the high-intensity, intermittent nature of the physical demands requires players to have a high level of fitness (Drinkwater et al, 2008). **PURPOSE:** To determine the anthropometric profile, body composition and explosive strength development of elite basketball players. **METHODS:** Ten male basketball players (age =  $24.1 \pm 2$  yr, height =  $195.9 \pm 8.8$  cm, body mass =  $95.7 \pm 10.9$  kg, body fat =  $10.9 \pm 1.1\%$ ) who played in the Fourth League of Spain (EBA), participated in this study. Body composition was calculated by measuring weight, height, skinfolds, limb circumference, and joint diameter. VO<sub>2</sub>max and jump tests were evaluated at the beginning of the season. The height jumped (VJH), the mechanical positive impulse (MPI), the peak power (PP), the mean power (MP), and the maximal force (MF) achieved during countermovement vertical (CMJ) jump, squat jump (SJ) and Abalakov (ABK) test where were assessed with a force plate. **RESULTS:** Mean and standard deviation values were: [VO<sub>2</sub>max =  $55.3 \pm 6.2$ ]; [VJH=  $32.1 \pm 2.0$ ,  $38.1 \pm 3.0$ ,  $45.6 \pm 4.6$  cm]; [MPI=  $24.4 \pm 3.9$ ,  $26.3 \pm 3.1$ ,  $28.9 \pm 3.6$  Kp.s]; [MP=  $19.7 \pm 2.8$ ,  $29.7 \pm 2.2$ ,  $31.5 \pm 4.5$  w/kg]; [PP=  $46.7 \pm 5.6$ ,  $52.2 \pm 4.1$ ,  $63.9 \pm 5.8$  w/kg]; [MF=  $118.5 \pm 25.7$ ,  $138.4 \pm 23.2$ ,  $161.2 \pm 40.5$  kp], SJ, CMJ and ABK respectively. **CONCLUSION:** These basketball players have 10-15% greater VO<sub>2</sub>max capacity than the non-active subjects of comparable age from the Spanish population. Their jumping capacities are also slightly higher than observed in sedentary subjects from our population and lower than in volleyball players.

### 'THE ANTHROPOMETRIC, PHYSIOLOGICAL, PHYSICAL AND MOTOR FITNESS FEATURES PROFILES IN THE IRANIAN SOCCER ELITE PLAYERS'

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The aim of the current investigation was to determine the anthropometric, physical and motor fitness features profiles in the IRANIAN soccer elite players. From the national team's players, 30 elite male were used as an overall sample and as voluntary. The players were analyzed according to the specific positions in the field. The anthropometric measures included body composition from total of 30 elite players. Also measurements (sectioned as: skinfolds, girths, lengths, and breadths) were made for each player. The procedure involved three measures at each site to calculate a mean value and compare with other positions. This case performed in all factors and positions. The physiological tests used were: VO<sub>2</sub>max, ventilation, maximum of heart rate. The physical and motor fitness tests used were: ergo jump vertical jump, agility, flexibility run and reaction time. . Mean calculated scores for playing position were obtained. A multivariate analysis of variance revealed differences between positions. The result showed, strikers players performed, higher speed. Reaction, agility, and flexibility, but lower vertical jump and height. Midfielder's players showed lower fat percent and higher Vo<sub>2</sub>max in compare with other positions. Also defenders players were higher weight, lean body weight, height and vertical jump from other positions. A range of relevant anthropometric , physical fitness and physiological factors can be considered which are subject to strong genetic influences or are largely environmentally determined and susceptible to training effects. Consequently, fitness profiling can generate a useful database against which talented groups may be compared. No single method allows for a representative assessment of a player's

physical capabilities for soccer. We conclude that anthropometric physical and physiological criteria do have a role as part of a holistic monitoring of talented elite players.

### SOMATOTYPE COMPONENTS OF JUNIOR ELITE HANDBALL PLAYERS

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**Introduction** Kinanthropometric studies have shown that high performance requires specific morphological characteristics. Body composition (body fat, body mass, muscle mass) and physique (somatotype) can significantly influence athletic performance (Carter & Heath, 1990). The aim of this study was to detect possible differences in somatotype components of junior elite handball players in three different age groups. **Methods** The study sample were members of the Greek national handball teams divided into three age groups: under 16 years old (U-16: n=20, age 15.9±0.4 years, height 182.4±6.6 cm, body mass 78.2±8.1 kg), under 18 years old (U-18: n=19, age 17.4±0.5 years, height 184.07±5.8 cm, body mass 84.2±9.8 kg) and under 20 years old (U-20: n=21, age 19.3±0.6 years, height 184.7±5.2 cm, body mass 85.4±7.6 kg). All anthropometric measurements were taken according to Heyward & Stolarczyk (1996) guidelines. Somatotype was determined using the method of Carter & Heath (1990). One way ANOVA was conducted in order to determine significant differences among the three subgroups. Statistical significance was set at p<0.05 level. **Results** No significant differences were found in endomorphy, mesomorphy and ectomorphy among the three age groups of players. U-16 somatotype is characterized as central (2.8-3.1-2.7), while U-18 and U-20 had almost the same somatotype characterized as mesomorph-endomorph (3.0-3.3-2.2 and 3.0-3.4-2.1, respectively). In all three groups mesomorphic component was the highest, while ectomorphic the lowest. **Discussion** The main finding of the present study was that the somatotype of elite junior handball players is characterized primarily by mesomorphic and secondly by endomorphic component. The presence of higher muscle mass reflected in the mesomorphic component constitutes a significant advantage for athletes in order to confront the intense body contacts during a handball game. In the last decade, there is only one study (Sibila & Pori, 2009) dealing with somatotype components of top-level male handball players. In the aforementioned study, athletes exhibited markedly higher mesomorphy values [3.0-4.8-2.2], than our study and were characterized as endomorphic-mesomorph. **References** Carter JEL, Heath HB. (1990). Somatotyping – development and application. Cambridge University Press. Sibila M, Pori P. (2009). Coll. Antropol 33,4: 1079-86. Heyward V, Stolarczyk L. (1996). Applied body composition assessment. Human Kinetics.

### THE EVOLUTION OF PHYSIQUE, AGE AND SPORTING EXPERIENCE IN MALE OLYMPIC HANDBALL

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**Introduction** Physique factors are important for success in a particular sport (Norton, Olds, 2001). The aim of the research was to carry out the tendencies of height, body mass, age, sporting experience of male olympic handball players through 4 decades: from Munich (1972) Olympic Games (MOG) to the Beijing (2008) Olympic Games (BOG). **Methods** The indices of height, body mass, age, and the international matches played by handball players (N=1869) of national teams taking part in 10th Olympics were taken from the official statistics documents of the International Handball Federation. All values were expressed as means ± SD. The data were analysed by means of the variance (ANOVA) and linear regression methods. Pearson's correlation method was used for assessing the mentioned indices influence to win. The value of P < 0.05 was accepted as significant. **Results** During 36 years (from MOG to BOG) all indices increased statistically significant (P < 0.001). The height of handball players increased by 6.3 cm (184.8 x ± 5.0 and 191.1 ± 6.51 respectively) (y = 0.7867 x + 184.54; R<sup>2</sup> = 0.8382), body mass – by 10.1 kg (82.3 ± 5.58 and 92.4 ± 8.62 respectively) (y = 1.4571 x + 81.618; R<sup>2</sup> = 0.9579), age – by 2.6 years (25.9 ± 3.33 and 28.5 ± 4.12 respectively) (y = 0.405 x + 24.808; R<sup>2</sup> = 0.8499), international matches played increased in double – by 48 matches (45.5 ± 31.2 and 93.4 ± 9.7 respectively) (y = 11.857 x + 33.667; R<sup>2</sup> = 0.706). **Discussion** In all OG (except Moscow 1980) champions were higher, greater body mass, older, more experienced than handball players in average or winners of medals (Skarbalis, 2002, 2010). Despite findings of importance of body size in elite performance (Ackland, 2005; Gabbet, 2006) current study did not show uniformity of prevalence of height, body mass, or experience to win a match in male olympic handball. Correlation between winnings points and indices varied from OG to OG: height (0.238–0.791), body mass (0.271–0.657), age (0.133–0.798), international matches played (0.243–0.666). In conclusion we suggest that playing pattern in elite male olympic handball may have more influence to win than body size (Skarbalis, 2010). **References** Ackland T. (2005). Built for success: Homogeneity in elite athlete morphology. In M.J. Marfell-Jones, A. Stewart, T. Olds (Eds.), Kinanthropometry IX (pp. 29–37). Gabbet T., (2006). A comparison of physiological and anthropometric characteristics among playing positions in sub-elite rugby league players. Journal of Sports Sciences, 24(12):1273–1280. Norton K., Olds T. (2001). Morphological evolution of athletes over the 20th century. Causes and consequences. Sports Medicine, 31(11): 763–783. Skarbalis A. (2002). Olympic Mens' Handball: Peculiarities and Tendencies. Kaunas: LAPE. Skarbalis A. (2010). Optimization of Coaching High-Performance Handball Athletes. Kaunas: LAPE.

### COMPARISON OF GENDER AND SPORT BRANCHES BETWEEN ANAEROBIC POWER, STRENGTH, SOME ANTHROPOMETRIC CHARACTERISTICS, SPEED AND REACTION TIME

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**Introduction** Gender and Sport branches (in team handball and soccer) are considered as important aspects of the game and contribute to the high performance of the team. Therefore, the aim of this study was to compare gender and sport branch between anaerobic power, some anthropometric characteristics, speed, strength and reaction time? **Methods** The total sample consisted of 40, male (n=20) and female (n=20). Team handball (age=21.30±2.8) and soccer (age=22.95±2.8) players who has been student at Marmara University of School of Physical Education and Sports. Anaerobic power was calculated by Lewis Formula (Fox, 1984). Vertical jump and Reaction time were measured by MPS-5001F Kompe System. Descriptive data was computed for all variables. Two way ANOVA was used. Statistical significance was set at p<0.05 **Results** Gender effect was stated at 30 m. Speed, anaerobic power, arm span, hand length, hand grip strength and standing long jump, except reaction time. Sport branch effect was stated at hand grip strength. Both gender and sport branch effect was stated at vertical jumping, reaction time and leg strength (p<0.05) **Discussion** Gender's effect: 30 m. Speed, anaerobic power, arm span, hand length, hand grip strength and standing long jump of male better than female (p<0.05). This findings was supported another research about 30m speed and standing long jump (Zapartidis et al., 2009) Sport branch's effect: Hand grip strength of handball players better than soccer players (p<0.05). Hand grip strength that is important in handball, from the moment pass is received

till the throw is affected from the arm segment isometric muscle force (Eler, Sevim, 2002). Both gender and sport branch's effect : Leg strenght and reaction time of male and female soccer players better than handball players ( $p < 0.05$ ). References Eler S., Sevim Y. : Hentbolcu ozgu kuvvet antrenmanlarının genç erkek hentbolcuların bazı parametreleri üzerine etkisinin incelenmesi. 7. Uluslararası Spor Bilimleri Kongresi, Kongre Kitabı , Antalya , 27-29 Ekim 2002 , 62. Zapartidis I, Varelziz I, Gouvali M, Kororos

### IS ANTHROPOMETRIC PROFILE OF ELITE MALE ICE CLIMBERS SAME AS PROFILE OF THE SPORT CLIMBERS?

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Introduction: Ice climbers (IC) commonly used knowledge regarding body composition, strength, endurance and flexibility on the basis of previous studies of sport climbers (SC). The aim of this study was to compare anthropometric profiles of elite IC and SC. Methods: The 23 male participants (age  $26.7 \pm 5.9$ ) of the Ice climbing World Cup were measured day before competition. Control group was made of 23 SC (age  $27.9 \pm 3.9$ ) who reported on site climbing grade over VII+/6c (UIAA/French) (Watts PB., 2004). The variables measured included age, height, weight, body mass index, % body fat by bioimpedance, % segmental body fat (trunk, left and right arms, -legs), fat mass, fat-free mass (FFM), total body water (TBW), basal metabolic rate (BMR), leg length, arm span, ratio of arm span to height (Ape index), right and left handgrip strength, handgrip strength to body mass ratio (SMR), pincer strength (dominant hand, i.e. thumb and forefinger), handgrip endurance (dominant hand), endurance of shoulder's muscles, foot raise, hip flexion, hip abduction and climbing ability through standing position or the most difficult on site lead climbing (Grant S., 1996; Giles LV., 2006). Results: We have found significant differences ( $p < 0.05$ ) between IC and SC for body fat % (IC  $9.4 \pm 2.3$ ; SC  $6.5 \pm 2.2$  %), fat mass (IC  $6.6 \pm 2.1$ ; SC  $4.7 \pm 1.9$  kg) and trunk fat % (IC  $9.5 \pm 3.9$ ; SC  $5.5 \pm 3.0$  %). IC have weaker ( $p < 0.05$ ) hand grip (left hand: IC  $442 \pm 96$ ; SC  $575 \pm 83$  N / right hand: IC  $495 \pm 95$ ; SC  $589 \pm 78$  N), SMR (IC  $7.0 \pm 1.1$ ; SC  $8.5 \pm 1.0$  N/kg) and foot rise (IC  $68 \pm 6$ ; SC  $76 \pm 7$  cm). No difference has been found for pincer strength, grip endurance, endurance of shoulder's muscles, hip flexion and abduction. Discussion: This results indicate that Ice climbers have lower body fat, probably as a reaction on cold environment. On other side all Sport Climbing training protocols for development of strength, endurance and flexibility can be used by Ice climbers because of their elementary influence on climbing sport performance (Grant S., 1996; Giles LV., 2006). References: Grant S., Hynes V., Whittaker A., Aitchison T. (1996). J Sport Sci, 14, 301-309. Watts PB., (2004). Eur J Appl Physiol 91, 361-372. Giles LV., Rhodes EC., Taunton JE. (2006). Sport Med 36(6), 529-545.

## Poster presentations

### PP-PM78 Exercise in Disease and Ageing

#### NO ADVERSE EFFECTS OF STATINS ON MUSCLE FUNCTION AND HEALTH-RELATED PARAMETERS IN THE ELDERLY: AN EXERCISE STUDY

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Introduction Statins are currently the most effective drugs for the therapy of hypercholesterolemia. However, the side effects of statins (myalgia, fatigue and muscle pain) may negatively impact the quality of life especially in elderly, leading to limited physical activity. Therefore, the aim of the present study was to investigate the effects of a repeated bout of eccentric exercise on health related parameters and muscle performance on subjects undergoing statin therapy. Methods Twenty eight elderly men participated in the investigation and were assigned in a control ( $n = 14$ ) and a statin therapy group ( $n = 14$ ). All participants performed two isokinetic eccentric exercise bouts separated by three weeks. During both sessions, participants completed 5 sets of 8 eccentric maximal voluntary contractions. Muscle damage indices evaluated before, immediately after, as well as 48h and 120h post-exercise. Resting energy expenditure (REE), substrate metabolism (RQ), lipid profile (i.e. total cholesterol, high and low density lipoproteins, triacylglycerols) and insulin sensitivity (i.e. insulin, glucose and HOMA) were evaluated before exercise as well as 48h and 120h post-exercise. Results All muscle function indices were modified significantly after the first bout of eccentric exercise in both groups, but the alterations were smaller after the second bout of eccentric exercise. No differences in muscle function were observed between the two groups. Eccentric exercise increased REE, decreased RQ, improved lipid profile and increased insulin sensitivity 48h after both eccentric exercise bouts. However, these changes appeared to lesser extent after the second bout. No differences were observed in the responses in the health related parameters in the control and in statin therapy group. Discussion Eccentric exercise affected similarly skeletal muscle function, substrate metabolism, blood lipid profile and insulin sensitivity in the control and in statin treated individuals. These findings indicating that statin therapy individuals does not negatively affect skeletal muscle function, health related responses and adaptation to eccentric exercise.

#### EXERCISE TRAINING IMPROVES PHYSICAL FITNESS AND VASCULAR FUNCTION IN CHILDREN WITH TYPE 1 DIABETES

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Children with diabetes mellitus type 1 (DM1) demonstrate endothelial dysfunction and mild artery wall thickening compared to their age-matched healthy peers. We examined the effect of 18-week exercise training on physical fitness, and vascular function and structure in children with DM1. We examined physical fitness, brachial artery endothelial function (flow-mediated dilation (FMD)) and common carotid artery diameter, wall thickness and wall-to-lumen ratio before and after 18-week exercise training in children with DM1 ( $n=7$ ). Physical fitness, measured as maximal oxygen consumption, improved after training ( $P=0.039$ ). Brachial artery FMD improved from  $7.5 \pm 4.2$  to  $12.4 \pm 5.2$  ( $P=0.038$ ). Carotid artery diameter, wall thickness and wall-to-lumen ratio did not change significantly ( $P=0.26$ ,  $0.53$  and  $0.27$ , respectively). We demonstrated that exercise training in children with DM1 effectively reverses endothelial dysfunction and improves physical fitness. These data emphasize the important role for physical activity in the management of DM1.

### LONG TERM RECREATIONAL PHYSICAL EXERCISE DECREASED ANGINA SUSCEPTIBILITY, REDUCED THE MYOCARDIAL INFARCT SIZE, IMPROVED THE HEART PERFUSION IN RATS

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UNIVERSITY OF SZEGED

**Introduction** Physical inactivity, i.e. sedentary life style increases circulatory disease risk. Carbon monoxide and nitric oxide produced by the heme oxygenase (HO) and by the constitutive nitric oxide synthase (cNOS) protect circulation. In contrast, the enhanced level of the matrix metalloproteinase (MMP) augments cardiovascular risks. We examined the actions of recreational physical exercise on the expression of these enzyme systems in conjunction with cardiovascular protection. **DESIGN:** Male Wistar rats were placed into cages installed with running wheels allowing them the self administration of physical exercise over 6 weeks. We studied 1./ the activity and expression of HO and NOS in the aorta and heart left ventricle (LV); 2./ the serum level of MMP-2; 3./ the angina susceptibility of the heart (assessed by lead II. surface ECG following adrenaline plus phentolamine challenge); 4./ the Infarct size by triphenyltetrazolium chloride staining was measured in hearts isolated from both groups and subjected to 30 min coronary occlusion followed by 120 min reperfusion; and 5./ the heart perfusion provoked by AVP according to Langendorff. **Results** We found that physical exercise 1./ increased LV and aortic HO activity (from  $0.83 \pm 0.21$  to  $5.35 \pm 0.36$  and from  $0.73 \pm 0.15$  to  $1.60 \pm 1.13$  nmol bilirubin/h/mg protein, respectively;  $n=12-15$ ;  $p<0.001$ ) and LV HO-1 isoenzyme expression (from  $106.3 \pm 3.132$  to  $164.0 \pm 16.479\%$ ;  $n=6-7$ ;  $p<0.05$ ) and increased LV and aortic cNOS activity (from  $16.32 \pm 3.71$  to  $59.11 \pm 7.94$  and from  $105.38 \pm 55.72$  to  $181.78 \pm 30.29$  pmol/min/mg protein, respectively;  $n=9-15$ ;  $p<0.001$ ) and LV endothelial NOS isoenzyme expression (from  $109.15 \pm 5.247$  to  $163.1 \pm 10.67\%$ ;  $n=3$ ;  $p<0.05$ ); and 2./ decreased serum and cardiac MMP-2 level (64 kDa; from  $1002.71 \pm 37.50$  to  $679.73 \pm 34.35$  intensity  $\times$  mm<sup>2</sup>;  $n=12-13$ ;  $p<0.001$ ); 3./ decreased heart ischaemia susceptibility (ST segment depression: from  $-0.14 \pm 0.018$  to  $-0.019 \pm 0.019$  mV;  $n=11$ ;  $p<0.001$ ); 4./ decreased the infarct size (from  $51.2 \pm 6.86$  to  $30.17 \pm 3.66\%$ ;  $n=5-6$ ;  $p<0.05$ ); and 5./ increased the isolated heart perfusion (from  $11.6 \pm 3.14$  to  $6.17 \pm 2.16\%$ ;  $n=8$ ;  $p<0.05$ ). **Discussion** Long term recreational physical exercise protects the heart against angina, decreased the infarct size and improved the isolated heart perfusion which might be associated with the up-regulation of the HO and NOS enzyme system, and the down-regulation of MMP-2 activation. Grant supports: SROP 4.2.1./B-09-1/KNOV-210-0005; SROP 4.2.2.-08/1-2008-0006; Bolyai Scholarship (Aniko Posa).

### SKELETAL MUSCLE FIBRE CONDUCTION VELOCITY AND EMG ACTIVITY, BEFORE AND AFTER REHABILITATION IN PATIENTS WITH CHRONIC CARDIAC DISEASE: A PILOT STUDY

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**Introduction** Patients with chronic cardiac disease are shown to have secondary structural and functional changes that occur in the skeletal muscle which can result in decreased functional capacity and exercise intolerance. Previous studies have shown that supervised exercise rehabilitation programs result in improvements in functional capacity (1; 2) but the exact effect of exercise training on skeletal muscle activity in these patients is unknown. Therefore the aim of the study was to determine the effect of a supervised 12-week exercise rehabilitation program on skeletal muscle activity and muscle fiber conduction velocity (MFCV) during static and dynamic muscle contractions. **Methods** 9 patients with chronic cardiac disease and 8 matched healthy controls undertook testing before and after a 12 wk period. An electrode array (4 electrodes, 4 mm inter-electrode distance) was placed on the Vastus lateralis of the right leg to measure MFCV. Both groups performed two 5 s isometric maximal voluntary contraction on the Biodex dynamometer, followed by 5 s submaximal contractions at 20 %, 40 %, 60 % and 80 % MVC. Three maximal concentric isokinetic contractions were then performed at 60, 120 and 180 deg/s. **Results** Patients have significantly lower muscle strength ( $183 \pm 18$  Nm) compared to controls ( $230 \pm 38.8$  Nm) ( $p=0.026$ ) and their strength significantly improved after 12 weeks of rehabilitation ( $203 \pm 32$  Nm) ( $p=0.038$ ). MFCV has shown no difference between controls ( $3.4 \pm 0.5$  ms) and patients ( $3.3 \pm 0.8$  ms) in the Pre rehabilitation trial during MVCs and dynamic contractions. Interestingly, the patients have greater EMG activity during submaximal and dynamic contractions before rehabilitation, whereas post rehabilitation the EMG returns to levels of the controls, but with increase in muscle strength ( $p=0.08$ ;  $p=0.07$ ). **Conclusions** The findings of this study suggest that skeletal muscle contractile function was altered so as to produce greater force output but with unchanged relative EMG activity and conduction velocity. This suggests that patients become more efficient in performing the required exercise task following exercise training. **References** 1) Derman W, Whitesman S, Dreyer M, Patel DN, Nossel CJ, Schweltnus MP. Healthy lifestyle interventions in general practice. Part 2: Lifestyle and cardiovascular disease. South African Family Practice 2008; 50:6-9. 2) Streuber SD, Amsterdam EA, Stebbins CL. Heart rate recovery in heart failure patients after a 12-week cardiac rehabilitation program. American Journal of Cardiology 2006; 97:694-698.

### POST-EXERCISE HYPOTENSION AFTER AEROBIC EXERCISE IN PATIENTS WITH INTERMITTENT CLAUDICATION

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**Introduction** Post-exercise hypotension has been demonstrated after aerobic exercise in normotensive and hypertensive subjects (Pescatello et al, 2004). However, in patients with intermittent claudication (IC), this phenomenon has been poorly studied. Thus, the aim of the present study was to analyze the occurrence of post-exercise hypotension and its hemodynamic determinants after a bout of aerobic exercise in IC patients. **Methods** Twelve patients underwent two sessions executed in a random order: aerobic exercise (E, 15 2-min bouts of walking on a treadmill) and control (C, 60 min of upright rest). Before and for 60 min after the interventions, blood pressure (BP), heart rate (HR) and cardiac output (CO, CO<sub>2</sub> rebreathing) were measured while subjects rested in supine position. Systemic vascular resistance (SVR) and stroke volume (SV) were calculated. A two-way ANOVA for repeated measures was employed. Data are mean $\pm$ SE. **Results** In comparison with pre-intervention values, systolic, diastolic and mean BP increased significantly after the C session. In contrast, systolic BP decreased, and diastolic and mean BP did not change after the E session, which produced a net reduction of  $-13 \pm 2$ ,  $-6 \pm 2$  and  $-8 \pm 2$  mmHg, respectively. In the sample as a whole, CO decreased while SVR increased significantly and similarly after the interventions in both sessions. Considering individual responses, SVR decreased in 42% of the sample, CO in 25%, and in another 25%, both mechanisms decreased simultaneously. In the C session, the reduction in the CO was due to a decrease in HR, while in the E session it was accompanied by a decrease in SV. **Discussion** The findings of present study show that a session of aerobic exercise promoted post-exercise hypotension in IC patients. The magnitude of BP reduction was similar to the one reported for hypertensive subjects (Pescatello et al, 2004). Thus, these results may have clinical relevance, since hypertension is a common comorbid in this population. The hemodynamic mechanisms of post-exercise BP reduction varied among the patients as already reported for healthy subjects (Forjaz et al., 2004), and

future studies may address the possible determinants of these mechanisms. Financial support: FAPESP (2009/17371-6), CAPES DEMANDA SOCIAL. References Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA. American College of Sports Medicine position stand. Exercise and hypertension. *Med Sci Sports Exerc*, 2004;36: 533-53. Forjaz CLM, Cardozo Jr CG, Rezk CC, Santaella DF, Tinucci T. Post-exercise hypotension and hemodynamics: the role of exercise intensity. *J Sports Med Physical Fit*, 2004; 44:54-62.

### THE EFFECT OF CONTINUOUS AEROBIC EXERCISE ON PEAK OXYGEN UPTAKE IN CABG PATIENTS

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IAU, NAJAFABAD BRANCH

The Effect of Continuous Aerobic Exercise on peak Oxygen Uptake in CABG Patients B.Sheikhsaraf1, F.Fathollahi Shoorabeh2, B. Tarverdi-zadeh3 1-Faculty member of IA University, Najafabad Branch 2-BSc of physical Education, Shahrekord University 4-Faculty member of IA University, Booshehr Branch Abstract Over the last decade, it has become increasingly clear that exercise is good for patients with heart failure. It can reduce symptoms and allowing patients to live more active lives. Increased aerobic exercise capacity appears to reduce cardiovascular mortality and so physical exercise to improve peak oxygen uptake (peak) is strongly recommended. The aim of this study was to assess the effect of continuous aerobic exercise on peak of patients after coronary artery bypass graft (CABG). Subjects were 36 male patients (BMI < 30) who were elapsed 3 months of their open heart surgery. They had no exercise activity, no orthopedics, pulmonary disease. They had no active chest pains or angina and were randomly assigned to one of two groups: a control group (C; n = 18) and a training group (T; n=18). T group exercised 41 minutes continuously at 50-70% of maximum heart rate (50-60% peak) for 8 weeks. peak was determined by ACSM formula. Continuous aerobic exercise has a significant effect on peak of CABG patients ( $p=0.036$ ), while there was no significant change in control group. The results of this study indicate that continuous aerobic exercise can be a method for increasing (peak) in CABG patients and it can reduce the risk of developing or speeding the progression of heart disease. This method can be used as an alternative method for decreasing the side effects of surgery.

### PHYSICAL ACTIVITY AS A MEDIATOR OF QUALITY OF LIFE IN BREAST CANCER PATIENTS ENROLLED IN A DISEASE MANAGEMENT PROGRAM

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Introduction Around 55.000 cases of breast cancer are registered and 18.000 women die due to this disease in Germany every year (Giersiepen et al., 2005). The women diagnosed with breast cancer are abruptly stricken by the psychological strain aside from the physical impairment. Physical activity is related to different aspects of the physical and psychological well-being (Dunlop & Self, 2008). The aim of the study is to evaluate the impact of a multimodal, behavioral-orientated physical activity program on health related quality of life (HRQoL) for women undergoing adjuvant therapy for breast cancer. Methods The study was designed as a classic follow-up intervention study. All participants were tested twice: In the first lesson of the exercise program (t1) and in the 12th and last lesson of the program (t2). At each time point data was taken about HRQoL (Bullinger & Kirchberger, 1998), fatigue and physical activity. Furthermore all the subjects participated in a 2 km walking test. Personal data was also recorded. Results 68 women took part in the program (aged  $64,7 \pm 7,76$ ; diagnosed in month  $45,2 \pm 45,7$ ; BMI  $25,6 \pm 4,37$ ). The following results have been found: • The sample showed clearly deviates in HRQoL from the values of the German norm of healthy women. These differences have been extremely dominant in the subscales ‚physical functioning‘ ( $d=0,58$ ) and ‚emotional roll functioning‘ ( $d=0,64$ ). • Significant and practical meaningful changes can be seen in the subscales ‚general health state‘ ( $N=46$ ,  $p<0,05$ ,  $d=0,23$ ), ‚psychological well-being‘ ( $N=45$ ,  $p<0,05$ ,  $d=0,38$ ) and ‚vitality‘ ( $N=45$ ,  $p<0,05$ ,  $d=0,23$ ). • Further analysis prove that the effects are independent of age ( $p=0,930$ ,  $F=0,148$ ) and of the time point of the diagnosis ( $p=0,173$ ,  $F=1,924$ ). • Having a  $p<0,01$  and an effect size of  $d=0,30$  the improvement of the endurance (2 km walking test,  $N=42$ ) is not only significant but also practical important. Discussion The design of the study does not allow the conclusion of a causal relationship between the participation in an exercise program and the effects demonstrated here. Yet, the effects that have been observed serve as an impulse to initiate further research in this area. The coming studies should have larger sample sizes and should use a control group. This could deliver further affirmation that this sort of exercise program should be standard as an adjuvant therapy for women enrolled in a DMP for breast cancer. References Bullinger M & Kirchberger I (1998). SF-36, Fragebogen zum Gesundheitszustand. Göttingen: Hogrefe. Dunlop BW, Self RL (2008). *Psychopharmacol Bull*, 41 (4), 65-75. Giersiepen K, Heitmann C, Jahnsen K, Lange C (2005). GdB, Heft 25 Brustkrebs, RKL, Berlin. (The study was funded by a grant of the DAK Health Insurance)

### EFFECTS OF DAILY PHYSICAL ACTIVITY ON FALLS RISK. A COMPARATIVE ANALYSIS BETWEEN INSTITUTIONALIZED AND COMMUNITY-DWELLING ELDERLY ADULTS

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Introduction: Strategies to increase daily physical activity may be viewed as a mean to counteract the high prevalence of falls in elderly subjects, which is an important and increasing single factor associated with disability, injury and death. On the other hand when the elderly have reduced autonomy and consequent need of institutionalization the social cost to support this prevalent scenario continues to rise. Thus, the present study aimed to evaluate the effect of daily physical activity, on balance, lower limbs strength and fear of falling in non-institutionalized (NI) and institutionalized (I) elderly subjects. Methods: This cross-sectional study included 40 institutionalized and 38 community-dwelling older adults aged 65 to 90 years. For data collection we used a socialdemographic questionnaire, the Tinetti Scale for balance assessment, the Falls Efficacy Scale (FES) to assess fear of falling based on the operational definition of fear as 'low perceived self-efficacy or confidence at avoiding falls' (Tinetti et al,1990) and validated for Portuguese population, and 30 seconds chair sit-to-stand for lower limbs strength assessment. Moreover, accelerometers (Actigraph GT1M) were used by the sample during 7 consecutive days for daily physical activity assessment. Data were verified for normality of distribution by Kolmogorov-Smirnov test. Impaired Student's t-test was used to compare means between groups and when the variables departed from normality, the Mann-Whitney test was used instead. Results: Data showed that the institutionalized older adults present lower daily physical activity (MVPA: I-  $250,11 \pm 218,52$  min/week vs NI-  $543,37 \pm 237,73$ ;  $p=0,000$ ) as well as less balance (Static balance: I-  $9,36 \pm 3,40$  vs NI-  $12,86 \pm 2,76$ ,  $p=0,000$  and Dynamic balance: I-  $8,05 \pm 2,79$  vs NI-  $11,16 \pm 1,90$ ;  $p=0,000$ ), increased fear of falls (I-  $63,93 \pm 20,49$  vs NI-  $88,81 \pm 14,51$ ;  $p=0,03$ ) and lower muscle strength (I-  $10,70$  reps vs  $18,76$  reps,  $p=0,00$ ) compared to non-institutionalized elderly peers. Conclusions: These results suggest that increase daily physical activity habits may be an effective strategy to positively influence fall risk in elderly subjects. Furthermore, this study supports the



idea that health care homes and institutionalizations for older subjects should promote Physical Activity instead of restricted it in order to prevent frailty. References: Tinetti, M.E., Richman, et al. (1990). *Journal of Gerontology* 45(6): P239-43. Acknowledgement This research was funded by the Portuguese Foundation of Science and Technology (FCT), grant FCOMP-01-0124-FEDER-009587 - PTDC/DES/102094/2008. E. A. Marques, and J. Mota are supported by grants from Portuguese FCT (SFRH/BD/36319/2007 and SFRH/BSAB/1025/2010 respectively).

### LONG-TERM SQUARE-STEPPING EXERCISE PROGRAMME AND ITS EFFECTS ON FUNCTIONAL FITNESS IN COMMUNITY-DWELLING ELDERLY PERSONS

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**Introduction** We have previously developed a novel exercise programme called the Square-Stepping Exercise (SSE) (Shigematsu and Okura, 2006). Walking involves forward-stepping movements, while SSE involves step movements in multiple directions. We confirmed the effects of SSE on the functional fitness of elderly persons in a 3-month randomised controlled trial. However, it is not clear whether SSE is consistently acceptable and effective is not known. The purpose of the study was to assess the acceptance of SSE and its effect on the functional fitness of elderly persons. **Methods** Community-dwelling elderly persons aged 69–77 years were randomly distributed into an SSE group (n = 32) and a walking group (n = 31). They participated in a 3-month exercise intervention programme with SSE and walking, respectively. After the programme, many participants in each group established autonomous exercise groups and continued to perform SSE or walk regularly. Functional fitness was assessed via physical performance tests 1 and 4 years after the programme. Results Of the SSE participants, 22 (69%) and 20 (63%) had been performing SSE regularly at 1 and 4 years, respectively. Of the walking participants, 20 (65%) and 20 (65%) continued walking regularly at 1 and 4 years, respectively. The number of participants in the SSE group who continued SSE did not differ significantly from those in the walking group who continued walking. Stepping agility and chair stands in both groups improved significantly from the baseline (beginning of the 3-month programme) at the 1- and 4-year assessment, but handgrip strength decreased significantly ( $P < 0.05$ ). Tandem walking, simple reaction time, choice reaction time, and walking agility improved significantly only in the SSE group at the 1-year assessment ( $P < 0.05$ ). In this group, the improvements in walking agility and choice reaction time were sustainably maintained at the 4-year assessment. Significant improvement in functional reach at 1-yr in both groups was attenuated at 4-yr. **Discussion** SSE seems sustainably acceptable among elderly persons because the percentage of adherence to SSE was similar to that to walking. Improvement in functional fitness was significantly higher in the SSE group than in the walking group. This may be because SSE involves stepping in multiple directions. Therefore, we recommend SSE as an alternative exercise programme, which is acceptable among elderly persons and has a significant long-term effect on the functional fitness of lower extremities. Reference Shigematsu R, Okura T. (2006). *Aging Clin Exp Res*, 18, 242-248.

### REGULAR LEVEL AND DOWNHILL TREADMILL WALKING AT SELF-SELECTED SPEED IMPROVES WALKING ABILITY AND PREDICTED AEROBIC CAPACITY IN OLDER PEOPLE

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**Introduction** Older women are able to self-select treadmill walking speeds that meet the recommended physical activity intensity guidelines (Haycock et al., 2009). This study examined the effects of regular level and downhill treadmill walking (i.e. concentric and eccentric endurance exercise) on maximal walking speed, 1-mile walk and predicted maximum oxygen uptake. **Methods** Twenty-four community-dwelling people (12 men, 12 women,  $67 \pm 4$  yrs,  $75 \pm 14$  kg) volunteered for the study. Self-selected level walking speed was determined by participants as a speed which could be maintained for 30-mins. Subjects began walking at  $2.5 \text{ km} \cdot \text{hr}^{-1}$ , increments of  $0.2 \text{ km} \cdot \text{hr}^{-1}$  were employed every 30-secs. Self-selected speed was readjusted at weeks 4 and 8. Participants walked  $3 \times 30$ -min on a level (LW: 0%) or downhill (DW: -10%) gradient every week, full adherence was required for progression. Completion rates were 9 (LW) and 10 (DW) after 12 weeks. Maximal walking speed over 10-m and a 1-mile indoor walk predicting maximum oxygen uptake (Fenstermaker et al., 1992) were performed at baseline, 4, 8 and 12 weeks. Physiological responses during the 1-mile walk were recorded with a portable metabolic system (Cosmed K4b2; Gault et al., 2009). Results Treadmill walking speeds were similar at baseline (LW:  $1.18 \pm 0.11 \text{ m} \cdot \text{s}^{-1}$ ; DW:  $1.26 \pm 0.16 \text{ m} \cdot \text{s}^{-1}$ ) and increased ( $P < 0.0001$ ) equally in both groups ( $P > 0.2$ ) at all time points. Maximum 10-m walking speeds were also similar at baseline (LW:  $2.39 \pm 0.38 \text{ m} \cdot \text{s}^{-1}$ ; DW:  $2.40 \pm 0.33 \text{ m} \cdot \text{s}^{-1}$ ) with equal increases at 4, 8 and 12 weeks ( $P < 0.0001$ ). Mean one-mile walking speed was  $1.78 \text{ m} \cdot \text{s}^{-1}$  in both groups at baseline, this increased significantly in both groups after 8 ( $P < 0.0001$ ) and 12 weeks ( $P < 0.0001$ ). Predicted maximum oxygen uptake increased after 8-weeks of training in both groups (LW:  $23 \pm 15\%$ ; DW:  $23 \pm 30\%$ ,  $P < 0.0001$ ) with no further increases measured at 12 weeks ( $P > 0.2$ ). **Discussion** Older men and women who engaged in regular downhill and level treadmill walking increased maximal walking speed after only 4 weeks; whereas the pace they could maintain over 1-mile increased after 8 weeks. Eccentric endurance exercise performed with a reduced cardiovascular load (Clements et al., 2011) resulted in similar aerobic adaptations to level treadmill walking. Therefore, downhill treadmill walking at a self-selected speed may serve as a novel exercise intervention to induce functional adaptations in elderly people. References Clements RE, Gault ML, Willems MET (2011). *Med Sci Sports Exerc*, 43(5), Suppl. (In Press). Fenstermaker KL, Plowman SA, Looney MA (1992). *Res Q Exerc Sport*, 63, 322-327. Gault M, Clements RE, Willems MET (2009). *J Hum Kinet*, 21, 41-48. Haycock M, Sabapathy S, Morris N, Gass G, Minahan C (2009). *Med Sci Sports Exerc*, 41(5), S466.

### IS IT TRUE THAT WALK WITH DOG INCREASES BOTH SEX ADOLESCENTS PHYSICAL ACTIVITY LEVEL?

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**Introduction** Physical activity is recognized as important behavior related to health for different age groups. Many adolescents do not reach enough amount of daily physical activity to prevent chronic diseases (Ceschini et al, 2009). Simple activities like walking and biking are recommended to increase physical activity level (PAL). Thus this paper aimed to determine the influence of active (ABe) and sedentary (SBe) behaviors in both sex adolescents PAL. **Methods** 136 adolescents boys and 126 girls living at São Paulo City-Brazil (15.3+1.1 years old boys and 15.6+1.3 years old girls) answered the International Physical Activity Questionnaire (IPAQ- short version 8). IPAQ determines the PAL accordingly total time related to body movement (locomotion, exercise program at leisure time, dog walking, bike riding). The classifi-

cation in active (AC) and insufficient active (INA) adolescents followed Ceschini and Figueira Junior (2011): AC-adolescent that accumulate more than 300 min/week of PA; INA-adolescent that accumulate less than 300 min/week of PA. Active behavior (ABe) was walk with the dog (min/week) and riding a bike (min/week). Sedentary behavior (SBe) chosen was TV watching (min/week) and computer use (min/week). Student Paired t Test compared AC and INA boys and girls for ABe and SBe. The level of significance was  $p < .01$ . Results Data evidenced that both sex adolescents accumulated in average 94.8 min/week in ABe and 475.1 min/week in SBe. AC boys spent 100.2 min/week in ABe while AC girls 143.3 min/week. INA boys spent 100.1 min/week in ABe and INA girls 41.2 min/week (ABe). Discussion These data evidenced the importance of walk with dog and bike riding as ABe for PAL. Both AC and INA boys presented similar contribution of dog walking and bike riding in PAL. However INA girls presented lower adherence in ABe activities than AC girls, and AC and INA boys. These data allow us to conclude that ABe contributed to total PAL in AC adolescents. SBe was higher in AC group, but did not decrease the PAL. Data presented that PAL was higher to those ones that walked with dog and ride a bike. We suggest to stimulate easy-daily activities as walking for increasing PAL (Gorely, et al, 2009). References Ceschini, F., Andrade, D., Oliveira L., Araújo, J., Matsudo, V. (2009). Prevalence of physical inactivity and associated factors among high school students from state's public schools. *Jornal de Pediatria*, 85(4), 301-306. Gorely, T., Biddle, S., Marshall, S., Cassey, N. (2009). The Association Between Distance to School, Physical Activity and Sedentary Behaviors in Adolescents: Project STIL. *Pediatric Exercise Science*, 21, 450-461. Ceschini, F. and Figueira Júnior, A. (2011). Prevalence of Physical Inactivity and associated factor among adolescents in São Paulo, Brazil. *Pediatric Exercise Science* (accept for publication)

## THE EFFECT OF DEPRESSION ON THE PARTICIPATION IN THE EXERCISE HABITS IN COMMUNITY-DWELLING JAPANESE OLDER PEOPLE

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Introduction: Physical activity is one of the most important health behaviors especially in later life. Previous studies found that physical activity was associated with prevention and improvement of depression. Although the association may be bidirectional, few studies examined the effect of depression on participation in regular physical activity in older people. The purpose of this study was to evaluate the impact of depression on participation in exercise habits in community-dwelling Japanese older people. Methods: The subjects consisted of 523 men and 461 women who were the participants aged 60 years and over in the 4th study of the National Institute for Longevity Sciences - Longitudinal Study of Aging (NLS-LSA). Exercise habits were assessed by questionnaire and interview. Physical activities or sports for 20 minutes or more, at least once a week and over 1 year were defined as an exercise habit. Depression was assessed by the Center for Epidemiologic Studies Depression (CES-D) scale. The score of 16 or over was defined as depression. Sociodemographics, health conditions and lifestyle factors were checked by questionnaire. Multiple logistic regression models were used to estimate the effect of depression on participation in exercise habits. Both the unadjusted model and the adjusted model for all potential confounders were performed in men and women separately. Significant probability levels were considered to be less than 0.05. Results: The participation rate in exercise habits was 65.4% in men and 57.1% in women. The prevalence of depression in the subjects with and without exercise habits was 10.7 % and 19.9 % in men and 16.0 % and 20.9 % in women, respectively. Men with exercise habits had a significantly lower prevalence rate of depression than those without exercise habit, whereas there was no significant difference in depression by exercise habits in women. In the unadjusted logistic regression model, exercise habit was significantly influenced by depression in men (OR 0.48, 95%CI 0.29-0.80). After adjusting for all potential confounders, the risk of depression on exercise habit was not significant in men. In women, there were no significant associations between depression and exercise habit in both models. Conclusion: Depression was cross-sectionally associated with lower participation in exercise habits in men aged 60 years and over. However, the association was modified by the confounders such as lifestyle factors and health conditions. In women, depression may not be associated with participation in exercise habit.

## Poster presentations

### PP-PM79 Sports Nutrition: CHO

## ARE CURRENT CARBOHYDRATE RECOMMENDATIONS FOR ENDURANCE EXERCISE APPROPRIATE AND ATTAINABLE FOR MOUNTAIN MARATHONERS?

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ARE CURRENT CARBOHYDRATE RECOMMENDATIONS FOR ENDURANCE EXERCISE APPROPRIATE AND ATTAINABLE FOR MOUNTAIN MARATHONERS? EA Mahon, IG Davies, TA Stott & AF Hackett, Liverpool John Moores University Introduction There is plentiful evidence that increasing available carbohydrate (CHO) enhances performance during exercise, but limited literature exists on the requirements of ultra-endurance athletes. Intakes of 30-60 g CHO per hour are currently recommended (American College of Sports Medicine, 2009), but data suggests mountain marathoners typically consume less than this (Kruessman et al., 2005). The purpose of this study was to investigate if the provision of written dietary guidelines is effective in helping mountain marathoners to meet these recommendations and whether it is associated with an improvement in performance. Methods An intervention study was performed using male participants entered in the Longmynd Hike (50 mile race). The intervention group (n = 8, mean age: 42 (SD: 13) y, body mass index (BMI): 24.0 (SD: 3.4) kg/m<sup>2</sup>) received written dietary advice for CHO consumption and the control group (n = 8, mean age: 44 (SD: 18) y, BMI: 24.1 (SD: 1.6) kg/m<sup>2</sup>) received no advice. Participants were assigned to each group by stratified random sampling. Participants completed a weighed food inventory of all items consumed during the event and provided a rating of perceived exertion (RPE) using the Borg 6-20 scale (Borg, 1970). All data are expressed as means (SD), statistical significance  $p < 0.05$ . Results Total CHO consumption was significantly different between groups [intervention: 670 (120) g, control: 491 (176) g,  $t = 2.39$ ,  $p = 0.034$ ]. All participants in the intervention group consumed within the recommended range [mean: 40 (10) g/h, range: 30-57 g/h], in comparison 62.5% of the control group consumed < 30g CHO/h [mean: 31 (14) g/h, range: 16-51 g/h]. CHO (g/h) showed a strong, positive correlation with performance ( $r = 0.622$ ,  $p = 0.017$ ,  $n = 16$ ). There was no significant difference in overall performance between the intervention and control groups [mean completion time: 17.0 (3.4) h and 16.9 (2.8) h, respectively], however RPE was significantly higher in the control group [intervention: 15 (2.0), control: 18 (1.2),  $t = -2.97$ ,  $p = 0.012$ ]. Discussion These findings suggest that written advice can be effective in aiding athletes to meet dietary guidelines. As CHO appears to

have a strong association with performance in such events, and the quantities consumed by the intervention group were still at the lower end of the recommendations, it may be beneficial to promote higher intakes of 1 g/kg/h closer to the maximum CHO oxidation rate (Hawley et al., 1992). References American College of Sports Medicine (2009). *Med Sci Sports Exerc* 41, 709-31. Borg G (1970). *Scand J Rehabil Med* 2, 92-8. Hawley JA, Dennis SC, Noakes TD (1992). *Sports Med* 14, 27-42. Kruesman M, Bucher S, Bovard M et al. (2005). *Eur J appl Physiol* 94, 151-7.

### **ADDITION OF CAFFEINE TO POST-EXERCISE CARBOHYDRATE FEEDING IMPROVES SUBSEQUENT HIGH-INTENSITY INTERVAL RUNNING CAPACITY COMPARED WITH CARBOHYDRATE ALONE**

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The aim of this study was to test the hypothesis that the addition of caffeine to post-exercise carbohydrate feedings improves subsequent high-intensity interval running capacity compared with carbohydrate alone. In a repeated measures design, six men performed a glycogen-depleting exercise protocol until volitional exhaustion in the morning. Immediately after and at 1, 2 and 3 h post-exercise, participants consumed either: 1) 1.2 g.kg<sup>-1</sup> body mass (CHO) of a 15% carbohydrate solution, 2) a similar CHO feeding protocol but with addition of 8 mg.kg<sup>-1</sup> body mass of caffeine (CHO+CAFF) or, 3) an equivalent volume of flavoured water only (WAT). After the 4 h recovery period, participants performed the Loughborough Intermittent Shuttle Test (LIST) to volitional exhaustion as a measure of high-intensity interval running capacity. Average blood glucose values during the 4 recovery period were higher in the CHO conditions ( $P < 0.005$ ) compared with the WAT trial ( $4.6 \pm 0.3$  mmol.L<sup>-1</sup>), although there was no difference ( $P = 0.46$ ) between CHO ( $6.2 \pm 0.8$  mmol.L<sup>-1</sup>) and CHO+CAFF ( $6.7 \pm 1.0$  mmol.L<sup>-1</sup>). Exercise capacity during the LIST was significantly longer in the CHO+CAFF trial ( $48 \pm 15$  min) compared with the CHO ( $32 \pm 15$  min,  $P = 0.04$ ) and WAT conditions ( $19 \pm 6$  min,  $P = 0.001$ ). All six participants improved performance in CHO+CAFF compared with CHO (95% CI for mean difference = 1-32 min). We conclude that addition of caffeine to post-exercise CHO feeding improves subsequent high-intensity interval running capacity, which may be related to higher rates of post-exercise muscle glycogen re-synthesis previously observed during similar feeding conditions (Pedersen et al. 2008).

### **PERFORMANCE AND METABOLIC EFFECTS OF HIGH AND LOW GLYCAEMIC INDEX MEALS PRIOR TO SOCCER SPECIFIC EXERCISE**

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**Introduction** Pre-exercise meals or single foods containing low glycaemic index (LGI) carbohydrates (CHO) have been shown to enhance performance prior to prolonged steady state exercise compared to high glycaemic index (HGI) CHO. This study investigated the impact of HGI and LGI pre-exercise meals on simulated-soccer activity. **Methods** Nine male recreational football players performed a football specific protocol followed by a 1 km time trial 3 ½ h after ingesting one of two isoenergetic test meals (HGI: 870.3 kcal, LGI: 889.5 kcal), which were either HGI (GI: 80) or LGI (GI: 44). Plasma glucose, non-esterified fatty acids (NEFA), glycerol,  $\beta$ -hydroxybutyrate, lactate and insulin were assessed before, during, and after the exercise bout, whilst rates of CHO and fat oxidation were determined at four time points during the protocol along with heart rate (HR), rating of perceived exertion (RPE) and ratings of hunger and fullness. **Results** No significant differences were found for the 1km time trial (LGI:  $210.2 \pm 19.1$  s; HGI:  $215.8 \pm 22.6$  s), nor for any of the other variables measured ( $P < 0.05$ ) apart from a significant condition effect with NEFA (LGI:  $1.69$  mmol.L<sup>-1</sup>; HGI:  $1.33$  mmol.L<sup>-1</sup>) and significant interaction effects observed for glucose,  $\beta$ -hydroxybutyrate and lactate ( $P > 0.05$ ). **Discussion** These findings suggest that the type of CHO ingested in a pre-match meal has no significant impact on metabolic responses during 90 minutes of football simulated activity or on a subsequent performance test.

### **HIGH AND LOW CARBOHYDRATE DIETS AND DISTANCES COVERED IN SOCCER**

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1: Faculty of Physical Education and Sports Science, University of Athens (Athens, Greece) 2: Department of Sports Organization and Management, University of Peloponnese, (Sparta - Laconias, Greece) 3: Department of Physical Education and Sport Science of Serres, Aristotle University of Thessaloniki (Thessaloniki, Greece) **Introduction** The intake of carbohydrate (CHO) in soccer may reduce the negative effects of fatigue (FIFA/F-MARC 2006). This study compared the distance covered during soccer following a high or a low CHO diet. **Methods** Twenty two professional male soccer players formed two teams of similar age, body characteristics, and training experience [Team A:  $24 \pm 0.7$  yrs;  $180 \pm 2$  cm;  $75.7 \pm 1.4$  Kg;  $10.6 \pm 0.3$  %;  $12.6 \pm 0.7$  yrs Vs. Team B:  $24.5 \pm 0.8$  yrs;  $180 \pm 2$  cm;  $76 \pm 1.4$  Kg;  $10.7 \pm 0.3$  %;  $13.5 \pm 0.9$  yrs, for age, height, body mass (BM), % body fat, and training experience respectively; mean  $\pm$  SE]. The teams played against each other twice with a week interval, following either a high (8 g CHO/ Kg BM) (HC) or a low (3 g CHO/ Kg BM) CHO diet (LC) for 3 days before each game. The goalkeepers were excluded from dietary intervention and data collection procedures. In the 1st match team A followed the HC diet and team B the LC diet, whereas in the 2nd match the treatment was reversed. Environmental conditions were similar between the two games (1st game:  $25^\circ\text{C}$ , 23% vs. 2nd game:  $26.2^\circ\text{C}$ , 29%, for temperature and humidity respectively), while fluid intake was provided ad libitum. Distances covered, running speeds, and heart rates during the games were recorded using GPS technology (GARMIN 305). **Results** When players followed the HC treatment won the matches [Team A vs. Team B: 3-1 (half time: 1-0) for the 1st game and Team A vs. Team B: 1-2 (half time: 0-0) for the 2nd game]. Every player covered a greater total distance in HC compared to the distance covered in LC (HC:  $9380 \pm 98$  m vs. LC:  $8077 \pm 109$  m;  $p < 0.01$ ). Also, when the total distance was analysed for different speeds of movement, it was observed that all distances covered from easy jogging ( $2$  m.sec<sup>-1</sup>) to sprinting ( $> 6.72$  m.sec<sup>-1</sup>) were higher in HC compared to LC ( $p < 0.01$ ). Furthermore, mean heart rate was higher in HC ( $169 \pm 1$  b.min<sup>-1</sup>) compared to LC ( $164 \pm 1$  b.min<sup>-1</sup>) condition ( $p < 0.01$ ). **Discussion** The data show that the HC diet helped players to cover a greater distance compared to LC, something that may have contributed to winning. **References** FIFA/F-MARC (2006). *J Sports Sci*, 24, 663-664.

## EFFECTS OF CARBOHYDRATE-ELECTROLYTE PLUS CAFFEINE INGESTION ON PERFORMANCE AFTER A ROLLER HOCKEY GAME

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**Introduction** A roller hockey game is a fast-paced highly skill game, characterised by short duration high intensity efforts, with variable periods of recovery, played indoors in halves of 25min. It challenges athletes' nutritional status, which if not properly assured increase the risk of impaired performance. This study compared the effect of ingesting a carbohydrate-electrolyte solution alone (CE) or with caffeine added (CEC) with water (W) on hydration status, and physical, technical and cognitive performances after a roller hockey game. **Methods** In a randomized, double-blind, crossover, 12 male well-trained roller hockey players ( $23.6 \pm 4.9$  yr) performed, in 3 different occasions separated by a week, a 60 min simulated roller hockey game ( $\sim 56\% \text{VO}_{2\text{max}}$ ), followed by a set of technical (dribble, pass, reception, shooting, control and ball possession) and physical (strength, speed, acceleration, agility and reaction) drills ( $\sim 32\% \text{VO}_{2\text{max}}$ , 60 min) that ended with a YoYo Intermittent Endurance Test Level 2 ( $\sim 76\% \text{VO}_{2\text{max}}$ , 8 min). Athletes ingested W (0.38mg/100ml Na), CE (7% CHO, 68mg/100ml Na) or CEC (25mg caffeine/100ml) before (5 ml/kg), every 15 min during ( $4 \times 2$  ml/kg), and every 20 min after ( $3 \times 2$  ml/kg) the roller hockey game. Body weight lost, sweat rate, urine colour, rating of perceived exertion (RPE) and mood states (BRUMS) were determined. Results Athletes reported a higher RPE with W ( $13.75 \pm 1.06$ ) compared with CE ( $12.75 \pm 1.85$ ) and CEC ( $11.83 \pm 1.4$ ) immediately after the game ( $p=0.021$ ) that lost statistical significance after the drills and YoYo tests. The squat jump ( $38.9 \pm 3.8$  cm) and agility and reaction ( $35.5 \pm 1.4$  sec) were significantly improved in the CEC trial than with W ( $34.8 \pm 3.8$  cm and  $38.0 \pm 1.5$  sec) and CE ( $38.0 \pm 3.9$  cm  $36.6 \pm 2.2$  sec). Athletes reported lower levels of cognitive fatigue after the exercise protocol ( $p=0.03$ ) with CEC ( $-0.67$ ) than with CE ( $+0.08$ ) and W ( $+0.83$ ). The distance covered on the YoYo test increased ( $26.2\%$ ) non-significantly ( $p=0.058$ ) with CEC in comparison with W. It was observed an almost statistical significant ( $p=0.058$ ) negative correlation ( $r=-0.319$ ) between sweating rate and performance in the YoYo test. There were no significant differences in fluid intake, body weight loss, sweat rate, urine colour, skill parameters and the other physical variables between the 3 drinks. **Conclusions** The intake of carbohydrate-electrolyte solutions, with or without caffeine, appears to decline the perception of fatigue after exercise. Caffeine seems to further improve explosive power and reaction time and agility without adversely affecting hydration status.

## THE EFFECTS OF INGESTING A SOLID VS. A LIQUID CARBOHYDRATE SUPPLEMENT ON ERGOMETER ROWING PERFORMANCE.

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**Introduction.** Research indicates that carbohydrate (CHO) ingestion can improve cycling and running performance in events lasting longer than approximately 45-min (Jeukendrup et al., 1997; Rollo & Williams, 2009). Furthermore, in cycling exercise, the form of the ingested CHO does not affect its oxidation rate (Pfeiffer et al., 2010). However, research concerning the effects of CHO, either in a liquid or a solid form in rowing is limited and even fewer studies have investigated the impact on performance. This study evaluated the effects of solid or liquid CHO ingestion on ergometer rowing TT performance. **Methods.** On three occasions, five oarsmen (mean  $\pm$  SD age  $23 \pm 3$  y, height  $184.0 \pm 5.1$  cm, weight  $83.7 \pm 6.7$  kg,  $\text{VO}_{2\text{max}}$   $5.1 \pm 0.5$  L.min<sup>-1</sup>) performed 45-min of rowing at 60% of  $\text{VO}_{2\text{max}}$  on a Concept-2 ergometer, followed by a 5-km TT. Ten minutes before and immediately after the 45-min preload, participants ingested either: 900ml (600ml + 300ml) of a 6% CHO solution (DRINK), 900ml of a flavoured placebo beverage (PLA) or an isoenergetic solid CHO supplement with 100ml of PLA (SOLID) in a randomised order. **Statistics.** Heart rate (HR) and rating of perceived exertion (RPE) were analysed using a two way (trial  $\times$  time) repeated measures ANOVA. Time trial data (shown as mean  $\pm$  90% confidence limits) were analysed using the methods of Batterham & Hopkins (2006). **Results.** Ingestion of DRINK improved TT time by  $2.5 \pm 1.5\%$  (highly likely to improve performance) and  $1.9 \pm 2.6\%$  (likely to improve performance) compared to PLA and SOLID, respectively. There were no differences in HR or RPE between trials, although there was a trend for a higher mean HR during the TT in DRINK ( $175 \pm 8$ ,  $176 \pm 7$  and  $180 \pm 5$  bpm, for PLA, SOLID and DRINK, respectively,  $P=0.052$ ). **Discussion.** Ingestion of DRINK improved 5-km rowing TT time compared to both PLA and SOLID. It has been proposed that the presence of CHO in the mouth stimulates oral CHO receptors, which may have central effects (Chambers et al., 2009). Improvements in TT performance following CHO ingestion may be due to central effects of CHO increasing motor drive, leading to a higher power output, and thus HR. This may explain the trivial effect of SOLID ingestion, as oral exposure to CHO may have been limited in comparison to ingestion of 900ml of DRINK. Alternatively, the lower fluid content may have impaired performance due to cardiovascular or thermoregulatory limitations. **References.** Batterham AM & Hopkins WG (2006). Int J Sports Physiol Perform 1, 50-57. Chambers ES, Bridge MW & Jones DA (2009). J Physiol 587, 1779-1794. Jeukendrup A, Brouns F, Wagenmakers AJ & Saris WH (1997). Int J Sports Med 18, 125-129. Pfeiffer B, Stellingwerff T, Zaltas E & Jeukendrup AE (2010). Med Sci Sports Exerc 42, 2030-2037. Rollo I & Williams C (2009). Int J Sport Nutr Exerc Metab 19, 645-658.

## CARBOHYDRATE INGESTION DURING A 5KM SWIM: EFFECTS ON METABOLISM AND PERFORMANCE

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**Introduction** Prolonged swimming performance may decrease because of reduced carbohydrate stores, while muscle injury may occur depending on the intensity of exertion (Smith et al., 2002). The aim of this study was to determine whether carbohydrate consumption during a 5km swim would affect performance, glucose and lactate levels and the concentration of cytokine IL-6 which increases with fatigue and hypoglycemia (Krook A., 2008). **Methods** Ten open water swimmers (age:  $43 \pm 7.6$  yrs,  $\text{VO}_{2\text{peak}}$ :  $49 \pm 11$  ml/kg/min) performed a 5km swimming trial under two experimental conditions in a double blind cross over repeated measures design. At 1.5km in a brief 20s break they consumed either a maltodextrin supplement containing 0.5 g of glucose/kg BW in an aqueous concentration of 35% carbohydrate (C) or a placebo of equal volume (P). Venous blood samples were obtained before and after both trials to determine glucose, lactate and IL-6 concentrations. **Results** Performance was similar between C and P conditions ( $5306 \pm 494$  vs.  $5404 \pm 598$ s,  $p>0.05$ ). When comparing the first to the fifth 1km split, performance was decreased by  $2.9 \pm 4.6\%$  in the C and by  $9.5 \pm 10\%$  in the P trial ( $p>0.05$ ). Blood lactate and blood glucose concentrations were increased after each trial compared to resting values ( $p<0.05$ ) and this was more evident in the C condition. Interleukin-6 (IL-6) after the 5km trials was unchanged compared to resting values and similar between conditions. **Discussion** Carbohydrate supplementation during a 5km swim didn't significantly improve performance, despite showing trends of

maintaining velocity on the last 1km. High blood glucose levels after supplementation -a sign of increased glucose availability- is perhaps the reason for maintaining faster times in the latter part of the C trial as previously shown in cycling (Coyle et al. 1986). The low levels of lactate post exercise and the lack of changes in the IL-6 levels indirectly reflect the low intensity of swimming in both trials (<70% of maxHR), that wasn't adequate to challenge carbohydrate stores. References Coyle E.F., Coggan R., Hemmet M.K., Ivy J.L. (1986), J.A.P.61(1):165-172. Krook A. (2008), Diabetologia, 51:1097-1099. Nehlsen-Cannarella S.L., Fagoaga D.C., Davis J.,(1997), J.A.P.,82(5): 1662-1667. Smith G.L.,Rhodes E.C., Langill R.H. (2002), Int.J.Sp.Nutr.,12:136-144.

### **INFLUENCE OF CARBOHYDRATE SUPPLEMENTATION ON OVERTRAINING MARKERS IN ELITE RUNNERS DURING INTENSIVE TRAINING**

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**Introduction:** Combining a comprehensive training program with inadequate recovery periods and diet can result in overtraining syndrome, with consequent damage to athletic performance (Angeli et al. 2004). Therefore, the aim of this study was to evaluate the influence of carbohydrate supplementation on markers of overtraining for long distance runners undergoing an intensive training program. **Methods:** Twenty-four male elite runners ( $28.0 \pm 1.2$  years) who took part in overload training for 8 days followed by a high intensity intermittent running protocol (10x800m) on the 9th day, were randomly assigned to 2 groups (CHO-group and CON-group) using a double-blind design. The two groups were allotted isocaloric diets whereas one group ingested maltodextrin as a carbohydrate solution (CHO-group) during every training session and the other group was supplied with a placebo solution (CON-group). **Results:** After 8 days of intensive training LDH baseline levels remained constant in the CHO group and increased in the CON group. On the 9th day LDH concentrations were lower in the CHO group than in the CON group post 10x800m. CHO ingestion attenuated the increase of free plasma DNA post 10x800m ( $48240.3 \pm 5431.8$  Allels/ml) when compared to the CON group ( $73751.8 \pm 11546.6$  Allels/ml,  $p < 0.01$ ). Leukocyte counts were attenuated in the CHO group following 10x800m when compared with the CON group and at the 80 min of the recovery period. Cortisol levels were lower in the CHO group post 10x800m than CON group. **Discussion:** CHO ingestion reduced exercise-induced stress hormone evidenced by a lower cortisol response after 10x800m and at 80 min of the recovery period (de Sousa et al. 2010). This might explain the findings of the present study, regarding attenuation in the circulating concentration of free-plasma DNA, LDH and leukocytes after 10x800m in the CHO group. **Conclusion:** Our findings showed that carbohydrate beverage resulted in less DNA damage and attenuation of conventional indices of overtraining so providing a better recovery during intensive training. References Angeli A et al (2004) J Endocrinol Invest 27:603-612 de Sousa MV et al (2010) Eur J Appl Physiol 109:507-16

### **EVALUATION OF THE EFFECTS OF CARBOHYDRATE SUPPLEMENTS VARYING IN MOLECULAR WEIGHT ON REPEATED SPRINT PERFORMANCE AFTER SHORT TERM RECOVERY FROM INTERMITTENT EXERCISE**

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**EVALUATION OF THE EFFECTS OF CARBOHYDRATE SUPPLEMENTS VARYING IN MOLECULAR WEIGHT ON REPEATED SPRINT PERFORMANCE AFTER SHORT TERM RECOVERY FROM INTERMITTENT EXERCISE** Higgins, M.F (1,2), MacLaren, D.P.M (1) 1: Liverpool John Moores University (UK) 2: University of Coventry (UK) **Introduction** In professional sports, such as rugby union and soccer, players frequently train more than once a day, with training sessions usually two to three hours apart. Therefore, recovery between sessions is crucial if training in the second bout is to be maximised. This study evaluated the effects of two carbohydrate supplements, of different molecular weight (High; HMW and Low; LMW), on repeated sprint performance after a short (3-hour) recovery period from an initial strenuous bout of high-intensity intermittent exercise. **Methods** Six healthy, active males performed 60 minutes of high-intensity shuttle running (LIST; Nicholas et al. 2000) followed by three hours seated recovery. Participants then completed a further 30 minutes high-intensity shuttle running and a bout of six single sprints around a multi-directional course. During recovery, using a double blind and counterbalanced administration, participants consumed two 1 L (10%) solutions of the LMW or HMW solutions and a small isoenergetic meal. Performance was measured as the cumulative sprint time for: the twenty sprints during the post recovery shuttle running and six multidirectional sprints. **Results** No significant difference was apparent for the post recovery cumulative sprint time ( $51.7 \pm 2.3$  s;  $52.2 \pm 2.4$  s;  $P > 0.05$  for LMW and HMW respectively). However, cumulative sprint time for repeated multi-directional sprinting was 3% faster after the LMW solution ( $21.1 \pm 1.1$  s vs.  $21.8 \pm 0.7$  s,  $P < 0.05$ ). **Discussion** Ninety minutes of high intensity shuttle running results in significant depletion of muscle glycogen although higher in type II than type I fibres (Nicholas et al. 1999). With lower glycogen re-synthesis in type II fibres during recovery, reliability on type II fibres during subsequent exercise and no evidence of hypoglycaemia, it is likely that differences in muscle fibre type replenishment and thus substrate availability played some role in the contrasting results to similar previous research (Casey et al. 1995; Stephens et al. 2008). Although, the exact mechanism(s) remains to be elucidated these results may have practical implications for athletes engaging in repeated daily bouts of high intensity intermittent exercise which include multi-directional sprinting. References Casey A, Short AH, Hultman E. et al. (1995). J of Physiology, 483:265-271. Nicholas CW, Tsintzas K, Boobis L. et al. (1999). Med Sci Sport Ex; 31:1280-1286. Nicholas CW, Nuffall FE, Williams C. (2000). J Sports Sci 2000; 18:97-104. Stephens FB, Roig M, Armstrong G. et al. (2008) J Sports Sci, 26: 149-154.

### **THE EFFECT OF CARBOHYDRATE BAR INGESTION ON PHYSIOLOGICAL AND METABOLIC RESPONSES TO PROGRESSIVE EXERCISE**

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Carbohydrate feedings in the hour before exercise have been shown to improve exercise performance (Hargreaves et al., 2004). However most studies have used carbohydrate drinks of different concentration, prolonged exercise (over 60 min) and highly trained subjects. The purpose of this study was to assess the effects of a new, all-natural ingredients carbohydrate bar (The Buzz®) on physiological and metabolic responses to exercise in trained athletes and physically active individuals. Eight male and two female subjects aged 18-47 years participated in the study. The sample included four male professional rugby league players (mean  $\pm$  SD; age:  $18.3 \pm 1.3$  years, stature:  $190.2 \pm 5.6$  cm, body mass:  $101.1 \pm 8.7$  kg), four triathletes (three males; mean  $\pm$  SD; age:  $41.6 \pm 8.4$  years, stature:  $173.8 \pm 4.9$  cm, body mass:  $69.5 \pm 2.6$  kg and one female: 41 years, 168.0 cm, 57.5 kg), and two recreational exercisers (one female: 46 yrs, 177.0 cm, 78.3 kg and one male: 44 yrs, 188.0 cm, 94.7 kg). Subjects performed a submaximal running test that was followed by a graded test to

exhaustion under two conditions; without, and one hour after consuming, a Buzz bar in a randomised cross-over design. The submaximal test comprised 4 x 4 minute stages at increasing speeds (11, 12, 13, 14 km.hr<sup>-1</sup> and 12, 13, 14, 15 km.hr<sup>-1</sup> for female and male subjects, respectively). The graded test was performed at a constant speed (13 km.hr<sup>-1</sup> for females and 14 km.hr<sup>-1</sup> for males) with gradient increasing by 1% every minute until the subjects reached exhaustion. Oxygen uptake (VO<sub>2</sub>), blood glucose (Glu), blood lactate (La), heart rate (HR) and rating of perceived exertion (RPE) were determined at the end of each stage and at exhaustion. Time to exhaustion (TET) was recorded at the end of the graded test. Blood lactate (Lapeak) and blood glucose (Glupeak) were measured 5 min post-exercise. After consuming a Buzz bar, submaximal oxygen uptake at 13 km.hr<sup>-1</sup> (VO<sub>2</sub>-13; 37.86 ± 4.6 v 32.14 ± 6.09 ml.kg<sup>-1</sup>.min<sup>-1</sup>, P=0.004) and RPE at exhaustion were significantly lower (18 ± 1.49 v 16.8 ± 1.66, P=0.001) and TET was 10% longer (393.3 ± 125 s v 433.4 ± 110.9 s, P=0.01). Also, HLapeak (10.01 ± 3.44 mM v 12.07 ± 3.61, P=0.005) and Glupeak (4.87 ± 0.70 mM v 5.64 ± 0.66 mM, P=0.01) were significantly higher with the Buzz bar. There were no differences in HRpeak (175.4 ± 10.56 bpm v 176.4 ± 9.93 b.min<sup>-1</sup>, P=0.28) or VO<sub>2</sub>max (48.2 ± 8.8 v 48.7 ± 9.85 ml.kg<sup>-1</sup>.min<sup>-1</sup>, P=0.3). These results agree with those of previous studies that have used other carbohydrate meals one hour before exercise (Thomas et al., 1991; Stevenson et al., 2005). The 10% longer TET in this study compares favourably with that stated by Kirwan et al (1998). Furthermore, these findings show that the Buzz bar is effective in maintaining carbohydrate supply during progressive intensity exercise while it has the benefit of being a healthy, additive free alternative to other commercial bars. Even though its relative effectiveness compared to such supplements is yet to be investigated.

## THE EFFECT OF CARBOHYDRATE AND EXERCISE ON POSTPRANDIAL LIPID METABOLISM RELATED GENE EXPRESSION

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**Introduction** Postprandial lipemia may attenuate by exercise, subsequently, to reduce the risk of cardiovascular diseases. The underlying mechanism of lipid metabolism in the liver is not fully elucidated. Peripheral blood mononuclear cells (PBMCs) gene expression has been suggested to represent lipid metabolism in the liver. Therefore, the purpose of this study was to investigate the effect of carbohydrate and exercise on lipid metabolism related gene expression after high fat meal. **Methods** Eight healthy, active male subjects completed 4 experimental trials in a randomized order and cross-over design. After overnight fast, subjects either ingested 75 g fructose (F) or 75 g glucose (G) and rest or exercise at 60% VO<sub>2</sub>max for 1 hour (F+EX, G+EX) before an oral fat tolerance test. Blood samples were collected during 6 hour postprandial period. Peripheral blood mononuclear cells (PBMCs) were harvested to obtain RNA to determine ApoA-I, Apo B, LDL-receptor (LDLR), VLDL-receptor (VLDLR) and HMGCoA reductase (HMGCR) mRNA expression using real-time PCR technique. **Results** The results showed that F and F+EX induced higher plasma ApoA-I and lower plasma total cholesterol and LDL-C than G and G+EX. There were no significant differences in ApoA-I, Apo B, LDLR, HMGCR, VLDLR gene expression between trials. However, there was a trend that ingesting F trial indicated a lower VLDLR gene expression. The current data suggested that ingestion of different carbohydrates and exercise before a high fat meal did not influence postprandial lipid metabolism related gene expression. **References** Pocathikorn, A., Taylor, R., James, I., & Mamotte, C. (2007). *Journal of Nutrition*, 137(9), 2062.1049-1056. Hardman, A. E. (2000). *Am J Clin Nutr*, 72(4), 1061-1062.

## EFFECT OF WHEY PROTEIN ISOLATE ADDITION TO A CARBOHYDRATE-ELECTROLYTE REHYDRATION SOLUTION INGESTED AFTER EXERCISE IN THE HEAT

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It is commonly reported that individuals finish an exercise session in a hypohydrated state. This means effective rehydration after exercise is an important athletic consideration, especially in situations where two bouts of exercise are undertaken in close proximity. Seifert et al (2006) reported that retention of a 60 g/l carbohydrate, 15 g/l protein drink was greater than of a 60 g/l carbohydrate drink, but failure to match drinks in terms of energy density makes it difficult to determine whether the protein or the increased energy density accounted for the difference in drink retention. The purpose of the present study was to determine the effects of energy matched carbohydrate and carbohydrate-whey protein isolate solutions on rehydration after exercise-induced dehydration. Twelve apparently healthy males (Mean (SD)) 21 (1) y, height 1.82±0.08 m, body mass 82.71 (10.31) kg) lost 1.9 (0.1) % of their initial body mass via intermittent exercise in a hot environment (35 (0.1) °C, 50.9 (2.1) % relative humidity). Subjects then rehydrated with 150% of their body mass loss over 1 h, with either a 65 g/l carbohydrate (35 g/l glucose, 30 g/l maltodextrin) solution (C) or a 50 g/l carbohydrate (35 g/l glucose, 15 g/l maltodextrin), 15 g/l whey protein isolate solution (CP), matched for energy density, as well as sodium (~20 mmol/l) and potassium (~5 mmol/l) concentration. Urine samples were collected before and after exercise and for 4 hours after rehydration. Subjects' pre-trial body mass (P = 0.080) and urine osmolality (P = 0.355) were not different between trials, suggesting they started each trial in a similar euhydrated state. Total cumulative urine output after rehydration was not different between trials (1173 (481) ml (C) and 1180 (330) ml (CP)) (P = 0.964), whilst drink retention during the study was also not different between trials (50 (18) % (C) and 49 (13) % (CP)) (P = 0.876). At the end of the study, net fluid balance was significantly negative compared to baseline for C (-432 (436) ml (P = 0.034)) and CP (-432 (302) ml (P = 0.003)). Whilst urine osmolality changed over time (P < 0.001), there was no difference between trials (P = 0.803). These results suggest that when matched for energy density and electrolyte concentration, a carbohydrate-whey protein isolate solution neither enhances nor inhibits rehydration in comparison to a carbohydrate solution. These findings indicate that in situations where the ingestion of protein after exercise might infer some benefit for post-exercise recovery, whey protein could be added to rehydration solutions without interfering with the rehydration process. Seifert J, Harmon J and DeClercq P (2006) Protein added to a sports drink improves fluid retention. *International Journal of Sports Nutrition and Exercise Metabolism* 16, 420-429. Seifert J, Harmon J and DeClercq P (2006) Protein added to a sports drink improves fluid retention. *International Journal of Sports Nutrition and Exercise Metabolism* 16, 420-429.

## COMBINED EFFECTS OF AEROBIC EXERCISE AND HIGH CARBOHYDRATE MEAL ON PLASMA ACYLATED GHRELIN AND LEVELS OF HUNGER

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**Introduction:** Ghrelin is an orexigenic hormone that is involved in appetite control and energy homeostasis (Cummings, 2006). Acylation of ghrelin is essential for appetite regulation (van der Lely et al., 2004). Food intake and physical exercise affect energy homeostasis. Although many studies have separately examined the effect of short-term exercise and meal consumption on appetite (Burns et al.,

2006; Tannous dit El Khoury et al., 2006), the potential interactive effect of both has yet to be investigated. The present study examined the effect of an aerobic exercise bout associated with a high-carbohydrate (CHO) meal on plasma acylated ghrelin levels and hunger sensation. Methods: Eight healthy males signed an informed consent for participation in the study and performed two experimental trials, exercise (ET) and control (CT). In ET, participants consumed a high-CHO meal and after resting for 2 h, performed a 60-minutes cycling exercise at 10% below the second ventilatory threshold (~70% of maximal oxygen uptake). After exercise, they rested for an additional hour. In the CT, after consuming the high-CHO meal, participants remained at rest throughout the whole period. Blood samples were taken over the trials to determine the levels of acylated ghrelin, glucose, insulin, total cholesterol (TC) and triglycerides (TG). The hunger sensation was assessed by using a visual scale. This study was approved by the University Ethics Committee. Results: There was suppression of hunger after eating the meal in ET and CT ( $p=0.028$  and  $p=0.011$ ). Hunger increase in CT during the exercise session ( $p=0.017$ ) and remained suppressed in the ET. Acylated ghrelin levels were suppressed in ET when compared to CT at the end of exercise bout ( $24.4 \pm 8.1$  vs.  $55.8 \pm 33.3$  pg/dl, respectively,  $p=0.017$ ). Inverse correlations between acylated ghrelin levels and insulin, TC and TG levels at different time points were observed. Conclusion: This study suggests that one bout of aerobic exercise maintain the meal-induced suppression of hunger and the reduced levels of acylated ghrelin right after the exercise may be involved in the mechanism underlying the appetite regulation. Additional factors such as insulin, TC and TG concentrations may be also involved in this phenomenon. References: Burns SF, Broom DR, Miyashita M, Mundy C, Stensel, DJ (2006). *J Sports Sci*, 24, 1-8. Cummings, DE (2006). *Physiol Behav*, 89, 71-84. Tannous dit El Khoury D, Obeid O, Azar ST, Hwalla N (2006). *Ann Nutr Metab*, 50, 260-9. van der Lely AJ, Tschop M, Heiman ML, Ghigo E (2004). *Endocr Rev*, 25, 426-57.

## Poster presentations

### PP-PM80 Physical Activity and Interventions

#### THE EFFECTS OF RECREATION ACTIVITIES ON LIFE QUALITY OF OLD AGE PEOPLE IN LOCAL NURSERY HOUSE

MENSURE, A., NERMIN, S., BERGUN, B.M., CIGDEM, B.

KOCAELI UNIVERSITY

Mensure Aydin\*, Nermin Sari\*, Bergun Meric Bingul\*, Cigdem Bulgan\*\* \*Kocaeli University, School of Physical Education and Sport \*\* Haliç University, School of Physical Education and Sport The aim of this study was to investigate the effects of recreation activities on life quality of old age people who lives in local nursing house in Kocaeli, Turkey. 17 old people mean age  $67 \pm 3,4$ , was participated to the study who lives in Kocaeli Local Nursery House. Recreational activities were organized for 3 days per week and 20 weeks in total. All participants were applied recreation activities which were included finger exercises with stress ball, ventilation exercises, walking exercises on the line, simple folk dance activities, stretching exercises with elastic bandage and stretching exercises on chair, weight exercises with plastic water bottles, different figure activities with play dough etc. Whoool Bref (TR) Life Quality Scale was applied participants before and after the activities. All statistical analyses were done by SPSS 16.0 programme. Wilcoxon statistical test were applied to compare of the pretest and posttest. As a result of the study there was significant difference in psychological parameters ( $p < 0,05$ ). In conclusion, it can be say that recreational activities effect positively of people mind health and increase the life quality. Recreational activities might be quite important especially for old age people to support their psychological health.

#### INTERNATIONAL REPORT OF MASTERS ABILITY SURVEY < IRMAS >: THE EXPERIENCE OF THE WORLD MASTERS ORIENTEERING CHAMPIONSHIPS 2010 IN NEUCHATEL < SWITZERLAND >

SCHRAGO, G.

DALER HOSPITAL

Purpose: This medical study was performed during the World Masters Orienteering Championships in 2010 in Neuchatel ( Switzerland ). The objective was to make a good evaluation of the health of the international athletes according to the age, and therefore to test the efficiency of the new quick cardiovascular screening methods in current practice. Methods: The official medical informations were on the organization homepage: [www.wmoc2010.org](http://www.wmoc2010.org), and on this of the survey: [www.irmas.ch](http://www.irmas.ch) in 5 languages ( english, german, italian, french and russian ). In the clinical part, this parameters were controlled at the event center: heart rate, blood pressure, oxygen percentage in blood, intima media thickness ( IMT ). This material was used: for the heart rate and the blood pressure, an automatic system of the firm OMRON; to measure the oxygen, an ONYX pulsoxymeter; for the IMT, a portable ESAOTE My Lab 25 with a multi-frequency linear transducer ( 10-15 Mhz ). In the following monthes, 3 mailing ( with a link to a questionnaire of 40 epidemiological questions on the IRMAS homepage ) were sendes to the 2200 mails addresses in the database of the event organization. Results: In the clinical part, 201 participants, 35 to 83 years old ( mean age: 57 ), can be included: 83 women and 118 men. Mean heart rate at rest: 65 ( + 12 ) pro minute. Mean systolic blood pressure ( sitting ): 147 mmHg ( + 22 ). Mean diastolic blood pressure ( sitting ): 92 mmHg ( + 14 ). Mean oxygen percentage: 97% ( + 1,5 ). Mean IMT: 625 um ( + 146 ). 30 participants ( 15% ) had atheromatosis in the supraaortic vessels: 26 ( 13% ) < 25% stenosis, and 4 ( 2% ) with 25 to 50% stenosis. In the epidemiological part, we've received 578 valid questionnaires = a participation rate of 26,3% ( 28,5% women and 71,5% men ). Only 70 participants ( 12,1% ) have no history of trauma, and 196 ( 34% ) no illness history. 49 runners ( 8,5% ) have a past history of cardiovascular disease, and 22 ( 3,8% ) a cancer. Less than 1% were active smokers. The training level was good: one or more times sport a week for 94,8% of the participants. Conclusions: the regression analyse of the clinical data are according to the past studies for the systolic and diastolic blood pressure values 1. With the new portable sonography and softwares like for the IMT measure 2, it's possible to make a good cardiovascular screening in a few minutes ( mean time 10 minutes... ), out of the hospital, with low costs. The participants were good trained, and more fit as a standard reference population. 1) Data from prospective studies collaboration, Lancet 2002; 360: 1903. 2) Carotid Plaque Area and Intima-Media Thickness in Prediction of First-Ever Ischemic Stroke: A 10-Year Follow-up of 6584 Men and Women: The Tromso Study. Mahtiesen EB Johnsen SH Wilsaard T et al. Stroke 2011 Feb 10. Conflicts of Interest: Esaote, Echoworld, Menarini, Mephra, Vifor, Novartis

## THE RELATIONSHIP BETWEEN PHYSICAL FITNESS TEST AND QUESTIONNAIRE RELATED PHYSICAL EDUCATION IN UNIVERSITY STUDENTS

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**Introduction** For human beings, a healthy and active life is the most important. The goal of the physical education is to provide appropriate exercise and knowledge for students. However, in our university, the physical fitness level is decreasing after 1985, year by year. The purpose of this study is to clarify the relationship between physical fitness level and factors related physical activity or health in our university students. **Method** The physical fitness test (8 items) and self-description questionnaire (1. Likes and dislikes of physical education class, 2. Health status, 3. Fitness level, 4. Body type, 5. Fitness history (Extracurricular physical activity) in Junior HS and High school) were conducted annually in the period of 2003 to 2009. The physical fitness test was developed by the Ministry of Education Japan. The subjects (n=3438) were 18-years-old students enrolled at Hokusei Gakuen University. **Results and Discussion** Approximately two-thirds of the students liked physical education class (Male 67%, Female 58%). A significant association was found between Likes/Dislike of physical education class and total score of physical fitness test, in each gender. There was a difference of total score between Likes and Dislikes (Male 4.3 point, Female 3.6 point,  $p<0.01$ ). It is important that students who dislike physical education have an interest in physical activity. In addition, fitness history related to total score significantly. The extracurricular physical activity in Junior HS and High school improved total point of physical fitness test (Male 3.0 point, Female 2.8 point,  $p<0.01$ ). Longer in extracurricular physical activity, total score of physical fitness was higher. In university education, it is important to increase physical activity for students who lack experience of physical activity.

## FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY IN GERMAN ELDERLY MEN AND WOMEN: A CROSS-SECTIONAL STUDY

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**Background** Data on physical activity in German elderly people are scarce. The aim was to analyse physical activity patterns and factors associated with physical activity in different domains, i.e. sporting activities (SA) and domestic activities (DA), in German elderly men and women. **Methods** Within the 7-year follow-up telephone interviews of the getABI cohort (community-dwelling primary health care patients in Germany), participants were surveyed on their everyday physical activity patterns using the PRISCUS-PAQ. Time per week (hh:mm) spent in SA and DA (heavy housework, gardening) was analysed for men and women. Logistic regression analyses were done to assess the odds of participating in SA and DA for at least 2.5 hours/week (hrs/wk) in association with socio-demographic variables, cardiovascular risk factors, walking ability, falls, pain, chronic conditions, number of medications, and season. **Results** A total of 1609 primary health care patients (51.6% women) with a median age of 77 (range 72-93) years were included into the analyses. Men engaged more in SA than women (median: 01:45 vs. 01:10), whereas women did more DA per week than men (median: 04:00 vs. 03:00). The need of a walking aid consistently lowered the odds of being active in both activity domains and sexes. SA: Male migrants were more frequently active for at least 2.5 hrs/wk. Women reporting pain had reduced odds, those living alone increased odds of performing SA. DA: Being interviewed in spring/summer increased the chance to do at least 2.5 hrs/wk, higher education lowered the chance to reach the amount of 2.5 hrs/wk in this domain, both in men and women. In both sexes, selective associations were found between several chronic diseases and sporting or domestic activities. **Discussion** This exploratory study revealed gender-related differences in physical activity patterns. Several factors emerged to be associated with physical activity in either or both activity domains, in men and/or women. Further investigation of physical activity patterns as well as the multifaceted reasons for participation in diverse physical activities is needed to deduce sound target group-specific physical activity intervention and promotion strategies. The study was conducted within the research cooperation PRISCUS and funded by the German Federal Ministry of Education and Research (01ET0720).

## DANCE AEROBIC VERSUS PILATES INTERVENTIONS: CHANGES IN BODY COMPOSITION AND SPINE MOBILITY IN HEALTHY ADULT WOMEN

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**Introduction:** Pilates is an exercise approach developed in the early 1900s that is based on Eastern and Western theories (Keays y cols., 2008). While anecdotal evidence suggest that as the PM increases muscle flexibility and becomes your body firmer and sleeker (Gallagher and Kryzanowska, 1999), limited experimental research exists. The aim of the study was to evaluate changes in body composition and spine mobility after 20 weeks of PM or aerobic dance intervention (2 hours/week) between three groups: PM practitioners (PMg), aerobic dance practitioners (Ag) and non exercisers (NEg). **Methods:** Total sample comprised 52 healthy adult women; ages between 29 and 59 years old ( $42.23\pm7.17$  years). The sample was divided into three groups: PMg(n=16), age ( $43.75\pm5.51$ ); Ag (n=18), age ( $42.71\pm6.9$ ) and NEg (n=22); age ( $40.94\pm8.7$ ). Body composition measures were body weight, height and body fat measured from 6 skin-fold thicknesses. To asses lumbar flexion and extension we used the Modified Schober Test. PMg and Ag participated in a 20 weeks program consisting of PM and Aerobic Dance group classes (2 hours/week) respectively, while NEg did not engaged in any regular physical activity. Analyses were conducted using SPSS (version15.0). One-way analysis of variance was used to examine differences in body composition and spine mobility across groups followed by post-hoc contrasts. The level of statistical significance was set at  $p<0.05$ . **Results:** After exercise programs there were significant differences among the three groups in body weight ( $F(2,49)=4.1$   $p<0.05$ ), the sum of skinfold thicknesses ( $F(2,48)=4.59$   $p<0.05$ ), body fat % ( $F(2,48)=6.37$   $p<0.05$ ), lumbar extension mobility ( $F(2,48)=8.92$   $p<0.05$ ) and spinal flexion mobility ( $F(2,49)=3.99$   $p<0.05$ ). Post-hoc analyses indicated that Ag scored higher vs NEg in the sum of skinfold thicknesses in 6 sites ( $p=.01$ ) and percentage of body fat ( $p=0.004$ ). PMg scored higher vs NEg in body weight ( $p=0.04$ ), lumbar extension mobility ( $p=0.001$ ) and spinal flexion mobility ( $p=0.026$ ). **Conclusions:** A 20 weeks PM program (2 days/week) improves body weight and, spinal flexion and extension mobility, versus an aerobic dance program in a sample of healthy adults from Boadilla del Monte, Madrid, Spain. **Bibliography:** Keays, K. S., S. R. Harris, et al. (2008). 'Effects of Pilates exercises on shoulder range of motion, pain, mood, and upper-extremity function in women living with breast cancer: a pilot study.' *Phys Ther* 88(4): 494-510. Gallagher, S. and R. Kryzanowska (1999). *The Pilates Method of Body Conditioning*. Philadelphia, Bain Bridge Books.



## EFFECTS OF A MULTIDISCIPLINARY INTERVENTION ON THE MOTOR PHYSICAL FITNESS OF HEALTH CARE PROFESSIONALS.

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Evert.Zinzen@vub.ac.be Introduction. Low physical fitness is assumed to be one of the major factors contributing to an increased incidence of cardiovascular disease, diabetes mellitus, obesitas, musculoskeletal problems, .... Burton et al. (2004) indicate in their European Guidelines for Prevention of Low Back Pain (LBP) that increasing physical fitness level is the most effective action in primary prevention for LBP. The nursing population is very sensitive for LBP. Purpose. The first aim of this study was to investigate the immediate effects of a multidisciplinary intervention in a hospital setting on the physical fitness of health care personnel. The second aim was to investigate if these effects remain six months after the intervention. Methodology. Sixty health care professionals (50 F and 10 M) volunteered to participate to this study. The Eurofit test battery (EUT) was taken before the intervention, just after and after a period of 6 months. The EUT consists out of 8 tests: Flamingo Balance (FLB), Plate tapping (PLT), Sit and Reach (SAR), Standing Broad Jump (SBJ), Sit Up (SUP), Bent Arm Hang (BAH), Handgrip (HGR) and a Shuttle Run (SHR). BMI and waist circumference were added. The 5 month intervention consisted out of convincing the hospital management, improving general health aspects, an ergonomic approach and working on the psycho-social level according to Zinzen et al. (2000). One-way ANOVA with the Scheffé post hoc test was used ( $p < .05$ ). Results. Most participants experienced the EUT test as a rather heavy physical performance resulting in a reduced participating level for the post tests: 29 (24F and 5M) right after and 21 (16F and 5M) after six months. All datasets were overall normally distributed. For the total group only the FLB ( $25.5 \pm 27.3 > 12.9 \pm 4.8 > 11.4 \pm 4.8$ ) and PLT ( $12.07 \pm 1.9 > 10.7 \pm 1.5 > 10.8 \pm 1.7$ ) improved significantly after the intervention and stayed on the same level after six months. In the male group no significant differences could be noted between test sessions whilst in the female group FLB ( $25.9 \pm 27.6 > 13.3 \pm 4.8 > 10.9 \pm 4.7$ ), PLT ( $12.2 \pm 2.0 > 10.9 \pm 1.5 > 10.9$ ) and HGR ( $340.8 \pm 65.7 > 395.4 \pm 61.9 > 390.8 \pm 74.4$ ) significantly improved after the intervention and stayed better. The SBJ in the females improved ( $127.7 \pm 27.2 > 143.5 \pm 25.5 > 142.9 \pm 20.0$ ) although only significant immediately after the intervention. Conclusions. Improvements on equilibrium speed of limb movement, static arm strength and explosive leg power could be noted in the female nurses. The small male sample size could be the reason for not finding any improvements.

## EFFECT OF A LIFESTYLE INTERVENTION ON ADIPOSITY AND FITNESS IN HIGH-RISK SUBGROUPS OF PRESCHOOLERS: A CLUSTER-RANDOMIZED TRIAL

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UNIVERSITY OF BASEL, UNIVERSITY OF LAUSANNE

Background: Children with migration background and from families of low educational level (EL) are considered high risk groups for the development of obesity and low fitness and interventions in these populations seem to be less effective. We therefore investigated, whether a preschool-based lifestyle intervention was equally effective in migrant compared to nonmigrant children and in children from low EL families compared to those from families of middle/high EL. Methods: Forty preschool classes were randomly selected and randomized 1:1 into an intervention and a control arm after stratification for language region (French vs. German part of Switzerland). The intervention included a physical activity (PA) program, lessons on eating habits, media use and sleep, and adaptation of the built environment using approaches to target a multiethnic population. Primary outcomes were BMI and aerobic fitness; secondary outcomes were percent body fat, waist circumference and motor agility. Interactions with migrant status and parental EL were tested and stratified analyses performed. Results: In the total population the intervention had no effect on BMI, but was beneficial for total and central body fat and for both physical fitness measures (aerobic fitness and agility). There was a small tendency for a decreased intervention effect on aerobic fitness in children with migrant background and in children with low parental EL ( $p$  for interaction = 0.06 and 0.09). However, the intervention effects on all adiposity measures and on motor agility were not modified by migration background or EL ( $p$  for interaction 0.2 and 0.9), though intervention effect sizes were smaller in children of low EL families. Conclusion: Despite smaller effect sizes for the low EL children, this culturally targeted intervention was equally effective in preschoolers of migrant background and low EL children compared to their counterparts. It therefore might represent a promising option to reduce adiposity and increase fitness for these children.

## AWARENESS OF PHYSICAL ACTIVITY RECOMMENDATIONS FOR HEALTH IMPROVEMENT AMONG PORTUGUESE ADULTS

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1UBI (COVILHÃ, PORTUGAL), 2CIDESD (PORTUGAL), 3NECE (COVILHÃ, PORTUGAL)

Introduction Regular moderate physical activity (PA) has an important influence on health and well-being, but is not clear if adult population knows the adequate PA characteristics for health improvement (Bennett et al., 2009). ACSM recommends a minimum of 30 min of moderate-intensity PA on 5 days/week to promote and maintain health (Haskell et al., 2007). The aim of this study is to examine whether knowledge of ACSM recommendations is accurate among Portuguese adult population and if it varies with PA information source. Methods The study included a randomly recruited sample of 879 subjects (53% M; 47% F),  $42.3 \pm 19.4$  y. A survey was designed to (1) evaluate knowledge on PA characteristics for health benefits; (2) evaluate knowledge on adequate exercise heart rate; (3) relate PA knowledge and PA level (assessed by IPAQ) and (4) relate PA knowledge and PA information source. Results Evaluation on adequate PA characteristics found 74.5% of wrong answers. Evaluation of knowledge on adequate exercise heart rate found 82.1% wrong answers. For information sources friends/family; teachers, Internet and sport professionals there were statistically significant differences between the groups with adequate and low PA, meaning that those information sources positively influence an active lifestyle. Teachers, Internet and sport professionals are the only information sources that report a positive effect on % of right answers, regarding adequate PA characteristics. Discussion Despite efforts to promote PA and widespread knowledge on ACSM recommendations, few (about a quarter) Portuguese adults can accurately identify adequate PA characteristics for health improvement. Similar results were found by Bennet et al. (2009) among USA adults. These findings highlight the limited ability to enhance knowledge from traditional PA informative campaigns (Hornik, 2002, Pinheiro et al., 2011) and the need for more effective campaigns to widespread accurate information, using new technologies coordinated with traditional media. References Bennett, G., Wolin, K. et al. (2009) Awareness of National Physical Activity Recommendations for Health Promotion among US Adults. *Med Sci Sports Exerc.* 41(10), pp. 1849-1855 Haskell WL, Lee IM et al. (2009). Physical activity and public health: updated recommendation for adults from the ACSM and the AHA. *Med Sci Sports Exerc.*;39(8), pp. 1423-34. Hornik R.

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## 15:00 - 16:00

### Poster presentations

#### PP-SH01 Physical Education: Movement Skills

##### THE RELATIONSHIP BETWEEN THE PSYCHOLOGICAL EMPOWERMENT FACTORS AND ORGANIZATIONAL ENTREPRENEURSHIP IN PHYSICAL EDUCATION TEACHERS

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Hemmati, J.1 Eslami, S.2 1: IAU (Islamic Azad University, Khoramabad Branch, Iran), 2: PNU (Delfan/Iran) Introduction Physical education teachers in university with abilities such as innovation, creativity and empowerment can help human resource and guide them during the education in universities. They could educate aware human resource and prepare them to accommodate with all of the changes that exist in around them. Therefore the aim of this study was to investigate the relationship between the psychological empowerment factors such as meaningfulness, Competency, self determining, impact, Trust and entrepreneurship in teachers of physical education in university. Methods Method in our research was descriptive- correlational. Fifty three of physical education teachers were selected from participant in scientific development volleyball congress. Spritzer and Samad Aghaee Questionnaires, were used to gather data related to empowerment factors and organizational entrepreneurship respectively. We used statistical test of Pierson to investigate the relationship between psychological empowerment factor and organizational entrepreneurship. Results Test of emphasis showed that four of psychological empowerment factors including: Meaningfulness, Competency, Self determining and impact did not directly deal with organizational entrepreneurship. But there was a significant relation between trust factor and organizational entrepreneurship. Discussion Findings in our research showed that in universities is not paid attention to some of teachers psychological empowerment factors such as; meaningfulness and mental standards, Competency and attention to skills and abilities of teachers, Self determining and independence and liberty of teachers activates, Impact and teacher effectiveness too (Laxchinger & et al., 2005). but the result of trust factor shown that assurance to teachers in university lead to empowerment of organizational entrepreneurship in sport faculties (Skinner et al., 2003). Some of the factors that lead to different this study with others includes; sample and statistical universe, education, social situation and anticipations of organizational environment (Ozaralli., 2003 & Siegall et al., 2000). References Laxchinger, S. Hk. & Manojlovich, M. (2005). University of Michigan, School of Nursing Ozaralli, N. (2003). Leadership & Organization Development Journal, vol. 24, No.3 Siegall, M. & Gardner, S. (2000). Personnel Review, vol. 29, No. 6: 703-722 Skinner, J., Fleener, B., Rinchiuso, M., Sowinski, D., Patel, D.7 Frame, M. (2003), 24th Annual Conference for Industrial Organizational Behavior.

##### STUDY ON NEUROPHYSIOLOGICAL AND PHYSO-PEDAGOGICAL ASPECTS OF REGULATION DOCUMENTS IN ITALIAN PRIMARY SCHOOL

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Introduction In recent years Italian primary school, as called in the past time elementary school and the pupils go between 5 years old to 10, has been updated the ministerial documents relating to the educational contents and activities. At the same time, recent discoveries about the neurophysiology of the brain changed the scientific bases on which are based psychological and pedagogic paradigms on educational theories. These theories are the basis on motor learning according to motor control system such as closed loop system (Adams 1975), open loop system (Schmidt 1985) and motor imagery (Rizzolatti 2006, Iacoboni 2008). The aim is to identify, into the regulation documents regarding the educational activity, aspects of psychology and pedagogy in the field of body and movement Method Research is integrated by two approaches: Theoretical and argumentative one on scientific paradigms regarding the motor control system theory and the related motor learning in the early years of life and, the second one, historical and documentary approach on regulation documents relating to the contents and the teaching activities Result It does not carry out any aspects of education and didactics that can be connected to psychological and pedagogic aspects according to the new scientific and neurological theories. All regulation documents do not provide any reference to recent discoveries related to the theory of movement correlating the motor learning Conclusion It may be useful to update the regulation documents. It needs to deep properly the study and then to deliver the results to the governmental experts for the necessary updates to fill up the vacuum of the contents, didactics and teaching method for the particular field of motor control and learning. Furthermore, the movement field must help the educational science in an holistic vision of development References Latash M., (2008) Neurophysiological Basis of Movement, Human Kinetics, Champaign IL USA Schmidt, R., A., Wrisberg, G., A., (2008) Motor Learning and Performance, Human Kinetics, Champaign IL, USA Iacoboni M., (2008) Mirroring People. The new science of how we connect with others, Farrar Straus & Girox, L.A. USA Rizzolatti, G., (2006) So quel che fai. Il cervello che agisce e i neuroni specchio. Raffaello Cortina Editore, Milano, Italia Decree of Republic President (2009) no. 89 20/03, Revision of the educational organization regulated directions for the first cycle of the school, Rome, Italy Ministerial Decree (2007) 31/07, The Guidelines for the curriculum of the first cycle of education, Rome, Italy Legislative Decree (2004) no. 59 19/02 National Guideline for the Programs of studies of the first cycle of education attachment A Rome, Italy Decree of Republic President (1985) no. 104 12/02 Programme for the educational activity in elementary school Rome, Italy

## A RESEARCH ON THE PROBLEM-SOLVING AND AUTOMATIC –THOUGHTS SKILLS OF THE STUDENTS STUDYING AT PHYSICAL EDUCATION AND SPORTS ACADEMY

TEKIN, M.

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A RESEARCH ON THE PROBLEM-SOLVING AND AUTOMATIC –THOUGHTS SKILLS OF THE STUDENTS STUDYING AT PHYSICAL EDUCATION AND SPORTS ACADEMY Tekin, M. 1, Şahan, H. 2, Yıldız, M.3, Güllü, M.4 Devecioğlu, S.5 1 Karamanoğlu Mehmetbey University College of Physical Education and Sports, Karaman, Turkey 2 Karamanoğlu Mehmetbey University College of Physical Education and Sports, Karaman, Turkey 3 Karamanoğlu Mehmetbey University College of Physical Education and Sports, Karaman, Turkey 4 İnönü University College of Physical Education and Sports, Malatya, Turkey 5 Firat University College of Physical Education and Sports, Elazığ, Turkey Introduction It is important that negative automatic thoughts and problem solving skills of the students studying at physical education and sports academy be examined out of their tasks such as being a good model in future, educating a qualified student and developing creativity. For this reason in this research; problem solving and automatic thoughts skills of the students studying at physical education and sports academy are aimed to be investigated. Method Research stuff is consisted of 196 male and 146 female (age=19,3713 + 1,6968) and totally 342 students studying at Selçuk University, İnönü University, Gazi University and Karamanoğlu Mehmetbey University Physical Education and Sports Academy. To reach the aim of this research; Problem-solving Inventory (PSI) developed by P.P. Heppner and C.H. Petersen (1982) and adjusted to Turkish by Savaşır and Şahin (1997) and Automatic Thoughts Questionnaire developed by Hollon and Kendall (1980) and adjusted to Turkish by Şahin and Şahin (1992) are used. Results As the result of this study; Moreover; it is discovered that there is an effective explanatory among thinking approach, avoidance approach, evaluator approach, self-confident approach and planned approach from sub-dimensions of the automatic thoughts skills and problem-solving skills ( $p < 0.05$ ). Discussion All these results show that students studying at physical education and sports academy, who are representing only a part of university students, have some problems in terms of problem solving skills and automatic thoughts and it is thought that some part of these problems arise from university students' conditions in which they live. (Ingram and Wisnicki, 1988) The findings in this study were parallel with the current study. References Heppner P.P., Petersen, C.H. (1982). The development and implications of a personal problem solving inventory. *Journal of Counselling Psychology*, 29, 66-75. Hollon S., Kendal P (1980). Cognitive self-statement in depression: Clinical validation of an automatic thoughts questionnaire. *Cognitive Therapy and Research*. 4. Ingram R.E., Wisnicki K.S (1988). Assessment of positive automatic cognition. *Journal of Consulting and Clinical Psychology*. 56(6), 898-902. Savaşır I., Şahin, N.H (1997). The evaluation of Cognitive-Behavioral Therapies: The most frequently used scales. Ankara: Turkish Psychological Association Press.

## SURVEY OF THE OPINIONS OF LIFE ORIENTATION SUBJECT ADVISORS ON THE RE-IMPLEMENTATION OF PHYSICAL EDUCATION IN SOUTH AFRICAN SCHOOLS

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Introduction Prior to 1994 Physical Education was a compulsory, non-examinable school subject in all South African schools. After the first democratic, non-racial election in South Africa in 1994, Physical Education was phased out as a lone standing, separate school subject according to the new South African schools act of 1996 (DoE, 2000). Physical Education was included as one of the five outcomes of the Learning Area Life Orientation and implemented gradually from Grade R to Grade 11 to be completed in 2008 when the outcome was presented in Grade 12 for the first time (Pote, 2008). Methods The aim of this research was the evaluation of the re-implementation of Physical Education in South African schools. The quantitative research design supported by a limited qualitative data set included six phases. In 2008 during Phase 3 of this study, 277 Life Orientation subject advisors from all nine provinces in South Africa completed a questionnaire directly after completion of a Physical Education training workshop. After two years, in 2010, these subject advisors completed a follow-up questionnaire on the re-implementation of Physical Education in schools. Results Irrespective of the fact that almost 50% of these subject advisors have no qualification in Physical Education, they are very positive about the presentation of the subject. Additional challenges experienced by the subject advisors are meagre or unqualified Life Orientation teachers in Physical Education (78%), no or inadequate facilities, apparatus (60%) and support (39%) for the presentation of the subject as well as very large numbers of learners in classes (70%). Discussion The reinstatement of Physical Education within Life Orientation in the South African school curriculum brings several challenges for Life Orientation subject advisors, especially in the light of insufficient qualifications and experience to advise teachers who teach Physical Education. This as well as the challenges with facilities, apparatus and support for the subject result in the non-presentation of Physical Education in several South African schools. Such an unwanted situation can hold serious consequences for the health situation, economic development as well as national and international sporting achievements for a potential upcoming, developing country as South Africa (Van der Merwe, 2010). References POTE, N. 2008. Physical Education as outcome of Life Orientation. Pretoria. (Personal conversation with researcher, 21 Sep. 2008.) SOUTH AFRICA. Department of Education. 2000. Draft ministerial briefing on guidelines for Policy on Human Movement Education and School Sport. Pretoria. VAN DER MERWE, N. 2010. Evaluation of the re-implementation of Physical Education in South African Schools Potchefstroom: North-West University, Potchefstroom Campus. (Thesis – Ph.D.)

## TRAINING OF THE PERSONAL TRAINERS THAT WORK IN REGION OF VALENCIA

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1: TECHNICAL UNIVERSITY OF MADRID (MADRID, SPAIN), 2: UNIVERSITY OF VALENCIA (VALENCIA, SPAIN), 3: UNIVERSITY CATHOLIC OF VALENCIA (VALENCIA, SPAIN), 4: UNIVERSITY OF ALCALÁ (ALCALÁ DE HENARES, SPAIN)

Introduction The personal trainer is a qualified professional that teach and train customers with safety and suitable exercises. The objective is to increase the physical condition and the health of his customers (Roberts, 1996). Forteza, Comellas y López (2004) add that the personal trainer is a professional dedicated to the individualized training for people that need to improve their physical condition in a general or specific way to achieve objectives from the health to the high performance. It is necessary that this personal trainer has an initial and continuous education adequate to carry out the training with efficiency and adequately. Methods We have used a quantitative methodology of descriptive cut. The procedures applied were the proper procedures of the survey. We have done individual interviews to 600 persons who work as personal trainers in Region of Valencia (Spain). Results When we analyze the initial education of the personal trainers polled we observe that 57'3% of them do not have any qualification in physical activity. 14'8% have a physical activity degree, 13'1% are trainers, 6'6% are physical education teachers of primary school, 6'6% have technical sport qualification (TAFAD) and 1'6% have

technical sport qualification in outdoor activities. Related with their continuous education, 65'6% of these personal trainers have done courses or postgraduate courses and 24'6% have attended to conferences. Discussion Most of personal trainers polled do not have any qualification in physical activity. Furthermore, to this percentage we have to add the people with sport qualifications without enough knowledges to develop this tasks. This reality shows the small percentage of personal trainers qualified with an initial education suitable to carry out this activity. These trainers cannot guarantee the quality and efficient development of the personal trainings (Camy, Chantelat y Le Roux, 1999; Campos, 2010). Related to the continuous education of the personal trainers, most of them have done courses or postgraduate courses (Campos, 2010). References Campos, A. (2010). Dirección de recursos humanos en las organizaciones de actividad física y deporte. Síntesis, Madrid Camy, J, Chantelat, P, Le Roux, N. (1999). Sport et emploi en Europe. France, Comisión Europea. Forteza, K, Comellas, J, López, P. (2004). El entrenador personal. Fitness y salud. Barcelona, Hispano Europea. Roberts, S. (1997). The business of personal training. Champaign IL, Human Kinetics.

## **GENDER DIFFERENCES IN FUNDAMENTAL MOVEMENT SKILL DEVELOPMENT IN SIX-YEAR-OLD FLEMISH PRE-SCHOOL CHILDREN**

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Gender differences in fundamental movement skill development in six-year-old Flemish pre-school children Vandaele, B (1,2), Cools, W (2), De Decker, S (1), De Martelaer Kristine (2) 1: Erasmus hogeschool Brussel, Departement of Teacher Training 2: Vrije Universiteit Brussel, Departement of Physical Education and Sports Training Introduction There is still no agreement on gender differences in movement skill performance of pre-school children. Some studies report no gender differences in FMS (locomotor tasks) at the age of six (Butterfeld, 2002), others only observe significant gender differences when explosive strength is the underlying ability of the task (Zurck, 2005). Methods Two hundred thirty six 6-year-old Flemish pre-school children (N=236) were individually assessed with the Motoriktest für Vier- bis Sechsjährige Kinder (MOT 4-6). Children's performances on 17 tasks were rated on a 3-point scale (0,1,2) and generated a Total Score (TS) of 34. Descriptive analyses were used to report frequencies and percentiles of scores. Results Mean TS was 20.78 (SD= 5.7), without significant gender differences. When comparing FMS profiles of boys and girls, different trends occurred. Boys outperformed girls in the object control skills throwing at a target (boys 68.1% and girls 35.7% score 1 or 2, U= 4218,5 p< 0.01, r= 3,63) and catching a ring (boys 78.3% and girls 57.1% score 1 or 2, U= 5014,0 p< 0.01, r= 3,33). In the locomotion skills 'jumping jacks' (girls 84.7% and boys 65.9% score 1 or 2, U= 4734,5 p<0.01, r= 3,43) and 'turning jump' (girls 87,8% and boys 83,3%, U= 5763,0 p<0.05, r= 3,11) girls outperformed boys. More subtle differences appeared for the 'jumping in a hoop and balancing on one leg' and 'side jump' for which girls performed better, and the 'transporting balls' and 'roll around the axis' in which boys had a higher proficiency. Discussion Significant gender differences in our study were in accordance with several other studies. Our results seemed to match the findings of other authors who demonstrate girls to be typically performing more successfully in balancing (Sigmundsen, 2003) and jumping tasks (except the height jump) and boys outshining in running and catching tasks (Hardy, 2009). References Butterfeld, S.A., Lehnhard, R.A., Coladarci, T. (2002). Age, sex and body mass index in performance of selected locomotor and fitness tasks by children in grades K-2. Perceptual Motor Skills, 94 (1): 80 – 86 Hardy, L.L., King, L., Farell, L., Macniven, R., Howlett, S. (2009). Fundamental movement skills among Australian preschool children, Journal of Science and Medicine in Sport, (in press) Sigmundsson, H., Rostoft, M.S. (2003). Motor Development: exploring the motor competence of 4-year-old Norwegian children, Scandinavian Journal of Educational Research, 47 (4): 451-459 Zurck, J., Piset, R., Strojnik, V. (2005). Gender differences in motor performance in 6.5-year-old children, Kinesiology Slovenica, 11 (1): 90-104

## **FUNDAMENTAL MOTOR SKILLS IN 11-12 YEARS-OLD BOYS AND GIRLS: A CROSS-SECTIONAL STUDY**

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INTRODUCTION Fundamental Motor Skills (FMS) are common motor activities with specific observable patterns. Most skills in sports and movement activities are advanced versions of FMS. During the secondary schooling period, students should be taught physical education to further develop their basic motor skills such as throwing, catching and running, into more complex and specific sport and leisure activities. It is also evident from research findings that many children and adults do not regularly take part in physical activities that contribute to a healthy lifestyle. There are many reasons for this lack of physical activity, the most evident being the lack of exposure at an early age to physical skill development activities. From a motor development perspective, FMS are important as they play a primary role in young children's skills learning and motor development (Haywood & Getchell, 2009). METHODS In the year 1985 a test battery was submitted to 1160 (589 boys 561 girls) Italian students aged 11 and 12 (GR1). The same test battery was proposed to 1465 (772 boys 693 girls) same aged students in 1996 (GR2) and 1276 (644 boys 632 girls) students in 2010 (GR3). The data were collected through the scholastic system by submitting tests during physical education (PE) lessons after a 20 minutes warm-up. Test battery: Speed Running (m. 80), Endurance Running (m.1000), Long Jumping, High Jumping, Precision Throwing (Basket) and Power Throwing (one hand ball throwing of a 0,3 Kg. for girls and 0,4 Kg for boys), Rope Skipping and Pole-Climbing. RESULTS In the two periods 1985-1996 (P1) and 1996-2010 (P2) differences in the body mass, in height and BMI were found. Today boys and girls are notably taller and heavier. The increase of these two dimensions in children's morphology is predominant for the increase in body mass, as shown by the marked increase in BMI. All data were compared with the NCHS Growth Charts (NCHS 2000). In all tests a loss of ability in each group was found. Gaps were more evident in endurance and power abilities than in precision tasks. Regarding the sex category, these differences are more evident in the girls. Differences among the participants according to their age and birth date were analyzed with the Pearson's Chi-square test and statistical significance were confirmed by the O.R. (Odds Ratio) values. DISCUSSION FMS competence has been shown to influence children in many ways. Students who have achieved FMS competence have been found to successfully participate in a range of sports and movement activities and maintain involvement during childhood and adolescence. Regular involvement in sport and movement activities lead to gains in health-related physical fitness. FMS competence plays a fundamental role in preparing students for a healthy lifestyle.

## THE ASSESSMENT OF THE MOTOR SKILLS AS INDICATOR OF THE TEACHER'S TEACHING ABILITIES. PILOT STUDY OF A POSSIBLE COMPARISON BETWEEN THE ITALIAN AND THE INDIAN PRIMARY SCHOOL

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The visual-motor integration represents a main condition in the learning processes and it is absolutely necessary to get the reading-writing ability. It supports as well the higher learning processes which are involved in the school experiences. Anyway, it isn't always considered important in the educational environments. Nowadays, the scientific literature seems to recognize the importance of the movement in the integration of different mental processes (Marsha W., Amundson S., 1994). With regard to this, Hannaford assumed that "every time we move in an organized manner, full brain activation and integration occurs, and the door to learning opens in a natural way" (Hannaford, C., 1995). The visual-motor answers can be considered as the first sensory integration of the growth and so they appear as one of the main goal that every educational system should pursue. The aim of this research is to carry out, investigate and monitor if the current school systems duly support the development of students' visual-motor abilities in the primary school. The method used scheduled the following phases: 1. Arrangement of an integrated plan between the school and the university to share the aims, the methods and the actions of the research. 2. Transfer of the needed knowledge to the teachers to give the VMI and VMI tests for the motor coordination. 3. Giving the VMI and VMI tests for the motor coordination to the students according to procedures described in the hand-book. 4. Assessment of the tests made. 5. Analysis and processing of the obtained data. The instrument used to carry out the research is the VMI test (K.E. Beery, 2000), scientifically effective, and its motor coordination sub-test. We got the data from 112 students of the Italian primary school and 51 students of the Indian primary school. The data show that the mean of the scores got from the Indian sample are significantly lower than the international mean. The data got from this sample have to be considered as an alarm bell which cannot be ignored. Due to the strong link of the VMI to the future school efficiency, the effects of the pathological situation described in this article risk to influence the future cultural level of the two Countries. References Marsha W., Amundson S. (1994). Relationship between visuo-motor and handwriting skills of children in kindergarten. *American Journal of Occupational Therapy*, 48(11), 982-983. Hannaford, C. (1995). *Smart moves*. Arlington, VA: Great Ocean. Beery, K.E., Buktenica, N.A. e Beery, N.A. (2000). *The Beery-Buktenica Developmental Test of Visual-Motor Integration*, Psychological Assessment Resources Inc.

## THE TEEN RISK SCREEN: A MOVEMENT SKILL SCREENING CHECKLIST DESIGNED FOR TEACHERS

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The teen risk screen: A movement skill screening checklist designed for teachers Eileen K. Africa (Department of Sport Science, Stellenbosch University, Stellenbosch, RSA) Introduction Late childhood is not only marked by rapid physical changes, children also need to perform a repertoire of movement skills during their daily functioning (Sugden & Sugden, 1990). The importance of fundamental movement skills are often taken for granted, as it is seen as a normal part of human development (Cools et al., 2008). It is expected that these movement skills will be adequate to muddle through the school career with ease, however, some children struggle and are regarded as clumsy. This study therefore aims to provide an easy-administered screening checklist to determine children's fundamental movement skills in a school setting. Methods The study sample (N=133) consisted of 126 girls and seven classroom teachers from a selected school in the Stellenbosch region, Western Province, South Africa. The teachers were trained by the researcher's assistant to administer a 26-item movement skills screening checklist, while the children were performing physical activities. The checklist consisted of seven subscales, namely, posture and stability (axial movement); postural stability (dynamic movement); locomotor skills (single skills); locomotor skills (combinations); manipulative skills (sending away); manipulative skills (maintaining possession) and manipulative skills (gaining possession). The items underneath each subscale ranged from two to seven items. Results The results will be reported at the conference in July 2011. Discussion Fundamental movement skills are seen as building blocks for complex movement patterns. Children with better fundamental movement skills are more likely to engage in physical activity, since motor proficiency is inversely related with sedentary lifestyles (Wrotniak et al., 2006). It is thus important to understand fundamental movement skills to identify problems so that remedial intervention can be offered (Piek & Edwards, 1997; Brantner et al., 2009). There is a paucity of research studies in this area (Ward et al., 2010). Consequently, future quality research is vital using validated screening checklists in conjunction with validated movement skill assessment tools (Cliff et al., 2009). References Brantner S, Piek JP, Smith LM. (2009). *Rehabilitation Psychology*, 54(4), 413-421. Sugden D, Sugden L. (1990). *British Journal of Educational Psychology*, 61, 329-345. Cliff D.P, Okely, A.D, Smith L.M, Mc Keen, K. (2009). *Pediatric Exercise Science*, 21, 436-449. Cools W, De Martelaer K, Samaey C, Andries C. (2008). *Journal of Science and Medicine*, 8, 154-168. Piek JP, Edwards K. (1997). *British Journal of Educational Psychology*, 67, 55-67. Ward DS, Vaughn A, Mc Williams C, Hales D. (2010). *Medicine and Science in Sports and Exercise*, 42(3), 526-534. Wrotniak BH, Epstein, LH, Dorn JM, Jones KE, Kondilis VA. (2006). *Pediatrics*, 118, e1758-e1765

## ARE ADDITIONAL 15 MINUTES A DAY SUFFICIENT TO PROMOTE FUNDAMENTAL MOTOR SKILLS IN PRE-SCHOOL CHILDREN IN A KINDERGARTEN-SETTING?

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ARE ADDITIONAL 15 MINUTES A DAY SUFFICIENT TO PROMOTE FUNDAMENTAL MOTOR SKILLS IN PRE-SCHOOL CHILDREN IN A KINDERGARTEN-SETTING? Zahner, L.1, Ernst, D.1, Baumann, A.1, Siebenhaar, N.1, Donath, R.1, Muehlbauer, T.2 1 Institute of Exercise and Health Sciences, University of Basel, Switzerland 2 Institute of Sport Science, Friedrich-Schiller-University Jena, Germany Introduction Due to an increase in sedentary behaviour (e.g., increase in media consumption, decrease in physical activity), basic public health physical activity recommendation cannot be achieved by the general population mainly in western societies. However, physical inactivity contributes to high prevalent chronic diseases such as obesity, coronary heart disease, and diabetes. This is of even greater importance, since childhood inactivity frequently maintains into adulthood (McMillan and Erdmann, 2010). Therefore, promoting health-related physical activity habits in pre-school children should be highlighted in present public health considerations. Thus, we assessed the effectiveness of a short bout physical activity program in pre-school children. Methods Pre-school children (N=217) were randomly assigned into control (C) and intervention (I) groups. Matching criteria were set by age, gender, height, and mass. The intervention group underwent a 15 minute exercise program per day on agility, balance, and strength performance. The program lasted for 7 months. Interventions as well as pre

and post testing took place at pre-school. Tests consisted of three subsets: agility running test, repetitive jump test and dynamic balance test (Bös, 1987). Performance data were z-transformed and the z-scores were used within mixed linear models. Results The adjusted differences in post testing are substantial concerning agility running (I, 17.1±3.8 to 15.5±2.6 seconds vs. C, 18.7±4.5 to 17.2±2.6; -0.39 seconds from pre to post; -0.39 (-0.68 to -0.09 CI), p=0.013) and repetitive jump testing test (I, 36.3±12.0 to 46.3±12.0 repetitions vs. C, 31.0±10.4 to 37.9±9.6 repetitions from pre to post; 0.43 (0.15 to 0.72 CI), p=0.005). In contrast, dynamic balance tests did not reveal any changes between pre and post testing in both groups. Also waist circumference and fat-free mass did not decrease significantly. Discussion A regular and short term basic physical activity program in a pre-school setting considerably increases agility running and jumping performance. Postural control did not benefit in an appropriate manner. The latter might be caused by age-related baseline varieties of postural sway. We therefore conclude that a daily amount of 15 minutes is not sufficient for postural control improvements but leads to adequate improvements in fundamental motor skills. Further studies should therefore focus on longer periods of exercise programs and maintaining exercise in adulthood depending on pre-school activities. References McMillan CS, Erdmann LD. (2010). *Pediatr Exerc Sci*, 22(2), 231-244. Bös K. (1987). *Handbuch motorische Tests*. Hogrefe Verlag, Göttingen.

## Poster presentations

### PP-SH02 Exercise Psychology

#### EFFECT OF HIP-HOP DANCE TRAINING ON EMOTIONAL PROCESSING IN HEALTHY YOUNG ADULTS.

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There is increasing evidence that exercise can improve symptoms of depression. Recent neuroimaging studies have suggested that abnormal neural responses to emotional stimuli appear in depressed patients, and the neural substrates underlying antidepressant treatment have studied. However, there are few studies about exercise. In the present study, we examined the effect of exercise training on neural response to happy and sad emotional stimuli using functional magnetic resonance imaging (fMRI) technique in healthy young adults. Methods: Twenty-two university students who did not regularly exercise and were not under clinical treatment were assigned to training (7 men and 4 women) and control (5 men and 6 women) groups. The training group performed short-term hip-hop dance training consisting of a 60-min class 3 times per week for 3 weeks. The control group maintained their daily activity. Functional MRI was acquired during the screening of pleasant, unpleasant, and neutral slides at the pre- and post-training periods. Neural response to happy (pleasant versus neutral) and sad (unpleasant versus neutral) emotional processing was calculated. Results: The results showed that the neural response to happy stimuli was enhanced by hip-hop dance training (group-by-time interactions were observed) in regions such as the extrastriate cortex, insula, temporal pole, and putamen. On the other hand, a few regions including posterior parietal region showed an increased brain response in the sad condition. Discussion: Enhanced extrastriate activity to happy emotional stimuli was considered as increased attention to happy emotional stimuli. In addition, activation of insula and putamen are associated not only with emotional feelings but also body states (including visceral sense). The present study suggested that exercise may improve anhedonia, which is core symptom of depression, by changing attention and body reaction to happy emotional stimuli.

#### PASSION FOR DANCE: A NEGATIVE DEPENDENCY THAT ENHANCES RISKY BEHAVIOUR?

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Passion is a strong desire toward an activity that is self-defining, of utmost importance, and receives a vast investment of time and effort from an individual. Grounded within self-determination theory, harmonious and obsessive passion are proposed, with the former more positive, and the latter negative in nature (Vallerand et al., 2003). Obsessive passion has been associated with increased injury and injury-related risky behaviour in dancers (Rip et al., 2006), which supports the negative connotations proposed. The current research set out to test whether exercise dependence can explain the obsessive passion – risky behaviour relationship. Participants were 100 (50 fs; 50 ms) professional dancers ranging from 18 to 25 years of age (M = 20.88; SD = 2.69). With institutional ethical approval, participants completed informed consent, self-ratings of risky behaviours (doctor visits; following treatment, and warming up) and two psychological measures: Passion for Dance Scale (Rip et al., 2006) and Dance Dependence Scale (adapted from Hausenblas & Downs, 2002). Findings revealed a positive correlation between dance dependence and both harmonious ( $r = .42, p < .01$ ) and obsessive passion ( $r = .72, p < .01$ ). However, only obsessive passion and dance dependence correlated with two risky behaviours (low doctor visits and not following treatment). Dance dependence fully mediated the relationship between obsessive passion and doctor visits, and between obsessive passion and following treatment. Findings provide further support to the negative associations of obsessive passion in terms of risky behaviour in dance (Rip et al., 2006), but also offer initial evidence that exercise dependence may explain this relationship. Results are discussed in light of self-determination theory and the benefits and dysfunctions of passion for dance. The current findings suggest that professional dancers are at risk of employing maladaptive behaviours in terms of training and injury if they report high levels of obsessive passion, which may be detectable via the symptoms of exercise dependence. Future research is recommended in terms of the obsessive passion – exercise dependence relationship. Hausenblas, H. A., & Downs, D. S. (2001). How much is too much? The development and validation of the exercise dependence scale. *Psychology of Health*, 17, 387-404. Rip, B., Fortin, S., & Vallerand, R. J. (2006). The relationship between passion and injury in dance students. *Journal of Dance Medicine & Science*, 10, 14-20. Vallerand, R. J., Blanchard, C., Mageau, G. A., Koestner, R., Ratelle, C., Léonard, M., Gagné, M., & Marsolais, J. (2003). On obsessive and harmonious passion. *Journal of Personality and Social Psychology*, 85, 756-767.

#### THE PREVALENCE OF EATING DISORDERED PSYCHOPATHOLOGY AND BEHAVIOURS AMONGST BRITISH ATHLETES

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THE PREVALENCE OF EATING DISORDERED PSYCHOPATHOLOGY AND BEHAVIOURS AMONGST BRITISH ATHLETES Shanmugam, V.1, Jowett, S. 1, Meyer, C. 2. 1: School of Sport, Exercise and Health Sciences (Loughborough, England), 2: Loughborough University Centre for Research into Eating Disorders (Loughborough, England) Introduction Athletes are considered to be at higher risk of developing eating

disorders than the general population; however the prevalence of eating disordered psychopathology and behaviours amongst British athletes is unknown. Therefore the central aim of the present study was to determine and compare the prevalence of self-reported eating disordered psychopathology and behaviours in elite, developmental and recreational British athletes against a sample of British non-athletes, as well as examine gender differences across and within performance levels. Methods A random sample of 945 British athletes and 186 British non-athletes completed the Eating Disorder Examination Questionnaire (EDEQ). Results Six percent of elite athletes, 5.9% of developmental athletes, 9.9% of recreational athletes and 12.4% of non-athletes were classified as potential cases with eating disorders. Significant gender differences were found between female athletes and female non-athletes across the four performance levels, as well as between males and females within each performance level. Discussion The current findings provide evidence to suggest that eating disorders are more common amongst the general population than athletes, with female non-athletes identified as at high risk. However, males and females who engage in sports for a recreational purpose may be at a higher risk of developing an eating disorder than competitive athletes.

### THE ACUTE EFFECTS OF PHYSICAL ACTIVITY ON CIGARETTE CRAVINGS: A META ANALYSIS WITH INDIVIDUAL PARTICIPANT DATA

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Introduction Strength of urge to smoke is one of the strongest predictors of smoking cessation (Fidler et al, 2010) and exercise acutely reduces Strength of Desire (SoD; West et al, 1989) to smoke (Taylor et al, 2007). The study aims to provide an up to date review and collate Individual Participant Data (IPD; Riley et al, 2010) for SoD following exercise (versus rest), and to identify predictors of craving reduction. Methods Sixteen randomised parallel group or crossover design studies met the inclusion criteria. Original data from the authors for SoD and a range of demographic & behavioural measures were collated. A two-stage IPD meta-analysis was performed using data from 8 parallel arm trials and randomly selected data from 7 crossover trials, using a random effects model. Participants engaging in physical activity (PA) were compared against control participants, using the difference between post-intervention and baseline SoD. Followed by a linear regression of post-PA SoD with demographic & behavioural covariates, adjusting for study and baseline SoD. All analyses used Stata v.11. Results For the two-stage meta-analysis, the pooled estimate for treatment effect (non-standardised mean difference) was -1.908 (95% CI -2.721; -1.095), with a high degree of between-study heterogeneity. IPD with SoD & covariates were available for participants engaging in a PA intervention in 14 trials. Age, smoking years, cigarettes per day (CPD) and carbon monoxide were significant individually ( $p < 0.05$ ). Data for carbon monoxide and smoking years were only available from 8 & 9 studies respectively. Age was highly correlated with smoking years ( $r = 0.93$ ), so used as a proxy. A model including age and CPD was considered the most appropriate ( $n = 350$ ). The regression coefficients for age and CPD were -0.026 (95% CI -0.045; -0.007;  $p = 0.006$ ) and 0.038 (95% CI 0.011; 0.066;  $p = 0.006$ ), respectively. Gender, body mass index, PA status, Fagerström Test for Nicotine Dependence (Heatherton et al, 1991), duration of abstinence, were not associated with post-PA SoD. Discussion This is the first analysis investigating factors moderating acute effects of PA on cigarette cravings. Future analysis should consider how best to integrate data from both parallel group and crossover design studies. References Fidler JA, Shahab L, West R. (2010). *Addict*, 106, 631-8. Heatherton TF, Kozlowski LT, Frecker RC, Fagerström KO. (1991). *Br J Addict*, 86, 1119-27. Riley RD, Lambert PC & Abo-Zaid G. (2010). *BMJ*, 340:c221. Taylor, AH, Ussher, MH, Faulkner, G. (2007). *Addict*, 102, 534-543. West R, Hajek P, Belcher M (1989) *Psychol Med*, 19, 981-985.

### COMPARATIVE ANALYSIS OF ANXIETY AND DEPRESSION LEVELS IN CHILDREN SUFFERING FROM DIFFERENT DEGREE SCOLIOTIC

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COMPARATIVE ANALYSIS OF ANXIETY AND DEPRESSION LEVELS IN CHILDREN SUFFERING FROM DIFFERENT DEGREE SCOLIOTIC KOVALENKO T., SHKLYARENKO A., JAHNIK J., ULYANOV D., POPKOV A. Volgograd State University Slavenskiy-on-Kuban Pedagogical State Institute, Russia Introduction. The unbalance of nervous processes can lead to anxiety and depression. In work with children suffering from locomotor apparatus diseases, it is especially important to reveal in time the psychotic disorders and to prescribe the required rehabilitation procedures. Methods. The present study was carried out in the Children's Orthopaedic Sanatorium. Fifty six adolescences, aged 12-14, were examined. The following four groups of children with different scoliosis degrees were revealed: fault in posture; scoliosis of first degree; scoliosis of second degree; scoliosis of third degree. Each group of children was tested to detect their anxiety and depression levels. It should be noted that the coefficients algebraic sum exceeding +1,28 is indicative of good mental state. The sum minor to -1,28 shows the expressed psychologic stress, anxiety and depression. Results and their discussion. Analyzing the data obtained, we observe the absence of evident depression condition in examined children of all groups. Moreover, the positive mental state is detected in the first, second and third groups. Intermediate value of depression rate is found in children with the second degree of scoliosis (the fourth group). The average coefficient of anxiety and depression levels is 1,95 which goes to prove good respondents mental state. The present research shows that children aged 12 have decreased anxiety and depression levels. This result gives evidence of age-specific positive mood. Children aged thirteen have positive indicator of depression rate as it is also decreased. The anxiety rate is indefinite. Children aged fourteen are indefinite level of anxiety and depression. The data obtained indicates the rise in emotional stress with advancing age. Conclusion. By this means, with the increase of years, children suffering from scoliosis of different degrees have rising mental stress level that may adversely affect children's treatment course as well as their socialization.

## Poster presentations

### PP-SH03 Notational and Performance Analysis

#### CONTEXTUAL EFFECTS ON THE TEAMS' PERFORMANCE IN DEFENCE-ATTACK TRANSITION IN ELITE FOOTBALL

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**Introduction** The influence of contextual factors of competition on the different aspects of teams' performance in football received a large research interest recently (Bloomfield et al., 2005; Taylor et al., 2008). Transition from defence to attack represents a crucial phase of the offensive process. Consequently, the analysis of factors that influence transition game efficacy in different competitive contexts can help to make the match analysis more objective. This study aimed to assess the effect of match status and quality of opposition on the organization and subsequent success of the team in defence-attack transition sequences. **Methods** The sample consisted of 570 defence-attack transition sequences from the 24 matches, played by the 4 best classified teams of the 2010 FIFA World Cup. The observation system, developed for this study, included 16 categories and 67 performance indicators that were analyzed in function of two contextual variables – match status and quality of opposition. Multinomial Logistic Regression was used to determine which and how performance indicators were associated with different levels of teams' success in defence-attack transition sequences (0 – lost the ball possession, 1 – shooting the ball behind the opponent's goal, 2 – shooting the ball into the opponent's goal) in different match contexts. **Results** The results showed that there were five categories associated with teams' success in defence-attack transition game: the zone of attack finalization ( $p \leq 0,001$ ); attack-defence numeric relationship in finalization phase of attack ( $p \leq 0,001$ ); the first pass direction after the ball possession recovery ( $p \leq 0,010$ ); the attack-defence numeric relationship at the moment of the ball possession recovery ( $p \leq 0,010$ ) and the quality of opposition ( $p \leq 0,010$ ). The match status did not show any significant effect on the teams' performance in transition game. **Discussion** It was concluded that quality of opposition had significant effect on the teams' performance in defence-attack transition sequences. When the teams played against weaker opponents, they created more succeed transition sequences, which ended with kicks from penalty area in numeric superiority situations. The absence of match status effect on the teams' performance in transition game might be explained by the high equilibrium of observed matches. **References** 1) Bloomfield, J. R., Polman, R.C.J., & O'Donoghue, P. G. (2005). *J Sports Sci*, 23, 192–193. 2) Taylor, J. B., Mellalieu, S. D., James, N. & Shearer, D. A. (2008). *J Sports Sci*, 26, 885-895.

#### VALIDATION OF SPACE PROTECTION DYNAMICS IN BASKETBALL DEFENSE

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**Introduction** In a basketball match two teams interact dynamically in order to disrupt the defense and score or to prevent the opponent from achieving the goal. The set of a team's offensive dynamics to disrupt the defensive system has been recently described (Lamas et al., 2011). However, the correspondent set of dynamics the defensive team may perform to contain the offense and protect the space has been not elaborated yet. Our aim was to validate a set of space protection dynamics (SPDs) that contemplate all defensive possibilities of a team. **Methods** SPDs classes contemplate all possible defensive reactions to 1x1, 2x2 and 3x3 offensive actions in basketball. Validation followed Fonseca's et al. (2008) procedures: 1a. Proposition of a model of SPDs classes based on researchers experience (ten years in match analysis field) and analysis of ten matches from the male tournament of Beijing'08 Olympic Games; 1b. Conceptual improvement: SPDs criteria were analyzed by three international class pro-coaches, who evaluated its description for consistency; 1c. Intra and inter-observers reliability tests were performed by three blind expert judges (three observation rounds, one week apart each); 1d. Application of the SPDs: analysis of 2000 ball possessions from pro-matches for verifying the completeness of the instrument. **Results** Resultant classes of SPDs (steps 1a-b): 1x1 defense: Neutral; Restricted (inducing the offensive player to a side). 2x2 defense of without ball displacements: Close; Spaced. 2x2 pick'n'roll on ball defense: Together (pass the screen as the second player); Middle (third player); Behind (fourth player); Trap; Switch; Reject. 2x2 pick'n'roll screener defense: Show; Open; Push; Switch; Trap. 3x3: Screen Away receiver defense: Together (second); Middle (third); Behind (fourth); Switch; Reject. Screen Away screener defense: Show; Open; Push; Switch; Bump. Kappa test (step 1c) presented scores higher than 0.80 of agreements between and within judges. Defensive behaviors of all ball possessions analyzed (step 1d) were classified in a SPD category, indicating adequate completeness of the instrument. **Discussion** The validation of the SPDs classes was successfully performed. For all 1x1, 2x2 and 3x3 offensive actions there was provided a respective defensive class of action to protect space. The theoretical analysis of specialists contributed to the improvement of the instrument and any empirical inconsistency was detected. The SPDs and the offensive dynamic classes provide a more complete possibility for evaluating the opposition process in basketball. **References** Fonseca, R, Salles, J, Parente, M. (2008). *Psychol Neurosci*, 1, 55-62. Lamas, L., De Rose, D., Santana, F., Rostaier, E., Negretti, L., Ugrinowitsch, C. (2011). *Int J Perform Analysis in Sports*, 11, 71-84, in press. FAPESP: 08/10810-1

#### STATISTICAL ANALYSES OF FEMALE BASKETBALL TEAM PERFORMANCE: TURNOVERS ACCORDING TO OFFENSIVE AND DEFENSIVE TACTICS.

TSAMOURTZIS, E., FYLAKTAKIDOU, A., KARIPIDIS, A., MAVRIDIS, G.

DEMOCRITUS UNIVERSITY OF THRACE

**Introduction** The turnovers, shots and fouls constitute the effectiveness of offense (Filaktakidou et al., 2003). Turnovers occur more often than you might imagine, especially taking into account the level of skills of today's players. Their display frequencies, is the main culprit for the reduction of offensive percentage, and even more than the percentage of shots and rebounds. The minimizing of turnovers should be the main concern of the offense to achieve a victory (Mikes, 1987). This research was done with the aim of recording and the analysing of turnovers and their role in shaping the outcome. Also, it was to study the interaction of turnovers in game situations (offensive tactics, defense tactics). **Methods** For the purpose of this study forty-three ( $n=43$ ) women A1 National league basketball games were videotaped and video-analyzed. The method of indirect observation was employed and "Sportscout" program were used for the analysis of the digital video (Tsimpiris A., Tsamourtzis E., Sfingos N., Zaggelidis G., Zaggelidis S., 2006). Statistical analysis of this data included the presentation of frequencies in a double table and the application of  $\chi^2$ . **Results** The results showed that a) 19,1% of the possessions stop after a turnover, b) the most common turnover to the women basketball is the passing errors. Travelling and fault ball handling follow, c) most of the turnovers happen during the set play, d) the ability to defeat the zone defense is of a real importance because the women basket-



ball teams use to play this defense and most of the turnovers seems to happen under these circumstances. Discussion In the future, the coaches should spend more time practicing passing skills and ball handling, if they want to reduce their team's turnover percentages and improve significantly their offensive performance, as reducing the turnovers means increasing the chances of effective ball possession. While taking into account the areas of the court where the turnovers occur and the type of turnover that occurs in each area, enables the coaches of the women's teams to prepare most effective systems, adapted specifically to women's basketball and to organize and guide better their practices. Also, we believe that the coaches of women's basketball should dedicate more time practicing defense zone because this strong defense zone is one fact that could affect the result of the game. Respectively speaking, there should be very good preparation by the team to deal with defense zones as they are commonly used in women's basketball. References Filaktakidou A., Tsamourtzis, E. Taxildaris K., (2003). *Woman and Sport*, II (1):73-84. Mikes, J. (1988). *Scholastic Coach*, 57(6): 82,84. Tsimpliris A., Tsamourtzis E., Sfigos N., Zaggelidis G, Zaggelidis S. (2006). *Stiinta sportului*, 52: 17-39.

### THE RECOVERY OF BALL POSSESSION IN DIFFERENT MATCH CONTEXTS. A CASE STUDY WITH THE PORTUGUESE PROFESSIONAL SOCCER TEAM

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**Introduction** Previous research has shown that the performance in sports games is influenced by the context of the competition (Lago, 2009; Taylor et al., 2008). Therefore, the valid assessment of performance should consider the quality of opposition and evolving status of match. This study aimed to identify the team's actions that led to the recovery of ball possession and analyze the further evolution of offensive sequence in different match contexts. **Methods** The sample consisted of 801 occurrences of ball possession recoveries from 10 matches of the Portuguese Professional Soccer League and Portugal Cup 2009/2010. The observation system included 8 categories and 47 performance indicators. All indicators were analyzed in function of two contextual variables - match status and quality of opposition. Binomial Logistic Regression was used to determine which and how performance indicators were associated with the dichotomous variable first pass direction (1 – forward pass, 0 – sideward or backward pass), in the different match contexts. **Results** The final model of logistic regression analysis included 3 variables associated with the first pass direction: the zone and the form of the ball possession recovery, as well as the area from where the first pass was made ( $p \leq 0.001$ ). The models estimated for different levels of quality of opposition included the same variables. **Discussion** The association between these 3 performance indicators and forward pass was higher, when the team played against outside opponents. As far as the match status effect is concerned, the variables included in the model had significant effect on the first pass direction only when teams were drawing ( $p \leq 0.001$ ). In draw situation the team preferred sideward and backward passes and showed less offensive attitude. The results suggested that the form and zone of recovery of ball possession, as far as the first pass direction, were influenced by the quality of opposition and evolving score. Thus, these contextual variables should be taken into account in teams' performance analysis. **References** 1) Lago (2009). *J Sports Sci*, 27(13): 1463-1469. 2) Taylor, J. B., Mellalieu, S. D., James, N. & Shearer, D. A. (2008). *J Sports Sci*, 26, 885-895.

### GAME LOCATION EFFECTS IN ELITE SOCCER

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**INTRODUCTION** Home advantage in sport has been the subject of much empirical work, although the causes underlying this effect are still unclear. However, few studies have directly examining whether the fundamental measures of match performance (i.e. technical and tactical aspects) differ as a function of match location (e.g. Lago and Martin, 2007; Sasaki et al., 1999). As a consequence, in the present study game location effects upon technical and tactics-related statistics were investigated in all the 380 matches of the 2008-2009 Spanish Soccer League. **METHODS** The examined sample consisted of 380 Spanish Soccer League First Division matches played throughout the 2008-2009 season. The collected data were provided by a multiple-camera match analysis system (Gecasport). The following game-related statistics were gathered: total shots, shots on goal, effectiveness, assists, crosses, offsides committed and received, fouls committed and received, corners, passes, successful passes, ball possession, crosses against, dribbles, yellow and red cards. Data were analysed through descriptive and inferential procedures. Independent student t-test was used to identify the differences in all performance indicators between each team's home and away. A discriminant analysis was conducted to find the statistical team variables that discriminate among home teams and visitors. Finally, Pearson coefficients of variation (CV) were calculated for each variable depending on the final league ranking of the teams. **RESULTS** An overall home advantage was found for the sample in relation to home-winning and home-goal percentage. For technical performance more passes, successful passes, dribbles, and corners were performed by home teams. Home teams spent more time in possession of the ball than visitors. Finally, the top-placed teams showed lower CVs for the analyzed variables per match compared to those who finished lower in the table. **DISCUSSION** Overall, the findings suggest that in addition to influencing match outcome (i.e. home win percentage) the home advantage in terms of behavioural and strategic effects appears to exist at an individual team level within soccer. The results partially confirmed the predictions that more successful technical and tactical performance indicators would be performed at home compared to away (Taylor et al, 2008). Future research should consider the influence of other confounding variables such as weather conditions, game status, team form and opposition quality. **REFERENCES** Lago C, Martin R. Determinants of possession of the ball in soccer. *J Sports Sci*, 2007. 25: 969-974. Sasaki Y, Nevill A, Reilly T. Home advantage: A case study of Ipswich Town football club during the 1996-1997 season. *J Sports Sci*, 1999. 17: 831. Taylor JB, Mellalieu SD, James N, Shearer D. The influence of match location, quality of opposition and match status on technical performance in professional association football. *J Sports Sci*, 2008. 26: 885-895.

### ANALYSIS OF TACTICAL SITUATIONS OF ELITE TURKISH TENNIS PLAYERS IN TERMS OF "5 GAME SITUATIONS"

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**Introduction** Tennis is a dynamic and complex sport in which there are recurrent positions and strokes. The strategic plans of the players help them make planning against their rivals' strong and weak sides, and adapt to the forthcoming tournaments (10). The limited studies made until now to analyze the tactical aspects of the Turkish Tennis players are remarkable. This study was done to determine the tactical game situations of the elite Turkish Tennis players in terms of "5 game situations". **Methods** The data were obtained by examining the

video records of 94 matches which were played by 108 players (44 female, 64 male) in the senior category in the Championship of Turkey. The statistical analyses were carried out with SPSS 15.0. Results It was seen at the end of the study that when the percentage changes of the winning and loss strokes of the Turkish tennis players were examined in terms of 5 games situations, the winning stroke percentages of female tennis players are as follows: serve 42%, baseline play 39, 2%, return of serve 12,7%, playing against a net player 2,2%, net play 3,9%, while their loss strokes are serve 8,4%, baseline play 61%, return of serve 27,6%, playing against a net player 1,2%, net play 1,8%. The winning stroke percentages of male tennis players are as follows: serving 45,4%, baseline play 30,5 %, return of serve 4,8%, playing against a net player 4,3%, net play 15%, while their loss strokes are serve 7%, baseline play 59,3 %, return of serve 25%, playing against a net player 4,1%, net play 4,6%. Discussion As a result of the research, female tennis player are generally successful in serving, baseline play, however they have high error ratio in baseline play and return of serve. Although Male tennis players are successful in serving and baseline play, they have high error ratio in baseline play and return of serve. Finally, the tennis players with fewer error strokes are more successful at matches. References Ingram B. O'Donoghue P. A notational analysis of elite tennis strategy. *Journal of Sports Sciences*, 2001; 19:107-115. Fernandez J, Mendez-Villanueva A, Pluim BM, Intensity of tennis match play, *Br J Sports Med*, 2006; 40:397. Caserta R. J. Singer R. N. The Effectiveness of Situational Awareness Learning in Response to Video Tennis Match Situations. *Journal of Applied Sport Psychology*, 2007; 19: 125-141,

### CASE-BY-CASE ANALYSIS OF GAME INTERRUPTIONS IN FOOTBALL

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TU MÜNCHEN

Introduction There are many studies on effective match time in soccer showing that about one third of the total time the game is interrupted (e.g. Meyer, et al., 2000). Drust, et al. (2000) simulated the loads imposed on football players during a soccer match using a treadmill-protocol. This study analyses the demands of a football match by a case by case examination of each game interruption in order to obtain a more precise description of the intermittent nature of a football match. Methods 16 matches of a German first league football team were analysed. To characterize the intermittent nature of a football match, the status of the match was coded (1 = running; 0 = interrupted) for every second. A forward moving average (length 120 seconds) was computed to describe the local relation between the two states. Results Results are given for a typical match. There are several phases in the game with a rather high proportion of interrupted match (>50%) although no interruption lasted for longer than two minutes. On the other hand we find six occasions of running match lasting longer than 2 minutes. Mean interrupted match time (28%) is almost never typical for the local interrupted match time. Instead, the moving average is characterized by large variations in match status thus reflecting typical behaviour in football. These results were found similarly in all 16 matches. Discussion Case-by-Case analyses of interruptions improve the understanding of the intermittent load characteristics in football. It turns out that mean interrupted match time is an inappropriate estimate for local match load. A player faces large, unforeseeable variation in running and interrupted match times. The methods presented gives valuable hints for the practical preparation of the players, because it informs on the respective durations of demanding and recovery match intervals. References Meyer T., Ohlendorf K., Kindermann W. (2000). *Dtsch Z Sportmed*, 7+8, 271-277. Drust B., Reilly T., Cable N.T. (2000). *J Sports Sci*, 18, 885-892.

### DO NATIONAL TEAMS IN THE FIFA WORLD CUP PLAY DIFFERENTLY? MATCH ANALYSIS OF SOUTH AFRICA 2010.

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Introduction: Teams participating in the FIFA World Cup (FWC) differ in level, technical and tactical characteristics. The FWC games are organized according to the official FIFA ranking. Match performance analysis of the highest ranked teams (HRT) and the lowest ranked teams (LRT) could reveal the differences in playing and highlight the technical aspects and tactical attitudes. The aim of this study was to examine the data of the matches of different FIFA ranking teams during the FWC in South Africa in 2010. Methods Sixteen national teams (n°8 HRT and n°8 LRT according to 2009 FIFA ranking) while playing the FWC 2010 were taken in consideration in this analysis. Data were collected from official FIFA reports (www.fifa.com). Data of final match results, goals, shots, corners, fouls, cards, ball possessions, actual playing times, correct and wrong passes (short: <10mt; medium: 10-29.99mt; long ≥30mt; cross), distance covered and running average speed of the team players were collected for each match. Descriptive analysis and chi square test analysis were used. Results A total of 69 matches were analyzed (n°41 HRT and n°28 LRT). HRT resulted to be higher than LRT in mean of goals scored, shots and shots on goal, corners, ball possession, actual playing time and number of passes (600 passes for each match for HRT vs 463 for LRT). In particular, HRT differed from LRT in number of correct passes: short 102.2±32 (HRT) vs 78.6±23 (LRT); medium 283.3±77 (HRT) vs 176.1±49 (LRT); long 52.2±16 (HRT) vs 43.2±13 (LRT); and crosses 4.7±3 (HRT) vs 3.2±2 (LRT). Total distance covered by teams during defined passage of play was 7708.2±609 mt for HRT and 7886.5±847 mt for LRT; and the same value of average players' top speed was found: 22.3±1.2 Km/h for HRT and 22.3±0.8 Km/h for LRT. The ball possession was 47.7%±6 for losing teams, was 49.8%±6 for teams that tied the match, and 53.7%±6 for winning teams. Discussion This study showed differences in match data of national teams ranked by FIFA and participating at the 2010 FIFA World Cup. Results showed a relationship between the percentage of ball possessions and final match outcomes. As well, data showed differences in technical aspects about the number and the accuracy of passes shorter than 30 mt, that could represent fundamental general direction for training. Match performance analysis of teams differently ranked by FIFA could reveal information about technical and tactical attitudes that can improve the soccer game development. References Hughes, M., & Franks, I. (2005). Hughes, M., Robertson, K., & Nicholson, A. (1988). Albin Tenga, Lars T. Ronglan & Roald Bahr. (2010).

### ANALYSIS OF THE DEFENSIVE COVERAGE IN HIGH-LEVEL VOLLEYBALL. A PRELIMINARY STUDY OF THE LIBERO PLAYER IN A SPANISH TOURNAMENT

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Introduction Spiker coverage is a defensive action present in all Game Complexes performed by the team in possession of the ball (Rodríguez et al., 2011). From setting to spiking, players who don't complete the attack change their location on the court to cover the spiker (Meier, 1994). A limited number of balls coming from block touch could be defended by the team with this action (Selinger & Ackermann-Blount, 1992). The aim of this study was to detect patterns of spatial behaviour between libero and attacker players during the Complex I. Methods 325 actions were registered from a randomized sample of the 2009 Queen's Cup, held in Menorca (Spain). A high-speed video camera (300 Hz) was used to record the rallies of 7 matches between the 8 best teams of the season. Overlay image

and frame by frame analysis were performed using the video analysis software Kinovea to determine the players' location while attack was completed. Synchronic analyse in lag 0 was carried out in the statistical software GSEQ to detect patterns of interactive behaviour. The 5 attack zones referring to the Attacker's Location (AL) and the 6 cover zones concerning to the Libero's Location (LL) were selected as givens and targets behaviours, respectively. Results 5 stable patterns of interactive behaviour were identified. The first between given Attacker's Location in Zone 4 and target Libero's Location in Zone 4 ( $Z=7.57$ ;  $p<.01$ ). The second between ALZ3 and LLZ1 ( $Z=4.19$ ;  $p<.01$ ), LLZ5 ( $Z=2.31$ ;  $p<.02$ ) or LLZ6 ( $Z=2.15$ ;  $p<.03$ ). The third between ALZ2 and LLZ2 ( $Z=9.66$ ;  $p<.01$ ) or LLZ3 ( $Z=2.08$ ;  $p<.04$ ). The fourth between ALZ6 and LLZ1 ( $Z=2.62$ ;  $p<.01$ ). And the last one between ALZ1 and LLZ3 ( $Z=3.1$ ;  $p<.01$ ). Discussion The results are agree with the idea that volleyball players should take a specific coverage responsibility area for each particular attack zone (Selinger & Ackermann-Blount, 1986). The Liberos are located at the front zones of the court (4, 3 and 2) to cover spikes in lateral zones (4, 2 and 1). Moreover, they cover in back zones (5, 6 and 1) with spikes in central zones (3 and 6). In addition, the Liberos and Attackers are located at the same area only when spiking in front lateral zones (4 and 2). In these situations the Liberos cover near the Attackers. References Meier, M. (1994). Movement dynamics in volleyball with young players. *International Volley Tech*, 1(94), 11-16. Rodríguez, D., Quiroga, M.E., Miralles, J.A., Sarmiento, S., De Saá, Y., García, J.M. (2011). Study of the technical and tactical variables determining set win or loss in top-level European Men's Volleyball. *Journal of Quantitative Analysis in Sports*, 7(1), Article 7. Selinger, A., Ackermann-Blount, J. (1992). *Power volleyball*. Paris: Vigot.

## CHARACTERISTICS OF THE RUNNING PERFORMANCE IN JAPANESE PROFESSIONAL SOCCER PLAYERS

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**Introduction** In time-motion analysis of soccer games, many researchers have been analyzing quantity of the distance covered in soccer players (Bangsbo et al. 1991). However, the previous data used for their analysis were collected only from players in European top-level soccer club or national teams. Actually, there was no studies used the data from Japanese professional soccer players. Therefore, the purpose of this study was to assess running performance in Japanese professional soccer players. **Methods** This study was carried out with sixteen J-League (Division 1) games in 2010 season. Thirty-two professional Japanese soccer players (age:  $25.7 \pm 4.0$  years, height:  $177.3 \pm 5.4$  cm, body mass:  $71.8 \pm 5.5$  kg) participated in this study, including defenders ( $n=12$ ), midfielders ( $n=12$ ), and forwards ( $n=8$ ). These players were filmed during the entire match. The digital video cameras (HDR-XR550V, Sony, Japan) were positioned at the side of the pitch, at the level of midfield line, at a height of about 20m and at a distance of about 30m from touch line. The digital movies were later replayed on a monitor. Then, total distance and running speed were analyzed using Track Performance software (Sports Code, Australia). This software system was applied most effectively with the use of a drawing tablet (PTK-1240, Wacom, Japan) connected to laptop computer. The locomotion categories were used for standing (0km/h), walking (6km/h), jogging (8km/h), low-speed (LS) running (12km/h), moderate-speed (MS) running (15km/h), high-speed (HS) running (18km/h), sprinting (30km/h). These locomotion categories were chosen in accordance with Bangsbo et al. (1991). **Results & Discussion** The mean total distance covered in 90 min. was  $11265 \pm 700$  m and ranged from 9740m to 12370m. The average distance covered (absolute & relative data) consisted of standing (0m, 1.4%), walking (2439m, 46.1%), jogging (1790m, 15.7%), LS running (3405m, 21.7%), MS running (1817m, 8.5%), HS running (1016m, 3.9%), and sprinting (802m, 2.7%). There was no significant difference between the first ( $5640 \pm 400$  m) and the second ( $5626 \pm 400$  m) half of the total distance covered (absolute data). However, relative data in the second half regarding standing and walking were significantly increased compared to the first half ( $P<0.05$ ). On the other hand, jogging, LS running, MS running, HS running, and sprinting were significantly decreased compared to the first half ( $P<0.05$ ). Therefore, it was suggested that fatigue accumulated in Japanese professional soccer players during the games affected faster running speed especially in the second half. **References** 1. Bangsbo, J., et al., Can. Activity profile of competition soccer. *J. Sport Sci.*, 16: 110-116, 1991

## Poster presentations

### PP-SH04 Doping

## MASCULINITIES AND BODIES: THE IMPORTANCE OF PHYSICAL ACTIVITIES TO ELDERLY MEN

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**Introduction** To be a man or to be a woman is not an acquired state – it is rather an appropriation, a condition in permanent active construction, which involves tensions and ambiguities (Vale-Almeida, 1996). And masculinity, beyond being perceived as a social process, involves practices which refer to the body and what the body does (Connell, 2000). With advancing age, elderly identities, especially masculine identity has perforce to be realigned due to the possible loss of sexual performance, reduced muscle power and strength and the onset of illness and frailty (Arber, Davidson & Ginn, 2003). This concern with physicality and body's functionality may encourage older man toward healthy activities, such as physical activity, exercise or sports (Halliwel & Dittmar, 2003). However, the literature that analyze the influence of regular exercise in older men perceptions of their "old or renew" masculinity is scarce. In this context, the aim of the present study was to recognize the way elderly men perceived their masculinity and body and how the practice of an exercise program interferes in those perceptions. **Methods** A qualitative approach, employing semi-structured interviews, was used to elicit masculinities and body concerns amongst a group of 10 older men (mean age= $67.8 \pm 5.6$  years old) that began an exercise program. Content analysis technique and interpretation was applied, after data being processed by the program QSRNVivo7. **Results** The results showed: (i) a strong association between masculinity and sexuality; (ii) that aging has an impact in older men masculinity through loss of active sexuality as well as functional and healthy body; (iii) the influence and importance of an exercise program in the masculinity negotiation process, through which man improve their abilities, functionality and therefore their self-perception of their body and masculinity. **Conclusion** The overall findings suggest that masculinity has a strong relation with body and sexuality. However, physical activities help them to renegotiate their masculinities and to regain the significance of a social body in the commitment to an active life style. **References** Arber, S.; Davidson, K. & Ginn, J. (2003). Open University Press, Berkshire. Connell, R. (2000). *The Men and the boys*. Sidney: Allen & Unwin. Halliwell, E. & Dittmar, H. (2003). *Sex Roles*, 49(11/12), 675 – 684. Vale-Almeida, M. (1996). *The Hegemonic Male: Masculinity in a Portuguese Town*. Oxford and Providence: Berghahn Books. **Acknowledgement** This research was funded by the Portuguese Foundation of Science and Technology (FCT), grant FCOMP-01-0124-FEDER-009587 - PTDC/DES/102094/2008.

### ATTITUDE TOWARDS PERFORMANCE-ENHANCING DRUGS IN SPANISH SPORT SCIENCES UNIVERSITY STUDENTS

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UNIVERSITY OF GRANADA

**Introduction** To prevent the wrong use of prohibited substances to improve performance in sport it is important to study first the attitudes towards Doping in athletes, but also in coaches or sport managers and other professionals (1). These attitudes can be mediated by culture, studies, social environment, or the sport practiced (2). The aim of this study was to know the attitude towards performance-enhancing drugs (PED) in Sport Sciences students as well as if it could be any difference due to the sport practiced (individual, team, or both sports). **Methods** The sample was made of 270 students ( $22.09 \pm 3.26$  years) of Sport Sciences degree -Faculty of Sport Sciences, University of Granada (Spain)-. Descriptive design was carried out by means of a validated questionnaire (1) of 17 questions using a Likert scale from 1 (Strongly Disagree) to 6 (Strongly Agree) for different statements that support the use of PED in sport. Three groups were made according to the practiced sport ( $n=27$  Team Sports -TS-;  $n=89$  Individual Sports -IS-;  $n=154$  Both Sports -BS-). Mean value  $\pm$  Standard Deviation was obtained for each item and Mann Whitney test for independent variables was carried out. **Results** In general, the score for the mean of all the items was  $2.04 \pm 0.55$  (2=Through Disagree). The lowest score was observed for the item "Doping is not cheating since everyone does it" with  $1.14 \pm 0.58$ , and the highest for "Athletes are pressured to take PED" with  $3.72 \pm 1.31$  (3=Slightly Disagree; 4=Slightly Agree). Just for one item ("Athletes have no alternative career choices, but sport") significant differences were observed between IS ( $2.48$ ) and the other groups TS ( $2.07$ ) and BS ( $2.00$ )  $-p=0.015-$ . For the rest items no significant differences between groups were observed. **Discussion** Sport Sciences University students in general disagree with the use of PED in competitive sport. In this kind of subjects that are not professionally involved in any of the sports there are no differences in attitudes towards PED due to the sport practiced (TS, IS, or BS), contrary to the hypothesis that argues that those subjects involved in IS are more likely to support the use of these substances (2). Different populations (sedentary, active, or professional) and sports (i.e. Cycling or Athletics Vs Soccer or Basketball) should be investigated in the future to get more patterns about attitudes towards doping in Sport, in relation to the specific sport practiced, frequency of practice, gender, etc. **References** 1. Petroczi, A. & Aidman, E. (2009). Measuring explicit attitude toward doping: Review of the psychometric properties of the Performance Enhancement Attitude Scale. *Psychology of Sport and Exercise*. 10. 390–396. 2. Striegel, H., Ulrich, R. & Simon, P. (2010). Randomized response estimates for doping and illicit drug use in elite athletes. *Drug and Alcohol Dependence*; 106(2-3): 230-2.

### DO PREVIOUS STUDIES AND EXPERIENCE AFFECT THE PERSPECTIVE ABOUT DOPING IN THE NEWEST SPANISH CYCLING TEAM MANAGERS?

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**Introduction** Nowadays the terms 'cycling' and 'doping' are associated (1). Doping cases of some cyclists (2) or the recent 'Contador Case' only emphasize this theory. The aim of this study was to know the perspective of the latest Spanish cycling team managers (highest level) in relation to the phenomenon of doping taking into account their previous level of technical formation and studies. **Methods** The study was composed by a total of 87 participants involved in the course of Cycling Team Manager (Spanish Cycling Federation) in 2009 and 2010. Of the total sample, 15 subjects were graduated in Sport Sciences (Sport Sciences Formation -SS-), 36 had previous federative certification (Federative Formation -FF-), and 36 did not have any technical formation or study but had been previously professional cyclists (No Formation -NF-). A descriptive design was carried out using a specific questionnaire consisting in 7 opened questions, and then answers were analyzed and categorized showing percentage (%) values. **Results** The data obtained (%), comparing the different groups (SSF, FF, NF), were, respectively: 1-Words associated with doping: Cheating (60%, 63.89%, 35.29%); Results/Performance (53.33%, 30.56%, 27.45%). 2- Responsible agents of doping: Laboratories (13.33%, 63.89%, 28%); Coach/Manager (60%, 77.78%, 43.14%). 3-Differences Cycling vs Other sports: Discriminatory treatment (73.33%, 75%, 47.06%); Hardness of cycling (6.67%, 41.67%, 3.92%); Number of controls (26.67%, 30.56%, 9.8%). 4-Reasons for the initiation in doping: Sport achievements (60%, 66.67%, 47.06%); Contract/money (60%, 19.44%, 25.49%); External pressures (33.3%, 47.72%, 37.25%). 5 - Have you been suggested to dope?: SSF (Yes 46.7%); FF (Yes 50%); NF (Yes 72.2%). 6 - Have you seen other people inciting others or being incited?: SFF (Yes 53.3%); FF (Yes 52.8%); NF (Yes 75%). 7 - Proposed solutions: Prevention at early ages (40%, 52.78%, 23.56%); Awareness (33.33%, 25%, 19.1%). **Discussion** Results support the theory that doping is a recognized reality, especially by NF. The SSF group associates 'doping' with 'performance' may be related to get a 'better contract', while FF does the same with 'cheating' possibly caused by 'outside pressures'. Newest managers recognize the main responsible agents involved in the phenomenon of doping. Federative Formation group considers that the main difference between cycling vs others is its hardness, while surprisingly NF does not see the number of controls as a difference with other sports. "Preventing at early ages" and "Awareness of cyclists" by means of psychosocial programs seem to be the most proposed solutions, being SSF group the clearest in this position. In summary, we find different perspectives that suggest that prevention must be taken into account. **References** Lenthion - Kaestner, V. (2008). Conduits dopantes chez les jeunes cyclistes du milieu professionnel. *Phycotrophes*. 14, 47-57. Berry, D. (2008). The science of doping. *Nature*. 454.692-693.

### MOTIVATION UNDERLYING BODY IMAGE CONSTRUCTION AMONG BRAZILIAN BODYBUILDERS

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**Introduction** Physical appearance, including male hyper-muscularity, is highly emphasized in today's consumer marketing. Current research studies suggest the cultural norms of the ideal male physique have grown increasingly more muscular (Leit et al., 2002; Leit et al., 2001). The purpose of the present study was to examine aesthetic motivation among young, male Brazilian bodybuilders seeking to improve physical appearance by increasing their body mass and muscularity. **Methods** Employing an ethnographic approach, with in-depth interviews, we qualitatively investigated body image construction among 7 bodybuilders (20-30 yrs of age) in an economically impoverished bodybuilders' gym in Recife, Pernambuco State, Brazil. We used the Discourse of the Collective Subject (DCS) (Lefèvre and Lefèvre, 2003) in order to tabulate and organize the qualitative data obtained during the semi-structured interviews. Adhering to the Theory of Social Representation, this technique permits synthesis of individual narratives – written in the singular, first person – into "one voice" in order to express 'community thought'. In other words, the discourse of seven individuals becomes one. **Results** Principal themes that emerged included "the objective of my workout is to reach perfection" and "friendships influenced my training", among others. The DCS interpretations for these themes are: 'For aesthetic reasons, I decided to practice bodybuilding', 'Definition, perfection, and keeping

my body 'taut' are my goals", "People prefer muscle mass", "I work out very seriously", "I was influenced by friends, a desire for good health, and by seeing other guys working out", and "Other people, especially girls, began to notice". Discussion Le Breton (2006) has proposed that every behaviour can be explained by a particular motivation, reason, aesthetic, ritual, or propitiation. We analyzed the bodybuilders' motivation for aesthetic enhancement (within the theoretical limits of satisfaction and dissatisfaction). Based on our results, we believe this group of bodybuilders – with the apparent purpose of modifying their physiques to meet personal and/or societal expectations – to be more susceptible to high-risk behavioural practices and disorders such as anabolic steroid abuse and muscle dysmorphia. Future research should provide health professionals with effective strategies to address this public health concern. References Le Breton, D. Petrópolis, Rio de Janeiro: Vozes, 2006. Lefèvre F, Lefèvre, AMC. Caxias do Sul: Educ, 2003. Leit RA, Pope HG, Gray JJ. Int. J. Eat. Disord. 29:90-93. 2001. Leit RA, Gray JJ, Pope HG. Int. J. Eat. Disord. 31:334-338. 2002.

## Poster presentations

### PP-SH05 Sports Management 1

#### THE COMPARISON OF LEVEL OF COMPETITIVE ANXIETY IN LORESTAN MALE PROFESSIONAL KARATE PLAYERS AND ITS RELATIONSHIP WITH MATCH RESULT

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**Abstract Introduction:** It is often seen that some sportsmen, although physically appropriate, are not able to demonstrate their potentialities due to stress and anxiety. Successful sportsmen use anxiety as a stimulator for better performance while less successful ones seem to doubt their performance and be afraid of defeat and, a consequently, they lead themselves to strong fear and anxiety. The aim of this study is to determine the relationship between competitive anxiety and competitive results in karate players. **Materials & Methods:** 150 karate player's (75 kata player's and 75 komite players) participating in championship, were selected. For evaluation of competitive anxiety SCAT inventory was used and completed one hour before the match. The reliability and validity of SCAT have been established in numerous studies. For data analyzes biserial correlation, Pearson correlation and independent T-test were used. **Results and Discussion:** Results showed no significant relationship between competitive anxiety and competitive performance in komite player's ( $P \geq 0/05$ ) but a significant negative relationship was found between competitive anxiety and competitive performance in kata player's ( $P \leq 0/05$ ). In the other hands when the player's competitive anxiety increases their performances degrades significantly. No significant relationship was found between Athlete's experiences in the level of competitive anxiety no significant difference was found between komite and kata players.

#### THE PERCEPTION OF HIGH SCHOOL SENIORS OF THE STUDIES IN THE SPORT UNIVERSITY; THE PROMOTION OF PROFESSIONAL SPORTS AS A CAREER

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UNIVERSITETI I SPORTEVE TIRANE

**THE PERCEPTION OF HIGH SCHOOL SENIORS OF THE STUDIES IN THE SPORT UNIVERSITY; THE PROMOTION OF PROFESSIONAL SPORTS AS A CAREER** CARKANJI, V. & LLESHI, E. Sports University of Tirana Introduction The role of sports in society has increased significantly in the past decades and it is being transformed in a major industry that affects many aspects of the economy. Recently, the sport industry has become an extremely profitable sector of the economy (Crockett, 2005). The variety of sport and sport related professions has also increased. The aim of this study was to explore the perception of and interest on sports as a future career path amongst high school students in Albania. We explored student's awareness and knowledge about sports professions, their perception of sports as a career and their wishes to follow such careers. **Methodology** The study was conducted among the senior students of Tirana's high school. We interviewed all seniors in all city's high schools. This is deemed the most efficient method of collecting information from a large number of populations (OGGS web, 2011). The main method of study was a questionnaire survey. Data was collected through face-to-face interviews. **Findings** The study found out that the information and knowledge on sports professions is low amongst high school students. In addition, their perception of sport as a profession is rather negative. As a result, the desire to pursue sports career is also very low. While there were no major differences between female and male students, students with higher academic achievements are less likely to choose a future in sports. We also found that many students are unaware of a number of various sports professions in particular those in the field of sports management. Further research is deemed necessary to explore factors which prevent the high school students senior to join the profession world of sports. **References** Crockett, S. S. (2005). Why undergraduate students choose sport management as a major: Factors influencing college choice decisions. Retrieved February 13, 2011 from [http://etd.lib.fsu.edu/theses\\_1/available/etd-07092005-160019/unrestricted/crockett\\_sarah.pdf](http://etd.lib.fsu.edu/theses_1/available/etd-07092005-160019/unrestricted/crockett_sarah.pdf) Ministry of Higher Education (2011). About the graduate survey system. Retrieved November 25, 2011 from [http://www.ogss.gov.om/index.php?option=com\\_content&view=article&id=2&Itemid=2&lang=en](http://www.ogss.gov.om/index.php?option=com_content&view=article&id=2&Itemid=2&lang=en)

#### PHYSICAL ACTIVITY AND SELF-MANAGEMENT SKILLS

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**Physical Activity and self-Management Skills** Bano ,E.1, Mara,F.1, Puma,B.1, Qeleshe, A.1,s 1: UNIVERSITY OF SPORT OF TIRANA Introduction: Regular physical activity done three times a week for 30 minutes at a time for moderate levels of activity (3) greatly reduces the risk of illness and death. . and exercise PA led to more positive self –perception of physical mastery and ability (Sorenson at. al ) **Objectives:** Our main objective is to see and to continue to understand how physical activity and self management go in correlation hand by hand when people exercise regular and for a long time ,by standards and professions authority . **Subjects:** This study engages 124 individual from 18 – 40 years old (62 female 62 male) that exercises for a couple years in afternoon, at University of Sport of Tirana ,three time a weak . **Methodology:** We have use The Self-Management Skills Questionnaire . (Charles B.Corbin, at al 2000). **Results:** Data from question are : Rating Total score female male total Good 30-36 ---- 40% 35% 37.5% Marginal 24-29 --- 50% 50% 50 % May need improvement less

than 24 --- 10% 15% 12.5% Discussion. Our information study show that both gender exercise regular using strategies and manage their time to allow regular performance of their physical activity program. Result from male and female persons seems to have approximately values and positive specially at marginal and good level ( in total 50 % and 37,5 %). References 1- Charles B. Corbin, Ruth Lindsey, Greg Welk. Concepts of Physical Fitness ,2000;2: 33-34. 2- Sorenson, M., S. Anderssen, i. Hjerman, and H. Ursin. 1997. Exercise and diet intervention improve perceptions of self in middle-aged adults. Scandinavian Journal of Medicine and Science in Sports 7: 312-320 . 3 -U.S. Department of Agriculture and U.S. Department of health and Human Services .1995. Nutrition and Your Health : Dietary Guidelines for Americans .Washington, DC: U.S. Government Printing Office.

### THE EFFECT OF YOGA EXERCISE ON MENTAL HEALTH IN WOMEN REFERRED TO YOGA ASSOCIATION OF FARS PROVINCE

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**Abstract Introduction:** Yoga is a dynamic method and has a valuable scientific and a practical philosophy used in daily life. The aim of this study is to determine the effect of yoga exercises on mental health in women referred to the yoga association of Fars province. **Materials & Methods:** This is a Quasi – experimental study. 83 women referred to the yoga association voluntarily participated in this study. Inclusion criteria were regular menstruation, lack of amenorrhea, nonsmoking or use alcohol, drugs and hormonal substances or suffered from certain diseases such as epilepsy, hepatitis, etc. yoga exercises composed of Asana, Pranayama and Meditation, these exercise carried out for 12 weeks. The mean age of subjects was 30.4 years with the range of 16-59 years. A modified questionnaire was to data collection and contains the evaluation of emotional excitement, somatic symptoms, anxiety; sever depression, professional ability and feeling of participants before and after the study. Descriptive statistics and T-test were used to analyses data. **Results:** The results of this study show a significant difference between the mental health scales before and after the intervention ( $P < 0.05$ ) and subjects had the better scores for their health after the yoga exercises in all parameters. **Discussion and Conclusion:** Our finding suggests that yoga exercises including Asana, Pranayama and Meditation are useful methods to improve the overall health in women.

### EVALUATION OF PHYSICAL ACTIVITY PROGRAMMES FOR THE ELDERLY IN PORTUGAL - EXPLORING THE LESSONS FROM OTHER SECTORS AND EXAMINING THE GENERAL CHARACTERISTICS OF THE PROGRAMMES

MARQUES, A.I.1, SOARES, P., SOARES-MIRANDA, L.I, MOREIRA, C.I, OLIVEIRA-TAVARES, A.I, CLARA-SANTOS, P.I.2, VALE, S.I, SANTOS, R.I.3, CARVALHO, J.I

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**Background** In Portugal, there are several physical activity (PA) programmes for elderly people developed by the local government. The importance of these programmes has been increasing since the evidence has shown that this type of health promotion interventions may reduce the deleterious effects of the ageing process. However, no study has already identified the general characteristics of these programmes nor if they use any scheme to assess the quality of the service provided. A widely-used scheme is the EFQM Excellence Model, which will be in the core of our present work. Thus, the main aims of this preliminary study were 1) to identify the general characteristics of the PA programmes developed by the Portuguese Local Public Administration 2) to determine the extent of implementation of quality initiatives in these programmes. **Methods** Data were collected by an on-line questionnaire sent to all Continental Municipalities ( $n=278$ ). Categorical data were expressed as absolute counts and percentages. Continuous data were expressed as the mean and SD. An open-ended question was analysed using qualitative content analysis with QSR NVivo software. Associations between categorical variables were tested by the use of contingency tables and the calculation of chi-square tests. Significance level was set at  $p \leq 0.05$ . **Results** Results showed: i) a total of 125 PA programmes were identified in the 18 districts of the Portugal mainland; ii) the main goal of the majority (95.2%) was the participants' health promotion; iii) different characteristics of the programmes were found according to different regions of the country; iv) certain characteristics of the programmes were associated to the existence of other features; v) only one PA programme developed quality initiatives. **Conclusions:** Although there are many PA programmes for elderly people spread throughout the country, aiming at improving the health of participants, the overwhelming majority does not adopt quality control initiatives. Considering that the quality of a service increases customer satisfaction, the continuous quality improvement of the PA programmes for elderly people should therefore be implemented since they can be useful and critical for elderly satisfaction and adherence.

### RECREATION WITHIN THE PROCESS OF INDUSTRIAL REVOLUTION

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**Introduction** Nowadays, we see that leisure time is evaluated as the benediction of development especially in the industrialized and developing countries within the process of development in understanding of leisure time. Since the beginning of process of Industrial Revolution, there have been occurred many problems such as urban population, working hours and child employment and these problems are important for leisure time and recreation concepts. When existence of these kinds of problems around the world is considered, it is required to examine and investigate recreation concept within the process of industrial revolution. Britain transformed its traditional economy and society to modern industrial condition between the years of 1750- 1830 and this transformation affected leisure time concept significantly. People left their villages and came to the conditions in which there were no sufficient time and place for resting. It was thought that people's working productively would provide individual and communal reconstruction and more than 70 hours per week were allocated for working. Male and female workers started working in similar conditions and works and they tended to re-creative activities in order to rescue from being tired and boringness of their working environment. In the later 1800's, America began realizing its responsibilities in local government recreation services; park zones and playgrounds were opened, schools released their facilities to the public and recreation unities were organized. The Playground Association of America was built and Play Congress was organized. And then European Countries, also, realized recreation need, for example: The Copenhagen Playground Association was organized. Park zones, open areas and swimming pools were made usable incrementally for community health and physical recreation in Britain. **Conclusion** With Industrial Revolution, an individual, who is physically active in his life in which he makes his living by working in lands (agricultural worker), separated from his lands, and became inactive; children and adults did not find comfort in city life as they found in rural

areas; its deficiency was needed. In that way, leisure time concept arose and people filled their leisure times with recreation activities. Valuing leisure time gained importance on the positive effects registered in working life by people. In the later 1800's, local governments began realizing their responsibilities in recreation services and organizing recreation unities and they arranged some places such as park zones and playgrounds. The Playground Association of America was found, European countries became conscious, institutions were reconstructed for recreation, organizations were made and the ability to do the necessary for recreation gained importance, working conditions were regularised and developed. References Bull, C., Hoose, J., Weed, M. (2003). An Introduction to Leisure Studies. London: Prentice Hall Inc. Torkildsen, G., (2005). Leisure and Recreation Management (5th edn.). New York: Routledge.

## Poster presentations

### PP-PM07 Physiology: Immunology 1

#### IMMUNE RESPONSE AND SERUM HEAT SHOCK PROTEINS CONCENTRATION IN YOUNG TENNIS PLAYERS AFTER THE WHOLE TOURNAMENT SEASON

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**Introduction** There are a lot of evidences that exaggerate sport activity may lead to systemic inflammation. Increase blood pro-inflammatory cytokines has been observed in basketball players sportsmen after play-off tournament (Zembroń-Lacny et al 2010) and among rowers after 8 weeks prior to the 2007 Rowing World Championships (Main et al, 2010). Still, these researches refer mostly to adult athletes. Only a small number of investigations focus on the relation between immune response and regular training with extensive exercise workload in adolescent athletes (Deguchi et al 1988). The main purpose of this study was to investigate if long lasting tournament season in young tennis players causes low grade systemic inflammation and induced adequate increase in anti-inflammatory heat shock proteins. **Methods** Well-trained 16 young tennis players ( $15 \pm 0.9$  years old, singles national ranking 3-39) took part in this study. The study was performed after tournament season, three days before a tennis-camp in autumn-winter period. It was approved by the hosting university's Research Ethics Board. Serum inflammatory cytokines (IL-1 $\beta$ , TNF $\alpha$ , IL-6, IL-10) and Hsp27, Hsp70 were measured by commercially Elisa kits. Results Pro-inflammatory cytokines have been shown to be elevated in most of the athletes compared to normal values reported for athletes (TNF $\alpha$  4.05 pg . ml<sup>-1</sup>, IL-1 $\beta$  2.9 pg . ml<sup>-1</sup>). However, the hydrogen peroxide and lipid peroxides did not point out on oxidative stress. The average values of Hsp27 and Hsp70 were 300 pg . ml<sup>-1</sup> and 4.7 ng . ml<sup>-1</sup> respectively. **Discussion** Our findings indicate that whole tournament season in young tennis players triggered elevated pro-inflammatory cytokine concentration response. Supposedly, this reaction could have resulted from the insufficient production of Hsp27. References Zembroń-Lacny A, Naczek M, Gajewski M, Ostapiuk-Karolczuk J, Dziewiecka H, Kasperska A, Szyszka K. *Physiol Res* 2010; 59: 945-51. Main LC, Dawson B, Heel K, Grove JR, Landers GJ, Goodman C *Res Sports Med* 2010; 18: 127-39. Deguchi Y, Negoro S, Kishimoto S. *Age Biochem Biophys Res Commun* 1988; 157: 580-4.

#### IMMUNE RESPONSE TO EXERCISE IN THE HEAT FOLLOWING A PERIOD OF PROBIOTICS SUPPLEMENTATION

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**Introduction** Intense exercise training and/or heat stress lead to various immune and gastrointestinal disturbances. These disturbances in immune function and gastrointestinal barrier have been associated with increases in systemic lipopolysaccharide (LPS) (Lim et al, 2009; Selkirk et al, 2008). In view of the purported benefits of probiotics on gastrointestinal immune function, this study investigated the influence of probiotics supplementation on gastrointestinal permeability and systemic inflammation when exercising in the heat. **Methods** Twelve trained, male runners (Height:  $178 \pm 7$  cm, Body Mass:  $72.6 \pm 7.6$ , VO<sub>2</sub>max:  $62.9 \pm 6.8$  kg/ml/min, Age:  $29 \pm 7$  years) completed the double-blind, placebo controlled, randomised cross-over trial. Runners exercised to fatigue at a speed corresponding to 80% ventilatory threshold in 35°C, 40% humidity. This treadmill run was repeated under the same conditions following four weeks of supplementation with either probiotics or a placebo. Following a three week washout period runners completed the cross over. Five grams each of lactulose and rhamnose were administered prior to each run and urine collected for a five hour period to assess gastrointestinal permeability. Venous blood samples were collected pre-, post-, and 1hr post-exercise for the determination of full blood counts, LPS and cytokines. Core temperature was monitored during each run via an ingested temperature sensor telemetry system. **Results** Four weeks of supplementation with probiotics significantly reduced lactulose-to-rhamnose ratio following running in the heat (pre-exercise:  $0.030 \pm 0.018$ , post-exercise:  $0.018 \pm 0.008$ ), when compared to a placebo (pre-exercise:  $0.022 \pm 0.008$ , post-exercise:  $0.021 \pm 0.009$ ) ( $p=0.032$ ). Probiotics supplementation was associated with a reduction in one hour post-exercise IL-10 ( $p=0.038$ ) and IL-6 concentration ( $p<0.005$ ). There was a significant effect of trial (pre- to post-supplementation) x group for LPS concentration ( $p=0.02$ ), with post-exercise values lower following probiotics supplementation. Area under the curve for core temperature was not significantly different between groups ( $p=0.34$ ). **Discussion** Probiotics supplementation reduces gastrointestinal permeability when running in the heat, which may influence circulating inflammatory cytokines and LPS concentration. References Lim CL, Pyne D, Horn P, Kalz A, Saunders P, Peake J, Suzuki K, Wilson G, Mackinnon LT. (2009). *App Phys Nut Met*, 34 (4), 616-624. Selkirk GA, McLellan TM, Wright HE, Rhind SG. (2008). *Am J Physiol Regul Integr Comp Physiol*, 296 (3), R611-623.

#### EFFECTS OF HIGH-INTENSITY EXERCISE ON SKIN SURFACE SECRETORY IMMUNOGLOBULIN A AND RESIDENT BACTERIA

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**Introduction** For athletes, preventing infectious disease on skin is important. It was reported that the number of staphylococcus aureus on athletes' skin increased after games and training (Kukidome et al., 2000 ; Daniel et al., 1989). Secretory immunoglobulin A (SigA) is secreted on skin surface with sweat, and works as the first line of defense against pathogenic microbial invasion. Therefore, SigA on skin

surface is useful to estimate athletes' skin condition. The aim of this study was to determine the effects of high-intensity endurance exercise on skin immunity by estimating SIgA concentration. Methods Seven healthy adult males participated in this study. Each of them performed bicycle exercise at 75%HRmax for 60 min. On middle of chest and medial side of the forearm, SIgA was obtained from 1 ml extraction liquids stirred with the microtube homogenizer in the polypropylene tube for 60 sec, and staphylococci were harvested by pressed agar-based media against the skin surface. Results SIgA concentration on medial side of the forearm was significantly lower at B2 ( $p < 0.05$ ) and B3 ( $p < 0.05$ ) than that at B1, and that on middle of chest at B1 tended to be higher compared with B2 ( $p=0.084$ ) and B3 ( $p=0.075$ ). The number of staphylococci was significantly higher at B2 than that at B1 ( $p < 0.01$ ) and B4 ( $p < 0.01$ ) on medial side of the forearm. Discussion SIgA concentration on skin surface significantly decreased after exercise. It is inferred the amount of sweating increased during exercise, so SIgA was flushed out with sweat and significantly reduced. The number of staphylococci on medial side of the forearm significantly increased after exercise. Staphylococci are resident bacteria on skin surface. It is possible that staphylococci leave through the pores with sweat during exercise. In this study, on medial side of the forearm, SIgA concentration significantly decreased and the number of staphylococci increased between B1 and B2. These results agree with previous studies that atopic dermatitis patients were lower SIgA concentration and more numbers of staphylococci, and susceptible to skin infections (Imayama et al., 1994; Nilsson et al., 1992). In summary, we conclude that high-intensity endurance exercise might depress immune function and enhance infectious risk on skin surface. References Kukidome T, Sato M, Yoshimura K, Tagami K. (2000). *J Clin Sports Med*, 17(11), 1387-1391. Daniel M. (1989). *Am J Sports Med*, 17(6), 828-832. Imayama S, Shimozone Y, Hoashi M, Yasumoto S, Ohta S, Yoneyama K, Hori Y. (1994). *J Allergy Clin Immunol*, 94, 195-200. Nilsson EJ, Henning CG, Magnusson J. (1992). *J Am Acad Dermatol*, 27(1), 29-34.

### EFFECT OF TAPERING ON SALIVARY SIGA IN ELITE SPEED SKATERS

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Introduction: Reductions in salivary secretory immunoglobulin A (SIgA) are related to incidence of upper respiratory tract infections (Kon et al., 2010). High-load exercise training causes a decline in salivary SIgA. The purpose of this study was to investigate the effect of tapering after high-load training on salivary SIgA in elite speed skaters. Methods: The subjects were 8 speed skaters who participated in the Japan single distances speed skating championships. Training load, saliva flow rate, salivary SIgA concentration, salivary SIgA secretion rate, and subjective fatigue were measured during high-load training and tapering periods. SIgA concentrations were measured by enzyme immunoassay, and SIgA secretion rate was calculated. Training load was quantified using Training Impulse (TRIMPs). A visual analogue scale was used to subjectively assess fatigue. Results: The training load recorded for tapering period was significantly lower than that recorded for high-load training period ( $p < 0.01$ ). There was no significant difference in the saliva flow rate and SIgA concentration. The SIgA secretion rate recorded for tapering period was significantly higher than that recorded for high-load training period ( $p < 0.05$ ). The subjective fatigue recorded for tapering period was significantly lower than that recorded for high-load training period ( $p < 0.05$ ). Discussion: It is reported that salivary SIgA is influenced by exercise training load. Akimoto et al. (1998) showed that salivary SIgA decreased after high-load exercise training. On the other hand, moderate exercise training increased salivary SIgA (Klentrou et al., 2002). Thus, salivary SIgA of elite speed skaters might be improved by the reduction in training load in this study. In summary, we concluded that tapering improves salivary SIgA secretion rate in elite speed skaters. Tapering before competition may be useful not only for the reduction of accumulated fatigue but also for the improvement in mucosal immune function (salivary SIgA) of elite athletes. References Kon M, Iizuka T, Maegawa T, Hashimoto E, Yuda J, Aoyanagi T, Akimoto T, Takahashi H. (2010). *J Strength Cond Res*, 24, 2249-2254. Akimoto T, Akama T, Koda Y, Waku T, Hayashi E, Tatsuno M, Sugiura K, Amano K, Kono I. (1998). *Jpn J Phys Fitness Sports Med*, 47, 245-252. Klentrou P, Cieslak T, MacNeil M, Vintinner A, Pyley M. (2002). *Eur J Appl Physiol*, 87, 153-158.

### EXERCISE-RELATED CHANGES IN THE ACTIVITY OF SALIVARY IMMUNOGLOBULIN A AND MELATONIN: A PILOT STUDY FOR DEPRESSION PATIENTS

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Introduction According to the Ministry of Health, Labour and Welfare, in Japan, the number of patients with mood disorders, including depression, doubled from 440,000 in 1999 to over 1,000,000 in 2008. It is well known that exercise is indispensable to effective health management. We believe that supports based on objective indicators along with exercise programs are beneficial for people with mood disorders. Thus, we aim to devise a simple index that is objectively appreciable of the physical condition of such patients. In an attempt to do so, we performed a pilot study for patients with depression by studying the physiologically active substances—immunoglobulin A (IgA) and melatonin (Mel)—in the saliva. Methods First, we observed the effects of daily events on the salivary activity of IgA and Mel in 10 healthy male university students. The activity of IgA and Mel were measured by ELISA and HPLC, respectively. We collected each sample 4 times a day (7:00, 12:00, 18:00, and 24:00) for 5 consecutive days. The daily events, i.e., exercise, work, sleep, and mealtime, were recorded simultaneously. Next, we determined the effects of an acute exercise on the activity of IgA and Mel in 20 healthy male university students. These students played football, basketball, table tennis, or recreational sports; the activity of IgA and Mel were measured before and after each exercise. Results In many individuals, the IgA concentration was higher in the morning than in the afternoon. However, in some subjects, different trends in IgA levels were observed. These individualistic differences were lifestyle-dependent, as were the differences in the concentrations of Mel. It was observed that the changes in IgA concentrations before and after the exercise differed according to the nature of the exercise. Discussion The changes in the activity of IgA and Mel depended on the lifestyle of the subject and/or the nature of the exercise performed. The patterns of change might be related to the individual's physical condition. It was suggested that exercise affects the physical condition and biological rhythm of individuals. Thus, the salivary activity of IgA and Mel can be considered as candidates for simple physiological indexes for the physical condition of depression patients.



## Poster presentations

### PP-PM08 Training and Testing: Strength and Flexibility

#### TESTSTATISTICAL EVALUATION OF THE DEUTSCHE MOTORIK-TEST 6-18

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Ellinger, B.1, Fröhlich, M.2, Koch, M.2 1: Bielefeld University (Bielefeld, Germany), 2: Saarland University (Saarbrücken, Germany) Introduction The Deutsche Motorik-Test 6-18 (DMT 6-18) is a test series to analyze the motor performance of male and female students aged between 6-18 years. The DMT 6-18 includes eight test dimensions for testing motor performance. These dimensions cover all of the motor abilities – endurance, strength, speed, coordination and flexibility (Bös et al., 2009). One of these dimensions determining coordination under time pressure is the so-called 'Seitliches Hin- und Herspringen' (SHH; means jumping bidirectionally for 15 seconds). The purpose of the study was to analyze the reliability of the chosen method by observer objectivity. Methods 15 male and 15 female students at an average age of  $12.97 \pm 0.31$  years were tested with DMT 6-18. The SHH was observed via video analysis and by two independent, trained observers to gain more objective results. The duration between the initial testing and the terminal testing was 8 weeks. The results of the video analysis and observer analysis were compared. The value of the coefficient of correlation was used for interpreting the reliability of SHH. Additionally, a test-retest method (video and observer data) was used for obtaining coefficients of reliability. Results The coefficient of correlation between observer and video analysis shows a highly significant correlation ( $r=0.91$ ;  $r^2=0.82$ ;  $p<0.05$ ). The mean difference between observer ( $43.38 \pm 8.32$ ) and video analysis ( $39.80 \pm 9.99$ ) was 3.6 errors. The test-retest reliability for observer data was  $r=0.81$  ( $r^2=0.65$ ), and for video data  $r=0.82$  ( $r^2=0.68$ ) (all  $p<0.05$ ). The mean difference for observer data was 4.13 errors, and for video data 1.86 errors. Discussion The results of the video analysis and independent observation show that the reliability for the test dimension SHH is assured. Only 18 % of variance is not clear. In total, the test-retest reliability is slightly lower, but still has a very good value. In all, reproducibility of the SHH result exists. Thus, independent testers can illustrate coordination under time pressure to a sufficient degree. If a real value on the performance in SHH is the goal, technical support, such as videometrics, is recommended. However, if multiple persons are examined under time pressure, video analysis is too complex a means. References Bös, K., Schlenker, L., Büsch, D., Lämmle, L., Müller, H., Oberer, J., Seidel, I. & Tittelbach, S. (2009). Deutscher Motoriktest 6–18 (DMT 6–18). Hamburg: Czwalina.

#### THE RELIABILITY OF ISOKINETIC KNEE STRENGTH TESTING IN PHYSICALLY ACTIVE STUDENTS

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Introduction Isokinetic strength is characterized by exercise with an accommodating resistance and fixed speed. Isokinetic dynamometry has been used in clinical and sport practice (Brown, 2000). In clinical practice, the isokinetic dynamometer has been used as part of the rehabilitation programme after muscle disfunction, in assessing disorders such as rotator cuff overuse, anterior instability or neurological pathology. In sport practice, isokinetic measurement has served to assess the stage of the training process in volleyball, tennis, swimming and baseball athletes (Dauty et al., 2003). The aim of the study was to compare the reliability of isokinetic knee strength testing in physical education students. Methods Thirteen physical education students (8 males, 5 females) were measured on the Cybex Humac Norm dynamometer. The concentric strength was tested during the right and left knee extension and flexion at angular velocities  $60^\circ/\text{s}$  (5 rep.) and  $180^\circ/\text{s}$  (15 rep.). The reliability was calculated using the ICC (3,k) (Shrout & Fleiss, 1979) for the right and left knee. The values of ICC were assessed for peak torque, total work and average power in extension and flexion of knee concentric muscle strength. Results The intraclass correlation coefficients (ICC) ranged between 0.92-0.95 for flexion and 0.91-0.96 for extension at angular velocity  $60^\circ/\text{s}$  and 0.88-0.94 and 0.95-0.97 at  $180^\circ/\text{s}$ . The results confirmed high reliability for the specific knee isokinetic strength testing. Discussion The value of reliability has been reviewed by many authors (Dauty et al., 2003; Shrout & Fleiss, 1979), suggesting that ICC values over 0.90 indicated excellent reproducibility, whereas scores of between 0.75-0.90 were acceptable. Our results of ICC indicated excellent values of reliability in majority of cases in physically active students. References Brown, L. E. (2000). Isokinetics in human performance. Champaign, IL.: Human Kinetics. Dauty, M., Delbrouck, C., Huguet, D., Rousseau, B., Potiron-Josse, M., & Dubois, C. (2003). Isokinetics and Exercise Science, 11, 95-100. Shrout, P. E., & Fleiss, J. L. (1979). Psychological Bulletin, 36, 420-428.

#### FAMILIARIZATION SESSION INCREASES INTRA SESSION RELIABILITY IN JUMP EVALUATION

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INTRODUCTION Good values of intra session reliability are important to identify significant differences in the outcome measures of transversal experimental studies (Hopkins, 2000; Weir, 2005). Familiarization session is necessary to increase stability on a task (Weir, 2005). Therefore, the aim of this study was to identify the effect of a familiarization session on variables of maximum effort drop jump task. METHODS Through the impulse method with one force plate the free falling displacement of the centre of gravity (FFDCG), the contact time (CT) and the jump height (JH) were determined. The subjects were 22 young physical active males (Age 21.4 years SD 2.2) (BW 74 kg SD 9.2) (BH 1.72m SD 0.11) (BMI 23.6 SD 2.1). Jumps were performed in a random order. Two perfect jumps were recorded from each of four drop platforms (20, 30, 40, 50 cm) with 3 minutes rest period between jumps. Before each jump the following command was given systematically: "with your hands on your hips, try to fall from the height that you were in, using the minimum contact time and maximum jump effort". These procedures were conducted twice with a two day interval. For each variable the typical error ( $TE = DP / \sqrt{2}$ ) and the typical percentage error ( $TE\% = TE \cdot 100 / \text{mean}$ ) were calculated. RESULTS The increase in the intra session reliability, expressed as TE%, were 1.2% (SD:0.8), 4.6% (SD:2.8), 2.8% (SD:2.5), for FFDCG, TC e JH, respectively. Moreover, a decreasing in the number of tries to get the two valid jumps from the 20, 30 and 50 cm drop platforms ( $p = 0.05$ ) was observed. DISCUSSION The decrease in the values of TE and TE% for all variables as well as the decrease in the number of tries from the first to the second day of evaluation demonstrate a positive learning effect (Schmidt & Lee, 2005), more specifically increasing the stability of the jump technique due to the familiarization session (first section) (Sale, 1991). REFERENCES Hopkins WG. (2000). Sports Med, 30, 1-15. Sale DG. (2003) In: KOMI (Ed.) 2nd ed. Oxford: Blackwell Sciences, 281-314. Schmidt RA, Lee TD. (2005). Champaign, 4<sup>o</sup> ed. Human Kinetics. Weir JP. (2005). J Strength Cond Res, 19, 231-240.

**RELIABILITY OF THREE CLINICAL TESTS MEASURING CORE AND WHOLE-BODY STABILITY**

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**RELIABILITY OF THREE CLINICAL TESTS MEASURING CORE AND WHOLE-BODY STABILITY** Borghuis, A.J.<sup>1</sup>, Lemmink, K.A.P.M.<sup>1,2</sup>, Hof, A.L.<sup>1</sup>. 1: Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands 2: School of Sports Studies, Hanze University of Applied Sciences, Groningen, the Netherlands **Introduction** To study the effect of neuromuscular training programs on improving core stability, a valid and reliable measurement method should be developed that is based on a widely accepted definition of the concept of core stability. The body's core is defined as the lumbopelvic complex with all its surrounding tissues, like muscles, tendons and ligaments. Postural stability is a dynamic state, characterized by efficient equilibrium recovery and resistance to perturbations. On the basis of these concepts, core stability is defined as the ability of the neuromusculoskeletal system to maintain or resume an upright position of the trunk in labile situations or in the presence of disturbances. The purpose of the present study was to introduce a graduated sitting balance test and a seated perturbation test as valid measures of core stability and robustness, respectively. Furthermore, test-retest reliability of both tests and of an adapted version of a previously developed standing balance test (the narrow ridge balance test developed by Curtze et al., 2010) was investigated, together with the relationships between the different test results. **Methods** Thirty healthy university students performed the three tests two times with a period of one week in between. Intra-class correlation coefficient (ICC), standard error of measurement (SEM) and minimal detectable change (MDC) were calculated to indicate reliability and responsiveness of the test results and correlations were calculated to relate the different test results to each other. **Results** A systematic bias was found for the balance scores obtained with the graduated narrow ridge test and the graduated sitting balance test and for some measures obtained with the seated perturbation test, indicating a learning effect. ICC values of all test results varied between 0.55 and 0.94. Lateral standing balance and sitting balance scores correlated significantly with lateral Time To Stabilization (TTS) in the seated perturbation test, with correlations ranging between -0.46 and -0.63. **Discussion** Test-retest reliability of the three tests investigated was moderate to substantial, with some measures showing almost perfect reliability. Results indicated that adequate reactive neuromuscular trunk control plays a role in stabilizing both standing and seated posture in the frontal plane. Future research should focus on refining these measurement methods to eventually use them in assessing the effect of neuromuscular interventions on improving core and whole-body stability. **References** Curtze C, Postema K, Akkermans HW, Otten B, Hof AL. (2010). Gait Posture, 32(4), 627-31.

**FIELD TESTS OF FLEXIBILITY OF THE LOWER EXTREMITY: THE SENSITIVITY ANALYSIS**

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**FIELD TESTS OF FLEXIBILITY OF THE LOWER EXTREMITY: THE SENSITIVITY ANALYSIS** Pazin, N.<sup>1</sup>, Berjan, B.<sup>2</sup>, Bozic, P.<sup>2</sup> 1: Faculty of Sport and Physical Education (Belgrade, Serbia), 2: Serbian Institute of Sport (Belgrade, Serbia) **Introduction** The field test of flexibility has been commonly used to identify performance limiting factors, to assess the intrinsic risk factors of sport injuries, to monitor the effects of training and rehabilitation programs, to compare various individuals and groups, as well as for the talent selection purposes. However, there is apparent lack of data regarding the sensitivity of field tests of flexibility of the lower extremity. Therefore, the purpose of this study was to evaluate the standard field tests of flexibility of the lower extremity through their sensitivity with respect to different training history. **Methods** Sixty-seven healthy male subjects with distinctive training histories were divided into 4 groups: soccer players (n = 21), basketball players (n = 18), karate competitors (n = 12), and physically active individuals (n = 16). Following a familiarization session, the subjects were tested by means of standard devices (i.e., kinantropometry, ruler tape, and protractor) on the following flexibility tests: Leg Raise in a Supine Position (LRSP), Hip Abduction Test (HAT), Single-Legged Knee Bend (SLKB), Sideward Leg Splits (SdLS), Sit and Reach (SR), Sideways Leg Splits (SsLS) and Lengthwise Leg Splits (LLS). **Results** A one-way MANOVA revealed significant main effects of group (Wilks'  $\lambda = 0.363$ ;  $F(21, 164) = 3.307$ ,  $p < 0.001$ ) where the post hoc ANOVAs generally suggested a high sensitivity (particularly in SdLS), except for SR and SLKB that proved to be insensitive. In addition, Tukey post hoc test revealed the highest level of flexibility in karate competitors, as compared to other participant groups. The effect size of difference (calculated as partial eta squared:  $\eta^2$ ) for all tests were relatively high ( $\eta^2 = 0.27 - 0.43$ ). **Discussion and conclusions** In general, the findings of the present study suggest that the simple and effective field tests of flexibility of lower extremity based on using both a standardized and inexpensive equipment could be sensitive with respect to different training background. We could particularly recommend using SdLS test rather than the most frequently used SR test, not only because of its exceptionally high sensitivity, but also because of advantageous methodological (i.e., high reliability and factorial validity; Bozic et al., 2010) and anatomical properties (Alter, 1996). **References** Alter MJ. (1996). Science of Flexibility. Champaign, IL: Human Kinetics. Bozic P, Pazin N, Berjan B, Planic N, Cuk I. (2010). J Strength Cond Res, 24(9), 2523-2531. **Acknowledgments** The study was supported in part by a grant from Serbian Research Council (#175037).

**EFFECT OF A HEAVY RESISTANCE EXERCISE WARM-UP ON PERFORMANCE DURING A RUGBY-SPECIFIC EXERCISE PROTOCOL**

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Rugby union is characterised by phases of intermittent, low intensity activity combined with short periods of maximal effort during which players are required to produce high forces against external loads (e.g. rucking, mauling and scrummaging). The purpose of this study was to investigate the effects of a heavy resistance exercise "post-activation potentiating" (PAP) warm-up on performance during one 21 min block of the Bath University Rugby Shuttle Test (BURST) (Roberts et al., 2010), a rugby union match-simulation protocol. Twelve male rugby players (mean (SD); age, 20 (2) years; body mass, 82.4 (11.5) kg) performed two trials in a random order at least one week apart. In each trial, prior to the 21-min block of the BURST, participants performed a warm-up of jogging, dynamic stretching, high-intensity running and then either three sets of three: (i) body-weight squats (control), or (ii) heavy squats at 80, 85 and 90% of one repetition maximum (PAP). Participants then recovered for 8 minutes before beginning the BURST. A 21-min block of the BURST comprised four identical 5-min cycles including 20-m shuttles of walking, jogging and cruising, interspersed with simulated rucks, scrums and mauls. In the last minute of every 5-min cycle, participants carried out a timed Performance Test comprising one 9-m tackle bag carry, one Assassin push (4-m horizontal leg drive of a 180-kg cart up an incline of 4° (RJF Design, Surrey, UK)) and an agility sprint with a ball. After 25 s of recovery, a 15-m sprint was performed. Outcome measures were the Performance Test time, Assassin push time and 15-m sprint time. Two-way repeated measures ANOVA showed that 15-m sprint time did not change significantly over time and was not significantly different be-

tween trials at any timepoint (control, 2.55 (0.12) s vs. PAP, 2.55 (0.11) s; time main effect,  $P = .30$ ; trial main effect,  $P = .98$ ; interaction effect,  $P = .56$ ). Assassin push performance did not change over time (time main effect,  $P = .07$ ), but was significantly faster in the PAP trial (control, 1.17 (0.12) s vs. PAP, 1.15 (0.12) s; trial main effect,  $P = .02$ ). The interaction effect was not significant ( $P = .70$ ). Performance Test time did not change significantly over time and was not significantly different between trials at any timepoint (control, 16.76 (0.92) s vs. PAP, 16.78 (1.05) s; time main effect,  $P = .23$ ; trial main effect,  $P = .95$ ; interaction effect,  $P = .76$ ). In conclusion, a heavy resistance exercise "potentiating" warm-up did not improve 15-m sprint or Performance Test time, but improved horizontal push performance. This finding may have benefits for rugby forwards during the early part of a match. Roberts, S P, Stokes, K A, Weston, L, Trewartha G. (2010). *Int J Sports Physiol Perform*, 5 (1), 64-74.

## PREDICTION OF OPTIMAL HQ RATIO IN TEST OF CONSECUTIVE MAXIMAL CONTRACTIONS

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**PREDICTION OF OPTIMAL HQ RATIO IN TEST OF CONSECUTIVE MAXIMAL CONTRACTIONS** Knezevic, O., Mirkov, D. Faculty of Sport and Physical Education, University of Belgrade, Serbia **INTRODUCTION** The hamstrings-to-quadriceps (HQ) ratio has received a lot of attention in rehabilitation monitoring (Suzovic et al., 2008). Although mostly assessed from standard strength tests measures, due to its simplicity, cost-effectiveness, and high test-retest reliability (Suzovic et al., 2008, Mirkov et al., 2009), the recently proposed test of neuromuscular function based on consecutive maximal contractions (CMC) could be a promising one. Since Q and H exert maximal strength at different knee angles (KA) while CMC requires them to be measured in a single one, the question remains which KA could provide the most appropriate HQ ratio. The aim of our study was to determine the "optimum" KA for CMC testing as well as to compare the obtained HQ ratio with the HQ ratios of healthy subjects and the athletes with recent ACL reconstruction. **METHODS** The quadriceps and hamstrings peak torque (PT) of dominant leg of 20 healthy male university students was assessed at KA of 100°, 120°, 140° and 160° by means of CMC test using Kin-Com isokinetic dynamometer. Subjects' mean PT for each individual angle and muscle was normalized and interpolated with 2nd order polynomial function to obtain the "optimum" KA and HQ ratio. To evaluate this HQ ratio, 17 students and 8 athletes 4 months following their surgery were tested at the determined KA, and HQ ratios of dominant and non-dominant dominant (or, alternatively non-dominant and injured leg) were calculated and compared with the "optimum" HQ ratio. **RESULTS** The results revealed optimum KA of 135° while the HQ ratio of 0.43(0.09). The HQ ratios obtained at the KA at 135° of dominant and non-dominant leg were (data as mean (SD) 0.47 (0.06) and 0.44 (0.12), and of healthy and injured leg 0.50 (0.09) and 0.84 (0.22), respectively. There were no differences between "optimum" and HQ ratios of the dominant, non-dominant and healthy leg, respectively. Significant differences were found between optimum and HQ ratio of the injured leg ( $p < 0.01$ ) as well as between healthy and injured leg ( $p < 0.01$ ). **DISCUSSION** The optimum angle could be between 120° and 150° interval, which provides maximum strength of Q and H. Therefore, PT obtained from CMC could assess muscles' ability to exert maximum sustained contraction despite being both transient and relatively low (Suzovic et al., 2008). Taking also into account findings (Suzovic et al., 2008, Mirkov et al., 2009) these results suggest that CMC test performed at the optimum angle and corresponding HQ values could provide a standardized procedure for monitoring recovery following knee injuries. **REFERENCES** [1] Suzovic D et al. (2008). *J Hum Kin*, 20, 51-67. [2] Mirkov D et al. (2009). 14th Ann. Congress of the ECSS, Oslo, Norway Acknowledgement: Study was supported in part by a grant #175037 from the Serbian Research Foundation

## ISOKINETIC PROFILE OF KNEE STRENGTH IN HEALTHY UNTRAINED MALES AND FEMALES

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**ISOKINETIC PROFILE OF KNEE STRENGTH IN HEALTHY UNTRAINED MALES AND FEMALES** Preshelkov, R. South-West University, Faculty of Public Health and Sports (Blagoevgrad, Bulgaria) **Introduction** Isokinetic evaluations can be used as an objective strength measure in clinical research and sports environments. The aim of the present study was: - to assess the isokinetic strength in different angular velocities of knee extensors and flexors in healthy untrained; and - to compare the main indices, including flexor/extensor or left/right ratios, between males and females. **Methods** Twelve male (19.8±0.3 years; 178.9±2.0 cm; 73.8±3.2 kg; BMI - 23.0±0.7) and 8 female (19.8±0.5 years; 169.5±1.9 cm; 59.5±2.2 kg; BMI - 20.7±0.5) healthy, right legged, untrained volunteers participated. To evaluate subject's maximal knee flexion/extension muscle strength, an isokinetic dynamometer (Biodex System 4 Pro) was used. The isokinetic concentric regime of loading at 3 angular velocities - 60, 180 and 300 degrees with 5, 10 and 15 repetitions, respectively, were included in the experimental protocol. **Results** The values (mean±SEM) of the isokinetic (velocity 60 degrees) extension peak torque 234±9 Nm, total work 1274±48 J and average power 150±9 W in males were significantly ( $p < 0.01$ ) higher as compared with those of females (146±7, 990±72 and 138±9, respectively). The decrease of knee flexor/extensor ratios in comparison with the normal limits (Dvir, 1995) in female volunteers was by 32, 35 and 31 % in angular velocities of 60, 180 and 300 degrees for both right and left legs, while that in males was by 18, 20 and 17 % respectively. There were no significant differences in the strength indices between the left and right knee in both genders. The correlation between the peak torque in all angular velocities and lean body mass was found ( $r = 0.8$ ,  $p < 0.05$ ) in males. **Discussion** The experimental design allows evaluation of the changes in the peak torque of knee extensor or flexor group at different joint angular velocities. The gender differences in the strength indices were established, although the influence of sex on skeletal muscle strength and its anthropometric reasons, is well documented (Miller et al., 1993; Doherty, 2001). The more pronounced decrease of the hamstring to quadriceps ratios in all angular velocities in females found in this study is in accordance with the data of Hewett et al., (2008) and Holm and Vollestad (2008). These findings give causes for application of the kinesitherapeutic programs to improve dynamic control of the knee by emphasizing hamstring strengthening. **References** Doherty TJ (2001). *Clin Nutr Metab Care*, 4(6), 503-508. Dvir Z (1995). Edinburgh, United Kingdom: Churchill Livingstone. Hewett TE, Myer GD, Zazulak BT (2008). *J Sci Med Sport*, 11(5), 452-459. Holm I, Vollestad N (2008). *Am J Sports Med*, 36(10), 2007-2013. Miller AEJ, Mac Dougall JD, Tarnopolsky MA, Sale DG. (1993) *Europ J Applied Physiol Occup Physiol*, 66, 254-262. **Acknowledgements.** The study was supported by Grants D002-54/08 and DVU 01/197 of NS Fund.

### ISOMETRIC STRENGTH AND STEADINESS OF M. QUADRICEPS FEMORIS FOLLOWING REGULAR LEVEL AND DOWNHILL TREADMILL WALKING AT SELF-SELECTED SPEED IN OLDER ADULTS

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ISOMETRIC STRENGTH AND STEADINESS OF M. QUADRICEPS FEMORIS FOLLOWING REGULAR LEVEL AND DOWNHILL TREADMILL WALKING AT SELF-SELECTED SPEED IN OLDER ADULTS Gault, ML1, Clements, RE.2, Willems, MET.2 1: University Campus Suffolk (Ipswich, UK), 2: University of Chichester (Chichester, UK) Introduction Older adults experience a decline in muscle strength and steadiness, decreasing quality of life and increasing risk for falls. Adaptations by eccentric endurance exercise (i.e. downhill walking) may preserve muscle strength and steadiness in older adults. The aim of the current study was to determine in older adults the effects of concentric (level treadmill walking) and eccentric endurance exercise (downhill treadmill walking) on maximal and submaximal sustained isometric contractions of m.quadriceps femoris (QF) with electromyographic recordings of the m.vastus lateralis (VL). Methods 18 healthy older adults (age:  $67 \pm 4$ , body mass:  $75 \pm 14$  kg) completed 12 weeks of level treadmill walking (LW, 0%,  $n=8$ ) or downhill treadmill walking (DW, -10%,  $n=10$ ) (30 min, 3 d•wk<sup>-1</sup>) at a self-selected walking speed (SSWS, re-adjusted in week 4 and 8). Maximal voluntary isometric force (MVIF) of QF and EMG of VL was measured at baseline, 4, 8 and 12 weeks. Steadiness of submaximal (5, 10 and 20%) isometric contractions (i.e. coefficient of variation of the force signal, CVI) of QF and EMG of VL was measured at baseline and 12 weeks. A two way repeated measures ANOVA with post-hoc pre-planned t-tests were used for data analysis ( $P < 0.05$ ). Results SSWS was similar for both groups and increased from  $1.18 \pm 0.11$  to  $1.53 \pm 0.09$  m•s<sup>-1</sup> (LW) and  $1.26 \pm 0.16$  to  $1.61 \pm 0.12$  m•s<sup>-1</sup> (DW) ( $P < 0.01$ ). Baseline MVIF of LW ( $340 \pm 112$  N) and DW ( $368 \pm 128$  N) increased equally by  $14 \pm 6$  and  $5 \pm 6$  % ( $P < 0.05$ ). Steadiness at 5% MVIF improved following 12 weeks of LW (baseline:  $0.04 \pm 0.01$ ; 12 wk:  $0.03 \pm 0.01$ ) and DW (baseline:  $0.04 \pm 0.02$ ; 12 wk:  $0.03 \pm 0.01$ ) ( $P < 0.05$ ). EMG root mean square of VL during MVIF increased by 38% ( $P < 0.05$ ) following 12 weeks but only in the level walking group. Discussion Regular level and downhill treadmill walking at a self-selected walking speed appears to be at an intensity to improve the ability to produce maximal voluntary isometric force of m.quadriceps femoris. For level walking, this may be explained by an increase in neural activation whereas muscle hypertrophy and coordination may explain the changes after regular downhill walking (Sipilä et al., 1996). The improvement in steadiness at 5% MVIF may be due to a change in discharge rate variability (Laidlaw et al., 2000). Improvements in the ability to produce maximal isometric force and isometric steadiness of submaximal isometric contractions by regular level and downhill treadmill walking at self-selected walking speed may reduce the risk for falls in older adults. References Laidlaw DH, Bilodeau M, Enoka RM. (2000). Muscle Nerve, 23, 600-612. Sipilä S, Multanen J, Kallinen M, Era P, Suominen H. (1996). Acta Physiol Scand, 156, 457-464.

### VALIDITY AND RELIABILITY OF THE TENDO WEIGHT-LIFTING ANALYZER SYSTEM FOR MEASURING MOVEMENT VELOCITY.

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Movement velocity in weight lifting exercises can be used as an indicator of relative load. The aim of this study was to evaluate the validity and reliability of movement velocity measurements obtained with the Tendo Weight-lifting Analyzer System (Trencin, Slovak Republic) by comparing them to those made with the T-Force Dynamic Measurement System (Ergotech, Murcia, Spain). For this purpose, three different exercises were carried out: bench press (BP), back squat (BS) and counter movement jump with load (CMJL). Forty subjects were asked to perform the aforementioned exercises and 1280 measurements of movement velocity (160 CMJL, 560 BS and 560 BP) were obtained in different sessions. Intraclass correlation coefficients (ICCs) for validity were very high (0.940-0.953). Test-retest reliability of the Tendo Analyzer System was also high, with ICCs ranging from 0.930 to 0.935. The Tendo Analyzer demonstrated to be a valuable and reliable system for measuring movement velocity in weight-lifting exercises.

### RELIABILITY OF TWO METHODS FOR ASSESSING MAXIMAL STRENGTH AND RATE OF FORCE DEVELOPMENT IN ROCK CLIMBERS

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Introduction Maximal voluntary contraction (MVC) of the finger flexors has been suggested to be a determinant of rock climbing performance [1]. However, studies using different tools have found contradictory results. Handgrip (HG) measures have shown low discriminant ability, probably due to their lack of specificity. Specific climbing dynamometers (SCD) that more closely mimic the hold position could differentiate climbers from non-climbers (REF). Furthermore, the peak of rate force development (pRFD) has been suggested to be more appropriate than MVC [1] for evaluating neuromuscular characteristics of climbers. The apparent lower discriminant ability of generic strength measures may be due to lower reliability. The aim of this study was to compare the reliability of MVC and pRFD assessed using generic and specific dynamometers in climbers. Methods Fifteen male climbers (age  $32 \pm 7$  yrs; height  $175 \pm 5$  cm; weight  $69 \pm 5$  kg) participated in the study. They performed, in a randomized order, 6 contractions (3 for MVC and 3 for pRFD) of 4 s with 2 min rest using HG and SCD. After 24 hours they were re-tested. Reproducibility was expressed as Typical Error of the Measurement (TEM) and Intraclass Correlation Coefficient (ICC). Results The mean MVC in the 2 tests were  $6.6 \pm 1.4$  and  $6.4 \pm 1.3$  N/kg for HG and  $7.6 \pm 2.2$  and  $8.2 \pm 2.1$  N/kg for SCD, respectively. The mean pRFD in the 2 tests were  $42.7 \pm 11.7$  and  $43.6 \pm 11.2$  N/kg/s for HG and  $39.9 \pm 14.1$  and  $42.5 \pm 15.1$  N/kg/s for SCD, respectively. The TEMs for MVC and pRFD using HG were 4.3 % (90%CI, 3.3 to 6.3) and 9.1% (6.9 to 13.5%). The TEMs for MVC and pRFD using SCD were 6.7% (5.1 to 9.9%) and 15.8% (11.9 to 23.9%). The ICCs for MVC and pRFD using HG were 0.95 (0.88 to 0.98) and 0.92 (0.80 to 0.96). The ICCs for MVC and pRFD using SCD were 0.94 (0.85 to 0.97) and 0.83 (0.63 to 0.93). Discussion The HG and SCD showed similar reproducibility for MVC and pRFD, with MVC displaying lower TEM than pRFD. However, the acceptability of these TEM values (representing the "noise" of measurement) depends on the magnitude of change or differences (signal). For example since the decline induced by competition and simulation is higher for pRFD (-19%) than MVC (-6%)[2], the reliability of pRFD is better than MVC for detecting neuromuscular fatigue. In conclusion, this study did not show a superior method in terms of reproducibility. Nevertheless, since SCD displays higher face validity, specific measures should be preferred. References 1. Watts PB. (2004) Eur J Appl Physiol, 91(4), 361-72. 2. Fanchini M, Impellizzeri FM, Bortolan L, Pellegrini B, Rosponi A, Schena F. Communication to 15th ECSS congress (2010), Antalya, Turkey.

## THE EFFECT OF THE STRETCH BREAK PROGRAM ON FLEXIBILITY, STRENGTH, AND MUSCULOSKELETAL SYMPTOMS OF WORKERS

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**Introduction:** Repetitive movements and abnormal or prolonged posture, positions, or movements are commonly assumed during many work activities such as administrative or warehouse and cause cumulative trauma disorder (CTD). CTD is a collection of musculoskeletal disorders that are characterized by chronic discomfort, pain, and possibly functional impairment. **Objective:** The aim of this study was to test the effect of Stretch Break Program (SBP) on flexibility, strength and musculoskeletal symptoms of warehouse (WW) and administrative (AW) sector workers. **Methods:** 26 male subjects have participated in this study. We have applied International Physical Activity Questionnaire and Nordic Questionnaire of musculoskeletal symptoms and have evaluated flexibility and strength before and after 6 months of SBP implantation. **Results:** After a 6 month-period of SBP, we observed an improvement on flexibility values for upper limbs and total regions in WW and AW group. This gain may be directly related to reduction of complaint of numbness and pain in upper limbs. **Conclusion:** SBP increased strength and improved flexibility in the regions with the higher rate of lesion related to work contributing to the decrease of complaint due to musculoskeletal symptoms.

## Poster presentations

### PP-PM09 Training and Testing: Methods

#### RELIABILITY OF A HIGH-INTENSITY CYCLING CAPACITY TEST

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**Introduction** The CCT110%, a cycling capacity test performed at 110% of maximum power output, was developed as a test lasting between 120 and 240 s and most likely limited by muscle acidosis (Hill et al., 2007). In subsequent studies (Sale et al., and Saunders et al., Unpublished data) we have used this test to examine the effects of dietary interventions designed to manipulate intra- and extra-cellular changes in pH during exercise. The aim of this investigation was to assess the reliability of the CCT110%. **Methods** Twenty seven males (age  $23 \pm 4$  y; height  $1.79 \pm 0.06$  m; body mass  $78.0 \pm 8.8$  kg) performed an incremental powermax cycle test to establish maximum power output. Participants were then required to complete two cycling capacity tests at 110% of maximum power output to determine time to exhaustion (TTE) and total work done (TWD). Participants performed the CCT110% in a fasted state with no alcohol or caffeine having been ingested during the previous 24 h. Trials were separated by 48 h. Blood pH, bicarbonate, base excess and lactate were determined pre-exercise, immediately post-exercise and 5 minutes post-exercise. Data were analysed using Bland-Altman analysis, intra-class correlations and repeated measures ANOVA. Data are presented as mean  $\pm$  1SD. **Results** TTE ( $P = 0.75$ ;  $134 \pm 20$  s and  $135 \pm 20$  s,  $d = 0.05$ ) and TWD ( $P = 0.97$ ;  $42.2 \pm 10.3$  kJ and  $42.2 \pm 9.8$  kJ,  $d = 0.00$ ) were not different between trials. The intra-class correlation between trials was  $r = 0.94$  for TTE and  $r = 0.97$  for TWD, with the coefficient of variation being 4.43% for TTE and 4.94% for TWD. Bland-Altman analysis indicates that the 95% limits of agreement ranged from -18.9 to +20.2 s for TTE and -6.94 to +6.99 kJ for TWD. There were no between trial differences in blood markers at any time point except immediately post-exercise pH ( $7.246 \pm 0.041$  Vs  $7.269 \pm 0.064$ ,  $P = 0.004$ ), although the actual difference was small (0.023). **Discussion** Performance measures were similar between trials, with times being within the expected range for this test. Exercise affected blood markers similarly in both trials. Although immediately post-exercise blood pH was significantly different between trials, the absolute differences are much smaller than those expected to be seen using nutritional interventions intended to alter extracellular pH changes during exercise. These findings suggest that the CCT110% is a reliable high-intensity cycling test. **References** Hill CA, Harris RC, Kim HJ, Harris BD, Sale C, Boobis LH, Kim CK, Wise JA. (2007). Amino Acids, 32, 225-233. Sale C, Saunders B, Hudson S, Wise JA, Harris RC, Sunderland CD. Unpublished data. Saunders B, Sale C, Harris, RC, Sunderland, CD. Unpublished data.

#### VALIDITY OF 5 HERTZ GPS UNITS FOR MEASURING DISTANCE, VELOCITY AND ACCELERATION IN FIELD HOCKEY SPECIFIC RUNNING PATTERNS

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**Introduction:** GPS devices are more and more used in out-door sports for the analysis of sports specific running profiles, including the run profile of single players in field hockey. In the last years, 5 hertz (Hz) devices are used. However, validity of these devices concerning short distance movement analysis is unclear. Therefore, the aim of this study was to evaluate the validity of a GPS device (SPI Pro, GPSports, Australia) for measuring distance, velocity and acceleration in straight-line running courses with 180° changes of direction with a laser diode system as criterion measure. **Methods:** Ten healthy participants ( $n=5$  females;  $25 \pm 3$  years;  $1.77 \pm 0.12$  m;  $72 \pm 15$  kg) agreed to participate. Assessment of distance, mean and maximum velocity ( $v_{mean}$ ,  $v_{max}$ ) and maximum acceleration ( $a_{max}$ ) in straight-line running courses with 180° changes of direction were performed using GPS devices at 5 Hz and a laser diode system (LDS) at 100 Hz as criterion measure. Two test courses (20-m course: 5 m + 5 m + 10 m; 4-m course: 1 m + 1 m + 2 m) were performed at 4 different movement intensities (walk, slow run, fast run and sprint) with and without carrying a field hockey stick. **Results:** GPS data tended to slightly underestimate distance ( $0.19 - 0.51$  m),  $v_{mean}$  ( $0.05 - 0.37$  km/h),  $v_{max}$  ( $0.23 - 1.48$  km/h) and  $a_{max}$  ( $0.59 - 2.25$  m/s<sup>2</sup>) for the 4m- and 20m-course. For nearly all parameters variance increased with higher movement intensities and shorter distances covered. No significant differences could be found between running the courses with and without carrying a hockey stick for all parameters indicating that upper-body movements and the associated changes in the degree of the GPS device towards the satellite do not influence validity of the device. **Conclusions:** GPS technology is a sufficiently valid method to measure distance,  $v_{mean}$ ,  $v_{max}$  and  $a_{max}$  for short distance straight-line running courses with 180° changes of direction. Recordings of  $v_{max}$  and  $a_{max}$ , however, should be interpreted carefully especially when analysing rapidly changing directions over a short distance.

## THE EFFECT OF DIFFERENT EXECUTION PROTOCOLS OF WINGATE TEST ON MEASURES OF ANAEROBIC PERFORMANCE

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**Introduction:** WAnT is a classic laboratory tool for the evaluation of anaerobic performance. The test determines peak power (PP), mean power (MP), and the fatigue index. The standard protocol includes maximal cycling for 30sec with the resistance progressively applied in 4sec. PP, MP, and fatigue index are determined from the six 5s-segments. Today, different execution protocols that modify the starting position of WAnT are used. Also, the calculation of WAnT parameters may be based on best 1s or 5s-averages. The aims of this study were to examine the effect of different WAnT execution protocols and the effect of different calculations on measures of anaerobic performance. **Methods:** Eleven men ( $24.3 \pm 2.7$  yrs) performed the WAnT using 4 execution protocols. In the 1st protocol (P1) the subjects were asked to cycle at 50rpm with no resistance. After stabilization, a 4sec countdown was applied. At the end of the countdown the resistance was applied with the drop basket and the subjects pedaled for 30s as fast as possible. In the 2nd protocol (P2), the resistance was set on the cycle-ergometer and the subjects started the 30-s test from a stationary position. In the 3rd protocol (P3), the 30s test started with maximal unloaded pedaling and the resistance was applied progressively in 4s. In the 4th protocol (P4), the 30s test started with maximal unloaded pedaling and the resistance was applied immediately at the 4sec with the use of a drop basket. Power was measured every second for the entire 30-s protocol. After each test, PP was calculated using the best 1s, 3s and 5s averages, and the best 5s-segment. The time to peak power, MP, and total work were calculated for all 4 execution protocols. **Results:** The values for PP were not significantly different among P1, P2 and P3, irrespective of method of calculation, but were lower compared to P4 ( $p < 0.01$ ). The method of calculation affected PP only in P4; that is the values of PP declined when using the best 1s, 3s and 5s averages, and the best 5s-segment (14.6, 13.3, 12.6 and 12.6 W/kg, respectively;  $p < 0.01$ ). MP and total work were significantly lower in P1, P2 and P3 vs. P4 ( $p < 0.05$ ). Finally, the time to peak power was longer in P1 and P2 vs. P3 and P4 ( $p < 0.01$ ). **Conclusion:** When using drop basket for the application of resistance during the WAnT, the protocols that do not involve maximal unloaded accelerations (P1 and P2) produce the more consistent results. The standardization of the execution protocol is necessary for computing and comparing the results of WAnT. The standardization procedure includes the starting position, the way of resistance application, and the method of calculation of measures of anaerobic performance.

## A RELIABILITY ANALYSIS OF THE 10M SPRINT TEST

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**Introduction** The ability of an athlete to accelerate and develop maximum speed is a crucial factor in many athletic sports; hence the reliability when employing sprint tests is paramount. Guggenheimer et al., (2009) reported Intraclass Correlation Coefficient (ICC) ranging between 0.47 and 0.81 for multiple split times over a 40-metre sprint. However, limited evidence exists regarding statistical measures of absolute reliability in sprint running tests. The evaluation of measurement error is very important in studies where small changes in sprint times between conditions are expected (e.g. in Post-Activation Potentiation (PAP) research). Therefore, this study aimed to identify the degree of random error, due to performance variation, in the 10-metre sprint test. **Methods** Six trained males (age:  $20.6 \pm 1.3$  years, height:  $1.78 \pm 0.07$  m, mass:  $80.8 \pm 6.1$  kg) who regularly took part in sprinting activities were recruited. The design of the study comprised one familiarisation and two identical testing sessions separated by 48 hours. The testing sessions consisted of: a 15-min warm-up, 2 practice sprints and then 5 sprints over 10 metres tested by a Brower timing system. The sprints were performed from a three point start position, with the back foot placed within 1 metre of the starting line. Three statistical methods for assessing reliability were used after the data were assessed for heteroscedasticity: 95% Limits of Agreement (LOA), Coefficient of Variation (CV) and ICC (3, 1) consistency). Reliability results were obtained as follows: a) reliability based on the average score of the 5 sprints (R5); b) reliability based on the best sprint performance (RB). Results ICC values of 0.99 ( $p < 0.001$ ) were observed for both R5 and RB analyses. In terms of the random error expressed as a percentage of the grand mean, both R5 and RB analyses showed low random errors of 1.5% and 1.7% respectively, and very similar LOA. In particular, the LOA (Bias  $\pm$  Random Error) for R5 were:  $0.00 \pm 0.03$  s and the LOA for RB were:  $0.01 \pm 0.03$  s. Finally, both analyses displayed a very low CV (0.5%). **Discussions** The ICC values demonstrated a very high reliability between the testing sessions. Furthermore, a random error of 1.5-1.7% ( $\pm 0.03$  s) demonstrates that the 10-m sprint test has adequate stability to identify small changes in sprint performance in intervention studies where small changes in sprint times are expected. The data also showed that when the calculations involved the average score of 5 trials the random error was slightly reduced. The estimation of the random error is of high importance particularly in PAP studies where changes in sprint performance range from 2-3% (Tillin & Bishop, 2009). **References** Guggenheimer J, Dikin C, Reyes G, Dolny D. (2009) J Strength Cond Res, 23(4), 898-902. Tillin N, Bishop D. (2009) Sports med, 39(2), 147-166.

## IMPLICATION OF "505 AGILITY TEST" BY MEANS OF INSTANTANEOUS VELOCITY MEASUREMENTS FOR THE ASSESSMENT OF CUTTING MOVEMENTS AS USED IN FOOTBALL PLAYERS

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**Introduction** "505 agility test" is a relatively simple test that measures the time for acceleration, deceleration and rapid change of direction over a short course with a running start. Subject should sprint from starting line, through the light gates to the zero line, where they are required to turn on either the left or right foot and then accelerate off the line back through the light gates (Australian Sports Commission 2000). Not only sprint ability but also cutting quickness might be one of the important factors for ball game players such as football. Therefore, purpose of this study were to examine the validity of the "505 agility test" by measuring instantaneous velocity changes and to evaluate specific ability in football (soccer) players. **Methods** During "505 agility test" trial, instantaneous velocity was measured by laser measuring instrument system (100Hz, Laveg, Germany) as well as 2D and 3D motion monitoring devices by high Speed Camera (500fpf, Fastcam SA3, Photron, Japan) and VICON motion capture system (100Hz, Oxford Metrics, England), respectively. All these data were synchronized with photo cell triggering device measured the elapse time taken for 5-meter interval shuttle sprint. Agility and kinematic data were taken from 14 male youth soccer players (age  $17.0 \pm 1.5$  years, body mass  $61.2 \pm 5.9$  kg). From Laveg measurements, following parameters were taken for the analysis: distance where maximum sprint velocity attained, maximum sprint velocity, from maximum sprint velocity ( $V_{max}$ ) and %decline in velocity at final goal. Results 505 time (mean $\pm$ SD) was  $2.43 \pm 0.11$  seconds and high correlation was

shown between 505 time measured by photo cell and by Laveg ( $r=0.9149$ ,  $p<0.001$ ). Maximum instantaneous velocity (mean $\pm$ SD) was  $6.88\pm0.25$  m/s which appeared at  $1.4\pm0.40$  m before approaching 5m interval shuttle run zone. No statistically significant correlation was observed between maximum velocity and 505 time. Discussion 505 agility time might be determined by not simply maximum sprint velocity but some complicated factors such as acceleration/deceleration abilities and cutting movement quickness. Draper and Lancaster (1985) introduced 505 agility test for the assessment of one of the important physical abilities in football player. From preset study, 505 agility test might be valid for evaluating cutting movement performance as used in football players. References Draper JA, Lancaster MG. (1985). Australian journal of Science and Medicine in Sport 17(1), 15-18.

## PLANNING AND MONITORING IN-SEASON TRAINING LOADS IN TEAM SPORTS BY MEANS OF MATCH DIFFICULTY AND SESSION-RPE

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Introduction A inherent problem in team sports periodization is determining the appropriate training loads during the competitive phase of the season. With this in mind, COUTTS & KELLY (2007) proposed a model that can be used to guide in season training loads in team sports, taken account the predict match difficulty and the session-RPE method (internal training load; Foster, 1998). However, we have found no study analyzing the association between the variables used in this model. Thus, the aim of this study was to examine the relationships among the difficulty of the games scheduled at the beginning of the season (DBS), the in-season match difficulty (DIS and the weekly internal training load (ITL). Methods Twelve professional male basketball players were investigated across a competition phase ( $25.3\pm 5$  years,  $97.6\pm 15$  kg, and  $195.8\pm 10.5$  cm). The monitoring model proposed by KELLY & COUTTS (2007) was adopted. The predict match difficulty (DBS) was determined before the commencement of the season by calculating the sum of "level of opposition", training days between matches and match location. The training intensity for each session was calculated using the CR-10 RPE scale. The DIS was determined reassessing the DBS on a weekly basis. The relationship between DBS, DIS and ITL was determined by means of Pearson correlation coefficient ( $p < 0.05$ ) Results Significant correlations were detected between DBS, and DIS ( $r = 0.86$ ) as well as between DBS and ITL ( $-0.59$ ) and DIS and ITL ( $-0.65$ ) Discussion The results of the present study indicate that the predicted level of difficulty of a match is useful to determine the training load for the week. The significant negative relationship between DBS and ITL suggests that when the predicted match difficulty was considered low, greater training load was planned. However, despite of the significant relationship between DBS and DIS, the DIS seems more accurate to manipulate the ITL. Greater coefficient of relationship was observed between DIS and ITL suggesting the needs to reassesses the DBS on a weekly basis to provide appropriate feedback to coaches which in turn can use this information to plan the in-season training loads. References 1- KELLY, V.; COUTTS, A. Planning and monitoring training loads during the competition phase in team sports. Strength and Conditioning Journal, 2007; 29, (4): 32-37. 2 - Foster, C. Monitoring training in athletes with reference to overtraining syndrome. Med Sci Sports Exerc 1998;30 (7): 1164-1168.

## CORRELATION PARAMETERS FOR INVASIVE AND NON-INVASIVE CONTINUOUS AND INTERVALS TRAINING SESSIONS IN COLLEGE PLAYERS

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CORRELATION PARAMETERS FOR INVASIVE AND NON-INVASIVE CONTINUOUS AND INTERVALS TRAINING SESSIONS IN COLLEGE PLAYERS Gonelli, PRG.1, Cesar, MC.1, Montebelo, MIL.1, Borin, JP.2, Simões, RA. 1:UNIMEP (Piracicaba, Brazil), 2:UNICAMP (Campinas, Brazil) Introduction The scientific advancement reaches all worldwide areas, not being different with sports, soccer has had many advances in the process of evolution, so evaluation and control of drills and matches is essential, for this, invasive parameters (IP) and non-invasive (NIP) are used, all with the goal of keeping the athletes at the level of excellence and able to face the current calendar. So, the aim of this study was to correlate (IP) and (NIP) in continuous training sessions (CTS) and interval (ITS) in college soccer players. Methods There were 10 players, between 17 to 24 years old, they performed two r sessions, an CTS, running 40 minutes at the speed of the anaerobic threshold, and ITS, sprints of 10, 20 and 30 meters, followed by 30, 45 and 60 seconds of recovery between sprints respectively. At the beginning and end (1st, 3th and 5 th minutes) of the sessions blood was collected for measurement of lactate, and the peak value used for analysis (Denadai et al., 1995), and asked the subjective rating of perceived exertion for dyspnea (RPED) and neuromuscular (RPEN), through the Borg scale (Borg, 1982). To correlate the data of lactate RPED and RPEN was used the Spearman coefficient,  $p < 0.05$  was adopted. Results The value of lactate peak was larger in the ITS ( $5.07$  mmol/l) compared to the CTS ( $4.00$  mmol/l), RPED and RPEN also had a higher value in ITS ( $14.8$  and  $15.2$ ) compared to CTS ( $13.8$  and  $13.8$ ). Only the results between lactate and end RPEN demonstrate high correlation and significant ( $r=0.76$ ,  $p=0.01$ ). Discussion From this data it can be observed that the ITS is more intense and showed that the lactate values were better correlated with the neuromuscular question. Using IP and NIP are important, so it is worth noting that if there is the possibility of using more of an intensity of training and matches can be better analyzed, since the use of these indicators are used at different times of periodization and games and has been investigated in researches (Castagna et al., 2007, Mohr et al., 2010). References Borg, GAV. (1982). Psychophysical bases of perceived exertion. Med. sci. sports exerc. 14, 377- 381. Castagna, C, Abt, G, D'ottavio, S. (2007). Physiological aspects of soccer refereeing performance and training. Sports Medicine. 37, 625 – 646. Denadai, BS. (1995). Limiar anaeróbio: considerações fisiológicas e metodológicas. Rev. bras. ativ. fis. Saúde. 1, 74 – 88. Mohr, M et al. (2010). Examination of fatigue development in elite soccer in a hot environment: a multi – experimental approach. Scand. J. Med. Sci. Sports, 20(Suppl 3), 125-132.

## EFFECTS OF DIFFERENT TRAINING PROTOCOLS ON AEROBIC CAPACITY AFTER 6 MONTHS OF INTERVENTION IN OVERWEIGHT PEOPLE

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Introduction Maximal aerobic capacity ( $VO_{2max}$ ) is a stronger cardiovascular diseases indicator, mortality predictor and is related with other health factors (1). The aim of this study was to determine which training protocol is the most effective to improve the  $VO_{2max}$  in overweight people. Methods Ninety overweight people, men and women (18 – 50 years; BMI > 25 and < 30 kg/m<sup>2</sup>), participated in the study. Each subject performed two incremental tests, before and after intervention, until exhaustion to determinate  $VO_{2max}$  on a treadmill, using a modified Bruce protocol (2). Subjects were randomized to one of the following training groups: strength training (ST; n = 22),

aerobic training (AT; n = 25), a combination of AT and ST (COM; n = 23) (Training frequency: 3 times per week / Intervention: 24 weeks) and control group (CG; n = 20). All of them in combination with the same diet restriction. Two way ANOVA with repeated measures was used to determine differences between pre and post intervention in each training group. The significant level was set at  $\alpha \leq 0.05$ . Results Significant improvements in VO2max (mL/min) were obtained in all groups although the highest increases were in ST (Pre.  $3180.6 \pm 704.1$  vs. Post.  $3788 \pm 509.5$ ) and COM (Pre.  $3277.2 \pm 589.1$  vs. Post.  $3859.4 \pm 430.2$ ) in men. In women, we have obtained significant improvements in VO2max (mL/min) in all groups, except in ST. Aerobic training group obtained the highest increase in women (Pre.  $2021.5 \pm 263.3$  vs. Post.  $2367.1 \pm 374.4$ ). When we compare the results of VO2max related to body mass (mL/min/kg) significant improvements in all groups were obtained. Discussion In young women, Poehlman et al. (2002) obtained similar results to us because the strength group did not improve. Sillanpää et al. (2009) obtained similar results with older women, all groups improved VO2max, except the ST group. Stensvold et al. (2010) obtained the highest improvements in aerobic and combined training groups, in contrast to our results, since we obtained improvements in ST in men too. We can conclude that aerobic training improves VO2max in women while in men the improvements are greater in strength training groups (ST and COM). References 1. Stensvold D, et al. J Appl Physiol (2010); 108: 804-10. 2. Hunter G, et al. Obesity (2008); 16: 1045-51. 3. Poehlman E, et al. J Clin Endocrinol Metab (2002); 87: 1004-9. 4. Sillanpää E, et al. Eur J Appl Physiol (2009); 106: 285-96.

## ANALYSIS OF ANAEROBIC THRESHOLDS DETECTING METHODS BY RESPIRATORY GAS EXCHANGE

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There are some well-known respiratory gas exchange methods for finding the anaerobic threshold (AT) during incremental exercise test. In this study, we found more useful way to detect the AT values and compare these AT values with those obtained from gas exchange variables by three different methods. We randomly chose 49 men and then accomplished a Bruce protocol test on treadmill. Respiratory gases were registered constantly, and gas exchange variables are calculated by computers. VO2 values at AT were acquired by 3 ways and analyzed; 1) VO2 at V-slope method (Vslope-AT), 2) VO2 at VE/CO2 versus O2 curve (EqCO2-AT), 3) VO2 at Respiratory Exchange Ratio method (RER-AT). We also tried to figure out the influence of the unit of the measurements. So VO2 values at AT were computed by 3 different units; 1) Normal VO2 (mL/min) nVO2, 2) Specific VO2 (mL/min/kg) sVO2 3) Percentage of the VO2max pVO2. We found that Vslope-AT is powerfully correlated with nVO2 at EqCO2-AT( $r=0.960^{**}$ ,  $P<0.01$ ), with sVO2 at EqCO2-AT( $r=0.962^{**}$ ,  $P<0.01$ ), and pVO2 at EqCO2-AT( $r=0.721^{**}$ ,  $P<0.01$ ). sVO2 had higher Pearson correlation coefficient(Pearson R) than nVO2 and pVO2. We also supported that the RER-AT is weakly correlated with Vslope-AT and EqCO2-AT; sVO2 at Vslope-AT( $r=0.772^{**}$ ,  $P<0.01$ ), sVO2 at EqCO2-AT( $r=0.743^{**}$ ,  $P<0.01$ ). We also acquired linear regressions between those variables. The VO2max could be estimated with above variables by a linear regression analysis; [VO2max =  $1.176(\text{Vslope-AT}) + 7.588$  with SEE of  $\pm 3.00$ ;  $r=0.922$ ], [VO2max =  $1.280(\text{EqCO2-AT}) + 4.800$  with SEE of  $\pm 2.03$ ;  $r=0.961$ ], and ; [VO2max =  $1.239(\text{RER-AT}) + 1.552$  with SEE of  $\pm 2.03$ ;  $r=0.766$ ]. In conclusion, the EqCO2-AT is more easy way to estimate the AT than v-slope method. In several cases v-slope method didn't show us some accurate point of inflection point which is AT. Even in this case EqCO2-AT method show that point better than V-slope method.

## Poster presentations

### PP-PM10 Soccer 1

#### MAINTAINING HAMSTRINGS TO QUADRICEPS RATIO IN ELITE ACADEMY SOCCER PLAYERS THROUGH A STRENGTH AND CONDITIONING PROGRAMME

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Introduction Within soccer the majority of injuries occur in the lower extremity, with the highest proportion being attributed to hamstring strains (Woods et al. 2004). Although the aetiology remains unclear a potential factor is a muscle imbalance between quadriceps (Q) and hamstrings (H) (Croisier, 2004). Indeed a H eccentric : Q concentric ratio of higher than 1.4 is considered protective against H injuries (Croisier et al. 2008). Furthermore, both soccer training and match play have recently been shown to develop the knee musculature towards Q dominance (Iga et al. 2009) and lead to a reduction in the H : Q ratio (Greig, 2008). Considering this, the development of a players athletic ability should be directed towards accommodating a balanced development of this apparently functionally important ratio alongside strength gains. Aim To evaluate changes in strength and H : Q ratio within elite academy players through a 18 month strength and conditioning programme. Methods 5 elite football academy players ( $17.4 \pm 0.1$  yrs;  $1.76 \pm 0.73$  m;  $66.2 \pm 5.6$  kg) undertook a 18 month (once or twice a week in season) strength and conditioning programme consisting firstly of developing technique (1st month) followed by a periodised programme consisting of strength and power phases. The programme mainly consisted of snatch and clean and jerk and derivatives of these exercises plus stiff leg deadlifts and nordic hamstring curls. The ratio of peak eccentric H strength ( $30^\circ/\text{s}$ ) to peak concentric Q strength ( $240^\circ/\text{s}$ ) (Croisier et al. 2008) was assessed pre and post intervention upon an isokinetic dynamometer (Cybex, Humac Norm System). Data were analysed using paired t-test. Results Q and H peak torque increased in both the right (17%,  $P=0.08$ ; 32%,  $P=0.06$ ) and left (22%,  $P=0.05$ ; 16%,  $P=0.15$ ) respectively. The H : Q ratio was maintained (right limb  $1.1 \pm 0.2 - 1.3 \pm 0.3$ ; left limb  $1.2 \pm 0.2 - 1.1 \pm 0.2$ ). Discussion Including eccentric H exercises (stiff leg deadlifts / nordic hamstring curls) within a strength and conditioning programme appears to assist with maintaining an acceptable H : Q ratio (Croisier et al. 2008) when developing a players athletic ability, potentially reducing both the immediate and long term risk of H injuries. References Croisier, J. (2004). Sports Med, 34, 681-695. Croisier JL, Ganteaume S, Binet J, Genty M, Ferret JM. (2008). Am J Sports Med, 36, 1469 -1476. Greig, M. (2008). Am J Sports Med, 36, 1403-1409. Iga J, George K, Lees A, Reilly T. (2009). Scand J Med Sci Sports, 19, 714-720. Woods C, Hawkins RD, Maltby S, Hulse M, Thomas A, Hodson A. (2004). Br J of Sports Med, 38, 36-41.



## STRENGTH ASSYMETRIES OF THIGH MUSCLES IN YOUNG ELITE SOCCER PLAYERS

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**Introduction** Since the game of soccer frequently involves one-sided activities such as kicking, tackling and passing, asymmetries in muscle strength between both legs are possible. Croisier et al. (2005) indicate that the isokinetic strength assessment before the start of the season enables identification of strength indicators as predictors of possible muscle injury. Lehance et al. (2009) present a higher proportion of muscle strength imbalances in young soccer players in comparison to senior players. **Methods** Twenty five soccer players of U16 national team (mean age  $15.6 \pm 0.2$  years, body height  $177.4 \pm 6.8$  cm and body weight  $67.0 \pm 7.7$  kg) participated in this study. Assessment was performed on the isokinetic dynamometer Cybex Humac Norm. Following parameters were obtained in concentric contraction during five velocities (60,120,180,240,300°/s) for dominant (D) and non-dominant leg (N): Peak torque (PT), quadriceps (QD:QN) and hamstring (HD:HN) ratio, ipsilateral ratio between H and Q for both legs (HD:QD; HN:QN). Student t-test for pair comparison or RM ANOVA was used for statistical assessment. **Results** Significant differences were found between PT of extensors at 240 and 300 °/s and flexors at the lowest velocity ( $p < 0.05$ ). H:Q ratio between legs at 240 °/s was significantly different ( $p < 0.05$ ). With increasing angular velocity, statistical differences in QD:QN ( $F_{4,96} = 0.802$ ;  $p > 0.05$ ) respectively HD:HN ratio ( $F_{4,96} = 0.133$ ;  $p > 0.05$ ) were not revealed. However HD:QD or HN:QN, respectively, significantly changed during increasing velocity ( $F_{4,96} = 7.588$ ;  $p < 0.05$  or  $F_{4,96} = 6.696$ ;  $p < 0.05$ ). HD:HQ at the lowest velocity was significant when compared to each other velocity ( $p < 0.05$ ). HN:QN at 60°/s was different in comparison to HN:HQ at 120 or 300°/s, respectively. **Discussion** The bilateral ratio was not significantly different from the angular velocity. Croisier et al. (2003) indicate a risk bilateral difference between concentric muscle strength in professional players higher than 15%. In our case, 15 players (60 %) reached this value minimum at one velocity. It is in line with Lehance et al. (2009) who reported that up to 56% of the players are at risk of muscle strength imbalances of knee flexors or extensors. The H:Q ratio raised with increasing angular velocity in both preferred and non-preferred extremities. H:Q ratio during the lowest velocity revealed the lowest value of H:Q in both legs. This project was supported by GACR P407/11/P784 and MSM 0021620864. **References** Croisier JL, Reveillon V, Ferret JM, Cotte T, Genty M, Popovich N, Filho, M, Faryniuk JE, Ganteaume S, Crielaard JM. (2003). *Isokinet Exerc Sci*, 11, 61-62. Croisier JL, Roisier JL, Ganteaume S, Ferret JM. (2005). *Brit J Sport Med*, 39, 379. Lehance C, Binet J, Bury T, Coisier JL. (2009). *Scand J Med Sci Spor*, 19, 243-251.

## THE EVALUATION OF MUSCLE FLEXIBILITY IN YOUNG SOCCER PLAYERS

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**Introduction** The agility and coordination are two of many attributes required to become a successful player. Several reports have showed that the training of muscle flexibility leads to improvements both in the coordinative and technical performance, and in the process of motor learning (1). The aim of our study was to evaluate the flexibility of shoulders, trunk and lower limbs in young male soccer players compared to that of sedentary subjects. **Methods** Twelve players (age:  $20.00 \pm 3.74$  years; weight:  $74.25 \pm 6.80$  kg; height:  $178.92 \pm 6.65$  cm) belonging all to the same soccer team and ten sedentary subjects (age:  $21.8 \pm 3.12$  years; weight:  $73.60 \pm 5.29$  kg; height:  $179.50 \pm 5.78$ ) were tested. The players had  $11.75 \pm 3.57$  years of experience in soccer game and 58% of them had undergone injuries (58% in upper limbs and 1.7% of them also in lower limbs). The sedentary subjects presented about 30% of injuries in upper limbs and 3% also in lower limbs. Low back and hamstring flexibility was measured by the sit and reach test. The range of motion of hip abduction was measured with a goniometer. The flexibility of shoulders was evaluated by a full circumduction of both arms and the lateral flexion of trunk with a measuring scale fixed to the wall. **Results** Soccer players had a higher flexibility of shoulders and trunk than sedentary subjects; however this difference was not significant ( $p > 0.05$ ). Moreover, the players showed a significant increase in range of motion of hip abduction compared with sedentary subjects and, in particular, the right hip was more flexible compared with the left one. The range of motion of hip abduction was not related to the age and body mass index of the soccer players. **Discussion** The difference of flexibility between the body upper and lower part in soccer players may be due to a scarce and unspecific training of shoulder and trunk flexibility compared with legs. This difference might provoke a postural unbalance with higher risks of injuries (2) due to falls and lower technical-coordinative performance. **References** (1) Gleim GW, McHugh MP. Flexibility and its effects on sports injury and performance. *Sports Med* 1997; 24: 289-99. (2) Witvrouw E et al. Muscle flexibility as a risk factor for developing injuries in male professional soccer players. A prospective study. *Am J Sports Med* 2003; 31: 41-6.

## COMPARISON BETWEEN ADOLESCENT AND COLLEGIATE SOCCER PLAYERS IN CHANGES IN DEEP ABDOMINAL MUSCLE THICKNESS DURING DRAW-IN MANEUVER USING ULTRASOUND IMAGING

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Watanabe, H.1, Yoshimoto, M.2, Fujii, M.1, Ashihara, M.2, Torii S.3., Uchida, Y.2, Takahira, N.1 1: Department of Rehabilitation, Kitasato University School of Allied Health Sciences (Kanagawa, Japan), 2: Graduate School of Medical Science, Kitasato University (Kanagawa, Japan), 3: Waseda University, Faculty of Sports Sciences (Saitama, Japan) **Introduction** Adolescent athletes show a high incidence of onset of low back pain (LBP) during sports activities. Development and increased contractility of the deep abdominal muscles have been found to improve the spinal stability and prevent LBP. Researchers have shown that the ability of the transversus abdominis (TrA) muscle to contract is important for decreasing the likelihood of onset of LBP during sports activities. The purpose of this study was to clarify the characteristics of abdominal deep muscles in adolescent soccer players. **Methods** The participants in this study were 53 soccer players (mean age, 13.6 years) from junior high school and 14 collegiate soccer players (mean age, 23.4 years). The deep abdominal muscles of both sides were imaged by brightness-mode (b-mode) ultrasonography (SSD-4000, ALOCA Co Ltd, Tokyo). Abdominal muscles on the dominant leg side were selected as the targets of measurements, and measurements of the TrA muscle and internal oblique (IO) muscle were conducted. The muscle thickness of these muscles was measured at rest and during contraction (while drawing-in of the abdominal wall). **Results** No significant differences were noted in the thickness of the TrA (adolescent players;  $3.5 \pm 0.9$ , collegiate players;  $3.5 \pm 0.9$ ) or IO muscle (adolescent players;  $8.5 \pm 2.1$ , collegiate players;  $10.1 \pm 2.5$ ) at rest, whereas significant differences were noted in the thickness of the TrA (adolescent players;  $4.5 \pm 1.3$ , collegiate players;  $6.1 \pm 1.7$ ) and IO (adolescent players;  $8.9 \pm 2.2$ , collegiate players;  $12.7 \pm 3.4$ ) muscle during the draw-in maneuver between the two groups. Significant differences between the two groups were also noted in the percent changes of the muscle thickness of both the TrA and IO muscles. **Discussion** The findings of the study revealed that the adolescent soccer players showed immature functioning of the deep abdominal muscles, suggesting that adolescent soccer players need to

train their deep abdominal muscles in order to prevent LBP. References Richardson CA, Snijders CJ, Hides JA, Damen L, Pas MS, Storm J. (2002). Spine (Phila Pa 1976), 27,399-405. Teyhen DS, Gill NW, Whittaker JL, Henry SM, Hides JA, (2007). J Orthop Sports Phys Ther., 37, 450-466. Froholdt A, Olsen OE, Bahr R. (2009). Am J Sports Med, 37, 1155-1160.

### COMPARAISON BETWEEN TWO TYPES OF INTERVAL TRAINING IN SOCCER PLAYERS: PHYSIOLOGICAL AND PERCEPTIVE SOLICITATIONS.

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**Introduction** Endurance is considered as an important factor of performance in soccer (Iaia et al., 2009). It is now well accepted that high intensity intermittent exercise (HIIE) may develop endurance. Since few years, other methods appear such as small-side games or specific track. One of those tracks is the Höff track (Höff et al., 2002). This last seems present good results despite the lack of data concerning the physiological and perceptive solicitations compared to a HIIE. Therefore, the purpose of this study is to compare the physiological and perceptive solicitations of two HIIE: 15s/15s at 120% of maximal aerobic speed (MAS) and an integrated exercise on the Höff track (Höff T). **Methods** Seven high level soccer players (24.1±4.5 yrs) realized a maximal graded test to determine their peak oxygen uptake (VO<sub>2peak</sub>), MAS and peak heart rate (HR<sub>peak</sub>). During the same week, they realized two randomized exercise: 1) physical controlled exercise (15s/15s Test) at 120% of MAS (corresponding to 90-95% of HR<sub>peak</sub>) during 4×4 minutes with 3 minutes of active recovery between series and 2) four sets of 4 minutes in the Höff T to dribbling the ball at an intensity of 90-95% of HR<sub>peak</sub> interspersed with 3 minutes of active recovery. The intensity of the active recovery was closed to 70% of HR<sub>peak</sub> during the two tests. HR, oxygen consumption (using a gas exchange telemetric system: VO<sub>2000</sub>, Medical Graphics, Minnesota, USA), lactate and rating of perceived exertion (RPE) were measured. **Results & Discussion** The mean VO<sub>2</sub> were significantly higher ( $p < 0.05$ ) during the Höff T ( $2.67 \pm 0.30$  mL/min;  $39.3 \pm 2.3$  mL/min/kg) than during the 15s/15s Test ( $2.49 \pm 0.34$  mL/min;  $36.8 \pm 1.9$  mL/min/kg). On the same way, the total O<sub>2</sub> consumed was significantly higher ( $p < 0.05$ ) during the Höff T ( $66.8 \pm 7.6$  L) than during the 15s/15s Test ( $62.3 \pm 8.6$  L). Blood lactate concentration was significantly higher after the first set of the Höff T ( $12.5 \pm 2.0$  mmol/L) than the 15s/15s Test ( $10.6 \pm 2.0$  mmol/L). Hence, as shown by the RPE score values, players perceived the 15s/15s test more difficult than the Höff T ( $13 \pm 1.8$  vs.  $11.7 \pm 1.4$ ,  $p < 0.05$ ). **Conclusion** Our results demonstrate that players consume more oxygen and produce more lactate during the Höff T than during the 15s/15s (especially during the first set). Despite that, they perceived the Höff circuit less difficult than 15s/15s test. Thus, the use of the Höff T for aerobic training appears as an interesting alternative to develop endurance in soccer players. However, fitness coaches had to propose this Höff circuit so far from the soccer game because it may induce more anaerobic participation to the energy production. References Iaia, M et al., (2009). Int J Sports Physiol Perf, 4(3):291-306 Höff, J et al., (2002). Bri J Sports Med, 36(3):218-221

### THE EFFECT OF 12-WEEKS CORE EXERCISE ON SOCCER SKILL AND PHYSICAL FITNESS IN MIDDLE SCHOOL SOCCER PLAYERS.

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The purpose of this study was to investigate the effect of 12-weeks core exercise on soccer skill (accuracy of passing, shooting, and kicking) and physical fitness (agility, muscle endurance, balance, flexibility, VO<sub>2max</sub>, isokinetic muscle strength) in middle school soccer players. Twenty four male students ( $14.5 \pm 0.05$  yrs) were participated. They were divided into two groups (core exercise group vs non-core exercise group). Core exercise was composed of 8 exercises (prone balance, balanced push-up, russian twist, v-sit ball transfer, supine resisted pull-in, back extension, triceps blaster, squat to overhead press). Core exercise group was performed at 30 repetition and 5 sets each other. Repeated measured ANOVA method was used to examine the differences by each factor between the two groups before and after the training. Significant level was .05. Main results of comparative analysis between difference two groups were as follows. First, for physical fitness, there were differences between the two groups in agility, balance, muscle strength and there were no differences in cardiopulmonary endurance, flexibility, anaerobic power, muscle endurance. Secondly, for soccer skill, there were no differences between the two groups. In conclusion, there were significant improvements in agility, balance, and muscle strength through 12-weeks core exercise training, and the most improved factor was balance. But core exercise alone does not improve accuracy of soccer skill. So skill training and core program should be combined in order to improve overall soccer performance.

### FATIGUE AND RECOVERY IN SOCCER – A STUDY OF AEROBIC PERFORMANCE ABILITY MARKERS

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**Introduction:** During the last decades the demands of competition in soccer has increased (Bloomfield, Polman, & O'Donoghue, 2007) (Bangsbo, Mohr, & Krstrup, 2006). The development is for periods leading to difficulties in obtaining high-quality training weeks. Implementing recovery strategies have thus become even more important. In soccer the recovery phase consists of a reversal of the changes that has occurred during match-play. Knowledge of what fatigue in soccer consists of and how it reestablishes when the match is over is therefore essential to execute targeted recovery actions. Previously published data on fatigue and recovery in soccer has been criticized because of its narrow measurement methods (Dawson, Gow, Modra, Bishop, & Stewart, 2005). The purpose of this study was therefore to examine fatigue and recovery in soccer with aerobic and holistic performance ability markers. **Methods:** 17 male soccer players (18-31 years) underwent a laboratory testing protocol containing aerobic performance markers 7 ( $\pm 4$ ) days before a soccer match (pre-test), immediately after the match (post test) and 24 hours after the match (post2test). To examine fatigue the difference between pre- and post-test was investigated and to examine recovery the difference between pre-and post2test was investigated. **Results:** The findings of fatigue shows a significant reduction in aerobic performance ability after the soccer match compared with before the match. For all variables, results were significantly decreased (0.9-34.3 %) after the match ( $p < 0.05$ ). Regarding recovery the findings show that the players were about to reestablish their performance, but that full recovery was still not achieved. **Discussion:** This study shows that soccer players have significantly reduced aerobic performance ability after a soccer match compared with before the match. Furthermore, it appears that this performance capability is not fully rebuilt 24 hours after the match ends. These findings are in agreement with previously published data and can be explained by both metabolic (glycogen depletion) and mechanic fatigue (muscle damage and inflammatory responses). References Bangsbo, J., Mohr, M., & Krstrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player Journal of Sports Science, 24(7), 665-674. Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical de-

mands of different positions in FA Premier League soccer. *Journal of Sports Science and Medicine*, 6, 63-70. Dawson, B., Gow, C., Modra, S., Bishop, D., & Stewart, G. (2005). Effects of immediate post-game recovery procedures on muscle soreness, power and flexibility levels over the next 48 hours. *Journal of science and medicine in sports*, 8(2), 210-221.

### TACTICAL ANALYSIS OF THE REAL MADRID OFFENSIVE PROCESS

BARBOSA, A.1,3, SARMENTO, H.1,2,3, MARTINS, N.1,2, LEITÃO, J.1,2, CAMPANIÇO, J.1,2

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1-UTAD, Vila Real, Portugal 2-CIDESD, Portugal 3-UB, Barcelona, Espanha Introduction The detection and analysis of regular structures of behavior in Football has received increasing attention from researchers and trainers. The main purpose of this study was to detect temporal regular structures (t-pattern) of behavior in the Real Madrid Offensive Process, in the 2010/2011 sporting season. Methods To collect data, we coded nine games of the Real Madrid football team, using the observational instrument developed and validated by Sarmento et al. (2010). We used the software THEME 5.0 for the detection of the t-patterns which is a professional system for detecting and analyzing hidden patterns in behavior, by performing intensive structural analysis of behavioral data. The study of the reliability shows high levels (above 0.95 for all criteria) for the intra-observer agreement. The level of significance was set at 0.005. Results and Discussion We detected six completed t-patterns (were repeated seven times) referring to the whole process, from recovering possession of the ball until completing the offensive process (OP) success fully. The analyze of the completed t-patterns, allow us to understand that the area of recovery of possession is the defensive midfield. In all detected patterns the second action happens in another zone of field always in a lateral corridor. After the ball gets to the offensive midfield, there is a rapid and long change of the playing area and then the team tries to quickly end the O.P.. All the patterns ended when the ball entered the zone eleven (offensive third). This was a constant in all found patterns. We identified also patterns that ended with relevant actions such as goals, shot on goal or shot defended by goalkeeper. Conclusion The results suggest that collecting a larger volume of data allowed us to detect more temporal patterns and more frequently repeated ones. This type of analyses in the natural context (the game), enable us to obtain information on how to organize the training process, so that the team understand ways to enhance the team's potential and oppose adversary actions of success. These preliminary results demonstrate the potential of THEME 5.0 software for detecting structures regular behavior in football. References (1) Sarmento, H., Anguera, T.; Campaniço, J. & Leitão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina(Kaunas)*, 46(6), 401-407.

### TEMPORAL INTERACTION PATTERNS IN THE OFFENSIVE PROCESS OF REAL MADRID FOOTBALL TEAM

BARBOSA, A.1,2, SARMENTO, H.1,2,3, MARTINS, N.1,2, LEITÃO, J.1,2, CAMPANIÇO, J.1,2

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1-UTAD, Vila Real, Portugal 2-CIDESD, Portugal 3-UB, Barcelona, Espanha Introduction The main purpose of this study was to investigate the existence of regular behavior patterns in Counter-Attack (C.A.) and Fast Attack (F.A.) of Real Madrid (RM) football team in 2010/2011 sporting Season. Materials and Methods To collect data, we used the instrument developed and validated by Sarmento et al. (2010). This instrument consists in a specific notation analysis tem to study the offensive process and its variables. Several offensive sequences were coded through the observation of nine games of RM football team. In order to verify the occurrence of patterns, we used the software THEME 5.0, which is a professional system for detecting and analyzing hidden patterns in behavior, by performing intensive structural analysis of behavioral data. It detects complex repeated patterns that otherwise remain hidden. The reliability of the data was calculated by the intra observer agreement, and values above 0.95 were achieved for all the variables. For the detection of the patterns, we only considered the ones that repeated three times, and the significance level was set at 0.005. Results We detected seven completed t-patterns, referring to the whole process, from recovering possession of the ball until completing the offensive process (OP) successfully. In the C.A., we verified the existence of two patterns, one of which ended in goal. In the F.A., we verified the existence of five patterns. Four patterns ended with a shot from the frontal zone of the goal. Discussion The analysis of the t-patterns allows us to conclude that the area of recovery of the ball possession is the midfield, with preponderance in the defensive midfield. In all detected patterns, the second action happens in another field zone, with great impact on the opposite lateral corridor. After the ball gets to the offensive sector, there is a rapid and long change of the playing area and then the team tries to quickly end the OP. The attack ends or passes again to the corridor where it started. There is high incidence of the game in the lateral corridors. The players tried to make the last pass for the area 10 (left corridor, attacking third). If the last pass is not performed in this zone, the next action is performed in the zone 9, or 12 (right corridor), where the players try to perform a goal by shot. This was a constant in all the patterns found. In C.A. there is a pattern that ends in a goal. Of these seven patterns found, both on C.A. and F.A., the pattern that ends in a goal is the only action that ends with numerical superiority. Conclusion This evidence seems to complement other studies about efficiency but shows them as repeated actions. The behavior in an acyclic, inconstant sport can have patterns that lead to success. References Sarmento, H., Anguera, T.; Campaniço, J. & Leitão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina(Kaunas)*, 46(6), 401-407.

### INFLUENCE OF DIFFERENT RECOVERY INTERVALS ON PERFORMANCE DURING REPEATED SWIMMING SPRINTS.

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In many team sports participants produce repeated maximal or near-maximal efforts of short duration with brief recovery periods (1). Recovery duration seems to influence performance in case of repeated sprints (2). Therefore, the purpose of the present study was to examine the influence of two different recovery intervals on performance during repeated swimming sprints. Thirteen female water polo players (age:  $19.1 \pm 0.8$  yrs, height:  $169.8 \pm 1.6$  cm, body mass:  $71.8 \pm 1.7$  kg, mean  $\pm$  SE) participated in this study. Participants performed 4x50m (L occasion) and 8x25m (S occasion) sprint swimming tests in random order. On L occasion the recovery interval after each sprint was 14sec, while on the S occasion the interval was 6sec so that the total recovery time was 42sec in both occasions. Blood samples were collected from finger 3 minutes after the end of each occasion and lactate concentrations ([La]) were calculated. Differences between the two occasions in performance time and [La] were analyzed using T-Test. Results are presented as mean  $\pm$  SE. Total performance time was significantly different between the two occasions ( $L=149.1 \pm 1.7$  vs  $S=143.1 \pm 2.1$  sec,  $p<0.001$ ). Despite the difference in performance time, [La] did not differ significantly ( $L=5.9 \pm 0.2$  vs  $S=5.6 \pm 0.2$  mmol/L,  $p=0.22$ ). The results of the present study suggest that despite the fact that total recovery time and total distance covered (200m) were the same in the two occasions, there was a significant difference in performance as a result of the recovery pattern in the case of S occasion. 1. Bishop, D., Spencer, M., Duffield, R. & Lawrence,

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## COMPARATIVE STUDY ON RECOVERY BETWEEN FIRST AND SECOND DIVISION FOOTBALL PLAYERS OF THE SPANISH LEAGUE.

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**Introduction:** several studies on high intensity intermittent exercise have stated that performance capacity at high intensity phases of exercise depend on the duration of the recovery phase and on the intensity of the exercise carried out at such phase (1-3). The difference found on recovery parameters between football players might be one of the factors that determine their performance on the match. **Methods:** 114 first division football players and 80 second division football players of the Spanish Football League underwent a maximal ergospirometry test, including a 3 minutes-long recovery phase. The alpha signification level was 0,05. **Results:** significant differences on oxygen uptake (p: 0,008) and heart rate (p: 0,024) were found out at recovery phase between players of both categories. No significant difference was found on ventilation (p: 0,055). **Discussion:** during the first minute of the recovery phase we found no significant differences between the individuals of both groups, probably because of baroreflex (4). There are differences between the first and third minute of recovery; it might be due to a different training volume and intensity (5). Our whole population sample consists of professional football players, who might probably have similar training loads. According to our findings, first division football players would have a greater recovery capacity. This could explain a greater competitive level in sports where repetitive efforts are needed, regardless of the technical qualities. **Bibliography:** 1. Dorado C, Sanchis J, Chavaren J, López-Calbet J. Efectos de la recuperación activa sobre la capacidad de rendimiento y el metabolismo energético durante el ejercicio de alta intensidad. *Arch Med Deporte*1999;16(73):397-413. 2. Saltin B, Bangsbo J, Graham T, Johansen I. Metabolism and performance in exhaustive intense exercise; different effects of muscle glycogen availability previous exercise and muscle acidity In: Marconnet P, Komi P, Saltin B, Sejersted O, editors. *Muscle fatigue mechanisms in exercise and training Medicine Sports Science*1992. p. 87-114. 3. Thiriet P, Gozal D, Wouassi D, Oumarou T, Lacour J, Gelas N. The effects of various recovery modalities on subsequent performance, in consecutive supramaximal exercise. *J Sports Med Phys Fitness*1993;33(2):118-29. 4. Calderon Montero F, Brita Paja J, González C, Machota V. Estudio de la recuperación de la frecuencia cardíaca en deportistas de élite. *Selección*1997;6(3):101-5. 5. Edwards AM, Macfadyen AM, Clark N. Test performance indicators from a single soccer specific fitness test differentiate between highly trained and recreationally active soccer players. *J Sports Med Phys Fitness*2003 Mar;43(1):14-20.

## Poster presentations

### PP-PM11 Physiology: Cardiovascular

#### EFFECTS OF DIFFERENT TRAINING ON SOME CHARACTERISTICS OF HEART IN FEMALE STUDENTS

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**Effects of different training on some characteristics of heart in female students** **Introduction:** Regular and long term training causes physiological adaptation of heart that opposite pathological adaptation(1,2). Sharma(2003) studied 623 elite athletes and found that rowers (Concurrent-trained athletes) had greatest left ventricular mass index(3). The aim of this study was to compare the effects of three different training programs on heart of female students. **Method:** 40 untrained female (age: 25 2.5yrs, height: 164 8.2cm, weight: 57.8 14.6kg) Being randomly divided into endurance (E;n=10), resistance (S;n=10), concurrent (SE;n=10) and control (C;n=10) groups. Left ventricular end diastolic dimension (LVEDD), left ventricular end systolic dimension (LVESD), heart - walls thicknesses, left ventricular mass (LVM) and lvm index of subjects measured by echocardiography both at the outset and after 8 weeks of training. The training programs were 8 weeks, 3 times per week. The Endurance training program comprised running at 65% of HR max for 16 minutes per session at first week where the HR reached 80% HR max towards the end of the program. The resistance training program involved performing 2 sets of bench press, squat, pull down and legs curl initially at 50% of 1RM with 10 repetition per set where the intensity reached 80% of 1RM with 3 sets of 6 repetitions per set towards the end of the program. The Concurrent training program included both E and S training requirements. **Result:** LVESD, lvm and lvmI in the (SE) Group and LVEDD in the (SE) and (E) Groups were significantly larger, compared with baseline (P<0.05). One way ANOVA appeared only to be significantly increased in the LVEDD of (SE) Group (P 0.05). **Conclusions:** The data suggest that the nature of concurrent training created these results. Eight weeks of training, however, to be an insufficient stimulus to elicit significant alterations in the heart structure. It is possible that concurrent training be the factor in preventing of some side effects of resistance training on heart. **References** 1. Haykowsky, M, Chan, S, Bhambhani, Y, Bell, G. (1998). 'Effect of combined endurance and strength training on left ventricular morphology in male and female rowers'. *Can. J Cardiol*. 14(3): 387 – 391. 2. Macfarlane, N. (1991) 'A comparative study of Lv structure and functions in elite athletes'. *Br.J. sports med*. 25:45-48. 3. Sharma Sanjay.( 2003) 'the Athlete's heart.', 88: 665-669.

#### EVALUATION OF TRAINING EFFECTS BY ECHOCARDIOGRAM

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**Introduction** Echocardiography is the basic and non-invasive method in assessment of cardiac structure and function in elite athletes, so it is used for medical check and studying the training status of athletes. In the previous female study, we reported that carotid flow volume can be used for evaluating training status or level besides IVSd (Inter-ventricular septal end diameter), LVPWd (left ventricular posterior wall diameter) and CO (cardiac output). In this study, we evaluate training effects of changes in IVSd, LVPWd and CO after four months training by using cardiac echocardiogram. **Method** For 15 eighteen years old female college students of basketball players (18.2 (SD:0.4) years old, 166.3 (6.2) cm, 58.4 (5.5)kg), we evaluate posterior wall- thickness ( LVPWd), septal end diameter (IVSd) and CO by digital diagnostic ultrasound device (UF-8700 made in Fukuda Denshi Company). After four months training schedule, we do echocardiogram again,

and we compare changes in LVPWd, IVSd and CO before to after training. ventricle divider (IVSd: Inter-ventricular septal end diastolic dimension) / the left ventricle by ultrasonography Results There were no remarkable changes in height, body weight and %body fat before to after training. However, LVPWd, IVSd and CO were significantly changed before 8.3 (1.1) mm, 7.9 (0.9) mm and 3.5 (0.51) L/min to 9.3 (0.8) mm, 9.4(0.8) mm and 4.1 (1.09) respectively. Discussion The evaluation by non invasive echocardiogram should be of use for training effect of athletes. References TANAKA, S, YAMADA, A, YOTSUMOTO, M et al. Carotid flow volume in evaluating exercise capacity/Mukogawa women's university (abstract) ECSS OSLO/NORWAY, JUNE ,p59 2009 Fujimoto N, Prasad A, Hastings JL et al. Cardiovascular effects of 1 year of progressive and vigorous exercise training in previously sedentary individuals older than 65 years of age. *Circulation*. 2010 122(18):1797-805. D'Andrea A, Riegler L, Cocchia R et al. Left atrial volume index in highly trained athletes. *Am Heart J*. 2010 159(6):1155-61.

## CHANGE OF LEFT ATRIAL DIMENSION IN FEMALE ADOLESCENT RUNNERS

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**Introduction** Left atrial (LA) enlargement is a predictor of atrial fibrillation (Af) in the general population. LA dimension (LAD) increases along with long-term exercise training (1) and several studies suggested that trained athletes were predisposed to Af (2). The data of LA enlargement related to exercise, however, is available only in adult athletes and in a cross-sectional manner. The aim of the study was to investigate the change of LAD in the early phase of athletic career. **Methods** The subjects were Japanese 51 female middle/long distance runners (15-16 y/o) in a competitive high school team with the national level of achievements. Echocardiography, underwater weighing, and maximal exercise tests were performed mostly at the recruitment when they had already had > 3 years of experience as competitive runners, and repeated after 20+/-6 months. They trained nearly every day throughout the period by running at a speed of 12-20 km/hr for totally 200-500 km/month. LAD was indexed for body surface area (LADi). The changes in variables were tested by paired t-test. LAD and LADi were compared with the average of Japanese young untrained females in the literature (3) by Z test ( $p < 0.05$  was considered significant). **Results** Fat free mass (FFM) and VO<sub>2</sub>max significantly increased (38.6 to 40.5 kg and 56.9 to 60.7 ml/kg/min, respectively) with significant decrease in fat% (16.9 to 14.8 %). The baseline LAD and LADi were significantly larger than the established normal data (32.8 vs. 29.0 mm and 22.7 vs. 19.0 mm, respectively). None revealed LAD > 40 mm at any time. LAD and LADi did not change significantly after 20 months of training (32.8 to 33.4 mm and 22.7 to 22.8 mm/m<sup>2</sup>, respectively), while left ventricular mass (LVM) indexed for FFM significantly increased (3.35 to 3.58 g/kg). Fractional shortening, peak A and E wave velocities, and deceleration time were normal on both occasions and did not differ from each other (37 vs. 37 %, 42 vs. 40 cm/s, 100 vs. 97 cm/s, and 149 vs. 157 ms, respectively). None developed palpitation or supraventricular tachyarrhythmia. **Discussion** LADi of the high school runners was slightly larger than that of young untrained females at the baseline. Although the subjects trained sufficiently to become leaner with increase in VO<sub>2</sub>max and LVM/FFM in 20 months, further LA enlargement did not develop. In conclusion, the left atrium could be enlarged in the very early stage of athlete's career but the pathological consequences (abnormal/persistent LA enlargement or Af) were not likely to occur along with the high school level of training. **References** 1. Pelliccia A, et al. *J Am Coll Cardiol*. 2005;46:690 2. Molina L, et al. *Europace*. 2008;10:618 3. Daimon M, et al. *Circ J*. 2008;72:1859

## LEFT VENTRICULAR WALL THICKENING IN HIGHLY POWER AND STRENGTH TRAINED ATHLETES

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Dr. Robert Çina1, Dr. Dhimitraq Prifti1, Msc. Altin Erindi,1 Dr. Tatjana Nurka, Dr. Meri Gjinushi 2 IUST (Tirana, Albania), 2UT, (Tirana, Albania) **Introduction:** It is demonstrated that the cardiac hypertrophy of the trained athlete is a normal response to the physiologic demand during increased physical activity. The evaluation of different morphological parameters of the CV system is used in sports medicine practice to evaluate the progress of training process. **Methods:** 14 track and field athletes (TFA) (short distance runners, throwers and jumpers), 10 weightlifters (WL) and 15 physical education students (PES) were studied. BSA was calculated according to Dubois&Dubois and through standard ultrasound records TDD, IVS and PW were measured. TDV and LV muscular mass (LVMM) was calculated.1 All the ultrasound findings and calculations were normalized with BSA. Means and SD were calculated for all the data and two tailed Student test between the sport groups and control group was performed. **Results and Discussion:** Mean values of both PW and IVS were significantly higher at the sport groups comparing to the PES ( $p < 0.001$ ), WL having the higher values. We found the same results for the BSA normalized values. IVS/PW ratio was similar for all the groups (1.1) and was below 1.3, showing symmetric LV hypertrophy. LVMM was significantly greater to the WL and TFA groups comparing to the PES ( $283.16 \pm 31.98$  and  $300.29 \pm 45.16$  versus  $223.84 \pm 41.29$  gr.  $p < 0.001$ ). Similar differences were found for the LVMM index (LVMM/BSA). LVMM index correlated well with LV wall thickness (IVS  $r = 0.76$  PW  $r = 0.8$ ). LVMM/LVW ratio is calculated as well. The greater values were found at the WL ( $2.36 \pm 0.31$  gr/ml) and TFA ( $2.01 \pm 0.24$  gr/ml), PES values were  $1.75 \pm 0.17$  ( $p < 0.01$  and respectively  $p < 0.01$ ). **Conclusions:** LV hypertrophy with increase of LVMM, as a result of IVS and PW thickening was found as a result of power training. Thickness of the IVS and PW is at the upper physiological normal limit and shows significant changes compared with the control group. LV hypertrophy is symmetrical and can be considered as a physiological response to intermittent intraventricular high pressure during training. **References** 1. Devereux RB, Reichek N: Echocardiographic determination of left ventricular mass in man. Anatomic validation of the method. *Circulation* 1977, 55:613-618 2. Pelliccia A, Thompson PD. The genetics of left ventricular remodeling in competitive athletes. *J Cardiovasc Med*. 2006;7:267-270. 3. Barry J. Maron and Antonio Pelliccia: The Heart of Trained Athletes: Cardiac Remodeling and the Risks of Sports, Including Sudden Death. *Circulation* 2006;114:1633-1644 4. Snoeckx L. and co. Echocardiographic dimensions in athletes in relation to their training program. *J Appl Phys*. 1982: 428. 5. Maron BJ. Structural features of the athlete heart as defined by echocardiography. *J Am Coll Cardiol*. 1986;7:190-203.

## THE CARDIAC EFFECTS ON WHO BEGAN EXERCISE IN ADULT AGES

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**Introduction:** Both in the endurance performance and in the primer prevention it is a very important question how do characteristic features of the athlete's heart develop if regular workouts began not in the childhood but in the adult age. **Methods:** The following echocardiography data were measured by 2D-guided M-mode, Doppler-recordings, and TDI, left ventricle wall thickness, left ventricle muscle mass, left ventricle internal diameter, E/A, E'/A'. **Subjects:** Group "A" contains who have began regular physical training in adult age (later

than 18 yr.) group "Y" started their sports activity in their younger age (elite vs. non-elite athletes) and non-athletic healthy subjects (altogether N=617). Results: Characteristics of the left ventricular hypertrophy (wall thickness/BSA<sup>1/2</sup>, muscle mass /BSA<sup>3/2</sup>) and training-bradycardia developed something less in group "A" than in group "Y". The effect of regular physical training to diminish age-related impairment of diastolic function manifested stronger in the group "Y", although the difference between the two athletic groups decreased in the oldest age range. In female differences between group "A" and group "Y" were higher in all parameters than in the males. Conclusions: Our results indicate that regular physical training started in the young age develop more markedly the characteristics of the athlete's heart, but to begin regular physical activity in the adult age is also useful.

### TESTING RISK FACTORS FOR ARRYTHMIAS IN ELIT ATHLETES

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Introduction: Sudden cardiac death of athletes is very rare but it is still 2 to 4 times more frequent than that of the gender- and age-matched normal population. The reasons of the sudden cardiac death in athletes are mostly unclear. Lots of risk factors are well known and it is supposed to relates to repolarization abnormalities. These may be caused by morphological abnormalities and vegetative disfunctions (increased sympathetic activity). Aime: Our aime was to investigate this risk factors related to arrhythmias and describe the results in Hungarian elit athletes compared to non-trained healthy controls. Methodes: 90 elite athletes (56 men (23 triathletes, 11 soccer, 16 handball players, 6 judo); 34 women (11 triathletes, 6 judo, 17 waterpolo players); mean age 23,29±4,5 years) and 24 non-trained control person (12 men, 12 women, mean age 23,36±2 years) took part in our study. Everybody was examined by echocardiography. We analysed the ECG parameters, the frequency range heart rate variability with a special ECG software (Human Cardiosys, Experimetria Ltd) which can be the markers of the myocardial repolarisation's instability (QT-period, QT-dispersion, short term variability of QT and RR (STVQT, STVRR), very low frequency (VLF), low frequency (LF), high frequency (HF), LF/HF). At the same time we took blood samples and analysed the serum levels of epinephrin (A), norepinephrin (NA), dopamin (D) angiotensinogen (AT) and cortisol (C) with ELISA. Results: The athletes have bigger interventricular septum and posterior wall thickness and left ventricular muscle mass compared to the controls (IVSs 15±2,4 to 13,8±1,5; IVSd 10±1,7 to 9,8±1,2; LVPWs 16±1,9 to 14±2; LVPWd 10±1 to 9,2±1; LVMM 239±53 to 205±51). The heart rate variability parameters showed dominant parasympathetic tone in athletes, but the levels of NA, D and AT were higher (HF 30±10 to 21±9; LF 21±5 to 28±8; LF/HF 0,85±0,4 to 1,8±1; A 48±25 to 59,9±19; NA 280±98 to 239±65; D 27±17 to 7,4±3; AT 4±1,5 to 3,4±0,5). The cortisol level was similar in the two groups. The repolarisation's instability parameters were significantly higher in the athletes (QT-dispersion 35±9 to 18,9±3,7; STVQT 5±1,8 to 3,8±1; STVRR 52±26 to 27,8±10). Conclusion: We found healthy athlete hearts without morphological abnormalities. But the markers of the myocardial repolarisation's instability were significantly higher in the athletes and some peptides were also elevated. Some athletes have extremely increased values compared to the other athletes and controls. Probably they must be on the focus and need to have more examinations.

### NEW CRITERIA PROPOSAL FOR T-WAVE POSITIVITY AND QRS COMPLEX MEASUREMENTS

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Introduction Sudden death in athletes presents great social and medical repercussion. Thus, most specialists in sports medicine advice the use of ECG under rest conditions as a pre-competition screening method which allows us to know multiple electrocardiographic variants in sportsmen. T wave alterations and electrocardiographic changes associated to ventricular hypertrophy affecting the QRS should be studied more in depth, since some controversies do exist. Thus, the objective of this study was to assess in detail measurements of QRS complex and T wave in sportsmen and propose new assessment criteria. Methods A cross-sectional study was performed to assess ECG findings under rest conditions in 1200 athletes of both sexes (M: 71.2%, F: 28.8%) in a regional Sports Medicine Center (period: 2006-2010). All participants were federated, and practitioners of different sports modalities, with different performance level and dedication. ECG was performed following the standard technique with a 12-lead ECG. For the QRS complex, the following measurement and analysis criteria were followed: a) Sokolow-Lyon index (1949), b) Kannel et al. criteria (1970), c) SV1,2,3 + RV4,5,6 ≥ 48mm (our measure proposal). With regards to T wave, the following criteria were used: a) Corrado et al. (2005), b) Corrado and McKenna (2007), c) flat-tened or inverted T waves in three or more consecutive leads (our proposal). The QRS complex and T-wave measure criteria proposed in this study were based on pilot studies contrasted with echocardiography performed in our center. Results For the QRS complex, the mean global percentage of left ventricular growth depended on the voltage criteria used (a: 33.7%; b: 54.4%; c: 25.7%, respectively). In all cases, prevalence was significantly higher in males (p<0.05). None of the used criteria showed significant differences in the prevalence of children compared to adults. The greatest prevalence of T-wave alterations was observed with the Corrado et al. criterion (32.4%), followed by that of Corrado and McKenna (18.3%); however, it was the lowest when using the criteria proposed in this study (11.3%). Discussion Since literature shows high discrepancy in the criteria with regards to voltage modifications, the possible abnormality in T waves, and their scarce association with ventricular hypertrophy, new criteria are proposed in the present study for measuring and analyzing the QRS complex and the T wave in a population of athletes. References Sokolow ML, Lyon TP (1949). Am Heart J 37(2), 161-86. Kannel WB, Gordon T, Castelli WP, Margolis JR (1970). Annals of Int Med 72(6), 813-2. Corrado D, Pelliccia A, Bjørnstad HH, Vanhees L, Biffi A, Borjesson M et al. (2005). Eur Heart J 26, 516-24. Corrado D, McKenna W (2007). Eur Heart J 28, 1920-2.

### LONG-TERM HOLTER ECG MONITORING OF PROFESSIONAL CYCLISTS

CRUZ-CAMPOS, J., CRUZ-MÁRQUEZ, J., CRUZ-CAMPOS, A., CUETO-MARTÍN, B., CAMPOS-BLASCO, T., GARCÍA-JIMÉNEZ, M., GARCÍA-MÁRMOL, E., GRANERO-GIL, P.

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The resting ECG can detect many cardiac abnormalities, but high levels of training to which athletes are subjected can trigger episodes of abnormal heart function, which should be evaluated by means of long-term records. • Objective: The purpose of the study was to detect the frequency and nature of rhythmic alterations in professional cyclists during the late recovery period following a race (average distance= 196,35 km). • Design: A retrospective study involving 22 professional cyclist, volunteers, from 22-34 years old (mean: 26.7 ± 3.4 years), members of a Professional Cyclist team. All were declared fit for cycling and had no ECG abnormalities. Underwent Holter ECG records before and immediately after a race. The Holter used was NORAV DXP-1000 model. • Setting: Interventions: Both the day before

and after a race, the cyclists did not train but did all work or academic activities normally. They were instructed to record their times of sleep and activity. Dependent variables: Pertaining to heart rate, rhythm and ST space. Independent Variable: Physical Exercise (match). • Results: The average pre/post-race heart rates were  $42.9 \pm 6.2$  bpm when awake;  $42.1 \pm 3.4$  ( $p < 0.01$ ) and  $44.6 \pm 5.7$ ;  $41.2 \pm 5.5$  ( $p < 0.01$ ) when sleeping. Both before and after the race, 20 players (92 %) had a mild or pronounced respiratory sinus arrhythmia. Isolated atrial or ventricular premature contractions were observed in 2 (8.3 %), first-degree intermittent A-V blocks and second-degree A-V blocks with Wenckebach periods were observed in 1, high T-waves were found in 10 (42 %), and high take-off of ST segments were found in 16 (72.2 %). • Conclusions: After the match, there are fewer pulsations recorded, there are more bradycardic rhythms and there are fewer arrhythmic events.

#### ELECTROCARDIOGRAPHIC PROFILE OF SPORTS TEAM

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The 12-lead electrocardiogram (ECG) is not only necessary for diagnosing the sports aptitude of players, but it also provides information on their training condition and cardiovascular adaptations to exercise. • Objective: To determine the electrocardiographic adaptations of sports team (Honor Division volleyball players, 2nd Div. football, ACB basketball, 2nd Div handball and 2nd Div rugby) and relate them to their level of training. • Design: Retrospective study over the course of 18 years, from 1992 to 2009. We analyzed the ECGs taken at the start of each season as part of routine medical test. We analyzed 2,255 ECGs. Setting, context, participants. Male and female youth and Honor Division teams from the same club. 180 women (94 youth, 86 senior) and 352 men (94 youth, 258 senior) (mean age, height, weight) • Intervention: In August-September of each season, a resting ECG was taken for each player to determine pre-competitive fitness. Independent variables: sex, age, years of training. Dependent variables: P waves, QRS, T in duration and voltage and ECG evaluation (axes) • Results: ECG / player Average:  $5.6 \pm 1.9$ , FC resting:  $66.3 \pm 3$  bpm. Left ventricular hypertrophy:  $38.95\% \pm 8.9$ ; Right ventricular hypertrophy:  $12.77\% \pm 3.4$ . Right Bundle Branch Block:  $25.64\% \pm 8.3$ . Participants who required echocardiography: 32 players: ST segment depression. 12 players: Inverted or flattened T wave in two or more leads. 7 men and 4 women: Corrected QT interval prolongation in heart rate (QTc)  $> 0.44$  s in men and  $> 0.46$  s in women. Echocardiography ruled out organic disease. There were no differences in terms of years of training or level. • Conclusions: Electrocardiographic adaptations are similar to those in the literature for team sports. There was no pathological study and all were declared fit for the high-level sport.

#### EFFECTS OF ROUTINE CYCLING TRAINING ON RELEASE OF BLOOD CARDIAC TROPONIN I IN TRAINED ADOLESCENT CYCLISTS

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EFFECTS OF ROUTINE CYCLING TRAINING ON RELEASE OF BLOOD CARDIAC TROPONIN I IN TRAINED ADOLESCENT CYCLISTS Jinlei, Nie.1, Tom, Tong.2, Hua, Lin.3, Qingde, Shi.1 1: Macao Polytechnic Institute (Macao, China). 2: Hong Kong Baptist University (Hong Kong, China). 3: Liaoning Normal University (Dalian, China) Introduction It has been reported that endurance exercise could lead to a transient and minor increase in biomarkers of cardiomyocyte insult such as blood cardiac troponins (cTn) in adults (Shave et al., 2007). However, there is a dearth of research on this subject in adolescents. Road bicycle racing is one of most popular sports in the world with cyclist populations ranged from adolescents to old adults. Cycling training program is usually composed of repeated bouts of high-intensity sprint (HI) and endurance workout at moderate intensity (END). This study was to examine the release of blood cardiac troponin I (cTnI) subsequent to the two types of routine training in trained adolescent cyclists. Methods Whole blood cTnI was assessed using a two-site enzyme-linked immunosorbent assay (i-STAT analyzer, Abbott, USA) in 12 adolescent cyclists (age:  $16.4 \pm 1.5$  years; height:  $178 \pm 5$  cm; weight:  $71 \pm 4$  kg; training period:  $2.9 \pm 1.3$  years; training volume: 100-200 km/wk) four hours after the HI and END training in two separated days. The HI training consisted of three bouts of all-out uphill 900-m cycling on mountain road (~3 min for each bout) with recovery downhill cycling at the same route (~3 min for each recovery); END was a 60-min continuous constant-load cycling at moderate intensity on a stationary bicycle. Results The blood cTnI levels in four of the twelve subjects after the END training [(Median) 0.015 ng/ml; (Range) 0-0.08 ng/ml] were above the cutoff of 0.03 ng/ml for myocardial injury. However, no cyclists in HI [(Median) 0.01 ng/ml; (Range) 0-0.03 ng/ml] displayed values exceeding the cutoff. Discussion It was found in the present study that four of the twelve trained adolescent cyclists who completed an endurance-type workout in a routine cycling training program were with positive serum cTnI that exceeded the myocardial injury cutoff. The findings are in agreement with our previous report that a single endurance workout would cause elevations of serum biomarkers of myocardial damage in trained adolescent athletes (Nie et al., In Press). In addition, the current findings also indicate that the release of cTnI in trained adolescent cyclists during routine cycling training is dependent of training mode. These provide further information about trends in the biochemical markers of myocardial injury in adolescent cyclists during training that physicians may find useful in the 'routine' clinical evaluation. References Nie J, Tong TK, George K, Fu FH, Lin H, Shi Q (In Press). Scand J Med Sci Sports. doi: 10.1111/j.1600-0838.2010.01096.x Shave R, George K, Gaze D (2007). Curr Med Chem, 14, 1427-1436. The study was supported by a grant from Macao Polytechnic Institute (RP/ESEFD-1/2007)

## Poster presentations

### PP-PM12 Vibration Training

#### THE EFFECTS OF ADDING DIFFERENT WHOLE BODY VIBRATION FREQUENCIES TO PRECONDITIONING EXERCISE ON SUBSEQUENT SPRINT PERFORMANCE

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The phenomenon postactivation potentiation (PAP) can possibly be used to acutely improve sprint performance. Two recent studies have investigated the additional effect of adding whole body vibration (WBV) to PAP-exercises (1, 2). Although both studies failed to find an

ergogenic effect of WBV, it does not seem appropriate to abandon the WBV-approach as a potential mean for performance enhancement. The apparent lack of effects may be due to the distinct features of the applied protocols. Accordingly, we aimed to investigate the effect of adding whole body vibration (WBV) to body-loaded half-squats, performed as preconditioning activity to 40 m sprint test. Nine male amateur soccer players performed one familiarization session and six separate test sessions. Each session included a standardized warm-up followed by one of the following preconditioning exercises; 30 s of half-squats with WBV at either 50 Hz or 30 Hz, or half-squats without WBV. The 40 m sprint was performed one minute after the preconditioning exercise. For each subject, each of the three protocols was repeated twice on separate days in a randomized order. Mean values were used in the statistical analysis. Performing the preconditioning exercise with WBV at a frequency of 50 Hz resulted in superior 40 m sprint performance compared to preconditioning exercise without WBV ( $5.48 \pm 0.19$  s vs.  $5.52 \pm 0.21$  s, respectively,  $p < 0.05$ ). There was no difference between preconditioning exercise with WBV at a frequency of 30 Hz and no WBV condition. In conclusion, preconditioning exercise performed with WBV at 50 Hz seems to enhance 40 m sprint performance in recreationally trained soccer players. The present findings suggest that coaches can incorporate such exercise into the warm-up to improve sprint performance or the quality of the sprint training. 1. J. D. Guggenheimer, D. C. Dickin, G. F. Reyes, D. G. Dolny, *Journal of Strength and Conditioning Research* 23, 1135. 2. N. Bullock et al., *Journal of Strength and Conditioning Research* 22, 1371.

### **INFLUENCE OF SIX WEEKS WHOLE-BODY VIBRATION EXERCISE ON ARTERIAL STIFFNESS IN THE ELDERLY**

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**Introduction** Whole body vibration (WBV) recent work has suggested that low amplitude, low frequency mechanical stimulation of the human body is a safe and effective way to exercise musculoskeletal structures and possible beneficial to the cardiovascular system. However, there is no study about WBV training on the elderly arterial function. So, the aim of this study was to analyse the influence of six weeks WBV training on arterial stiffness in the elderly. **Methods** To determine the six weeks WBV training effect on the elderly arterial stiffness which including three test : an arterial stiffness index (ASI) measurement (CardioVision MS-2000; USA) , six minutes walking and blood biomarker. 24 healthy elderly people were volunteered to participate in this study. Elderly people were performed in standing position on a BodyGreen whole vertical vibratory machine ( Taiwan ) for 3 times in a week. We analyze the data before 6 weeks WBV training and after the training for using Paired Samples T-test. **Results** After 6 weeks WBV exercise program, the blood pressure ( systolic pressure:  $146.4 \pm 4.8$  mmHg  $\rightarrow$   $130.3 \pm 4.7$  mmHg , diastolic pressure:  $80.5 \pm 2.6$  mmHg  $\rightarrow$   $74.1 \pm 1.5$  mmHg and pulse pressure:  $73.8 \pm 3.4$  mmHg  $\rightarrow$   $61.6 \pm 3.2$  mmHg), biomarker NO concentration:  $11.4 \pm 1.6 \mu\text{M}$   $\rightarrow$   $16.5 \pm 2.3 \mu\text{M}$  , the 6 minutes walking distance (  $382.2 \pm 23.9$  meter  $\rightarrow$   $425 \pm 20.2$  meter ) were significantly improved ( $p < 0.05$ ). And the inflammatory condition was no difference ( IL-6 and TNF- $\alpha$ ), even more the muscle was no damage (CK activity was no difference) before and after 6 weeks WBV training. **Discussion** Exercise can attenuate large artery stiffness in elderly people (Otsuki et al.2007). In our study, we found that WBV can significant lower ( $p < 0.05$ ) elderly blood pressure. Previous studies demonstrated that arterial remodeling in response to chronic changes in blood flow is endothelium- and NO-dependent (Rudic et al. 1998). Our WBV training increases the production of NO ( $p < 0.05$ ). NO is a potent endothelium-dependent vasodilator and reduces vasoconstrictor response to  $\alpha$ -adrenergic receptor stimulation. So, we think the blood pressure change was due to the increased NO concentration. According to our result, 6 weeks WBV training could be an effective strategy to combat arterial ageing. **References** Otsuki, T., Maeda, S., Iemitsu, M., Saito, Y., Tanimura, Y., Ajsaka, R. & Miyauchi, T. (2007). Vascular endothelium-derived factors and arterial stiffness in strength- and endurance- trained men. *Am J Physiol Heart Circ Physiol* 292, H786–H791. Otsuki, T., Takanami, Y., Aoi, W., Kawai, Y., Ichikawa, H. & Yoshikawa, T. (2008). Arterial stiffness acutely decreases after whole-body vibration in humans. *Acta Physiologica*, 1-6. Rudic, R., Shesley, E., Maeda, N., Smithies, O., Segal, S., Sessa, W. (1998). Direct evidence for the importance of endothelium-derived nitric oxide in vascular remodeling. *J Clin Invest* 101:731–736. Sugawara, J., Inoue, H., Hayashi, K., Yokoi, T., Kono, I. (2004) Effects of low-intensity aerobic exercise training on arterial compliance in postmenopausal women. *Hypertens Res* 27:897–901.

### **EFFECTS OF BRIEF WHOLE-BODY VIBRATION ON BONE MINERAL DENSITY AND BONE TURNOVER MARKERS IN THE RAT**

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**Introduction** Numerous studies have demonstrated the bone mass and strength benefits under the whole-body vibration programs based on high-frequency parameters. The goal of this study was to answer two questions: 1/ if the short-lasting vibration program is adequate for inducing bone tissue response and 2/ if the increased volume of a whole-body vibration modulates the metabolic processes of bone tissue. **Methods** Ten male Wistar rats, aged 6 months, were subjected to a regular 5-weeks whole-body vibration (WBV) program (5 days/week, frequency 50 Hz, amplitude of oscillations 2.5 mm). Results were compared to age-matched controls (n=5). Five animals underwent a vibration training in one session lasting 30 s (group 1) and other five were subjected to four vibration sessions lasting 30 s, separated by 60 s rest intervals (group 2). Before and after the vibration program the total bone mineral density (BMD) was measured using a dual-energy X-ray absorptiometry. After completing the training, the blood was taken from all animals to analyze biochemical parameters: osteocalcin (OC), C-terminal telopeptide of type I collagen (CTX), osteoprotegerin (OPG), receptor activator of nuclear factor (NF)- $\kappa$ B ligand (RANKL). **Results** There were no significant differences with respect to the total BMD values between two terms of the study in both groups of WBV animals. There were no significant differences between both groups of trained animals and the control with respect to concentrations of bone turnover markers, but the tendencies to decreased OC (by 28%) and CTX concentrations (by 15%) were observed in animals from the group 2. The RANKL levels were higher in both WBV groups in comparison to control animals, however, the significant difference was revealed only for animals from the group 1 ( $p < 0.05$ ). **Discussion** The brief whole-body vibration did not influence the BMD values, however, the altered bone turnover was observed after the higher intensity of WBV (4 x 30s). High values of receptor activator of nuclear factor (NF)- $\kappa$ B ligand (RANKL) in WBV groups of animals changed the RANKL/OPG ratio, which is critical to determine bone metabolism. However, the contribution of other tissues in increased serum levels of RANKL could not be excluded.



## EFFECTS OF LONG-TERM WHOLE BODY VIBRATION ON MOTOR UNIT CONTRACTILE PROPERTIES IN THE RAT MUSCLE

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**Introduction** Whole body vibration (WBV) has been reported to increase activity of motor units (MUs) and these effects are attributed to the enhanced afferent feedback and descending drive to the motoneuronal pool. During WBV high-threshold MUs are more effectively activated due to lower recruitment thresholds of MUs during reflex contractions induced by mechanical tendon vibration in comparison to voluntary contractions. Therefore WBV has been proposed to be a specific training for fast-twitch muscle fibers. We have previously demonstrated that a 5-week WBV indeed induces the considerable increase of twitch and tetanic forces for fast fatigable MUs. The aim of the present study was to determine long-term effects of WBV on MU contractile properties. **Methods** Two groups of Wistar rats were trained on the vibratory platform (Power Plate, USA) for 3 months or 6 months. Each research group underwent four times a day the 30 s vibration (with 60 s intervals), at 50 Hz frequency. The peak-to-peak amplitude of the vibrations was 2.5 mm, and the maximum acceleration of the platform 4.79g. Results were compared to two control groups of normally active rats (matched with respect to age and body weight). Functionally isolated MUs were investigated by electrical stimulation of filaments of the ventral roots of spinal nerves and force recordings from the medial gastrocnemius muscle. MUs were divided into three types: fast fatigable (FF), fast resistant to fatigue (FR) and slow (S). **Results** Changes in proportion of fast MUs were observed after 3 and 6 months of WBV: the increase of a relative number of FF and the decrease of FR units. However, the long-term WBV did not change significantly contractile parameters of FF units, only minor tendencies for an increase of tetanic forces of FF units were found after 3 or 6 months of WBV. On the other hand, there was a significant decrease of the twitch-to-tetanus force ratios in FR and S MUs, due to lower twitch forces and higher tetanic forces in both research groups. **Discussion** Contrary to previously demonstrated effects of force increase observed in FF units after short exposure to WBV, in this study no changes in twitch or tetanic force parameters were found for this type of MUs. This indicates that effects of WBV are temporary in FF MUs, which appear to adapt to a vibration stimulus. On the other hand, the increased proportion of FF units in the muscle after long-term vibration and the fact that the observed changes in MU properties are not restricted to the one type of MUs (but concern FR and S units as well) suggest that the long-term WBV induces deeper processes that influence mechanisms of MU contraction, as altered heavy-chain myosin expression or changed properties of motoneurons.

## ACUTE EFFECTS OF VARIOUS VIBRATION FREQUENCIES ON 1RM IN ELBOW EXTENSORS IN UNTRAINED AND TRAINED SUBJECTS

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**Acute effects of various vibration frequencies on 1RM in elbow extensors in untrained and trained subjects** Håvard Nygaard and Bent R. Rønnestad Lillehammer University College, Norway **Introduction** A number of studies have previously investigated the effect of mechanical vibration on several different measurements of physical performance. The purpose of this study was to compare the acute effects of superimposed vibration of different frequencies on 1RM performance in the elbow extensors of untrained and recreationally strength trained subjects. **Methods** Eleven untrained ( $\leq 1$  strength training session a week during the previous 6 months) and 10 recreationally strength trained (2-3 sessions of strength training a week during the previous 6 months) subjects participated in the study. The untrained and the recreationally strength trained group were randomly exposed to 30 Hz and 50 Hz of superimposed vibration or control conditions with no vibration, during 1RM tests in triceps pushdown. The vibration (amplitude 2.5 mm) was transmitted through the handle of the training device to the arm muscles. **Results** As a result of 50 Hz of vibration, the untrained group attained an increase in 1RM by 4.9% ( $p=0.013$ ) and 4.5% ( $p=0.014$ ) compared to no vibration and 30 Hz of vibration, respectively. No significant differences between the test conditions were observed in the recreationally strength trained group. **Discussion** The finding of increased 1RM load with vibration of 50 Hz, is in line with previous studies indicating a larger exercise stimulus when vibrations of 45-50 Hz are added to muscle actions with maximal effort, compared to lower vibration frequencies (Hazell et al. 2007; Rønnestad 2009 a & b; Hazell et al. 2010). The increased exercise stimulus is commonly explained by increased activation of the intrafusal muscle spindles that increases the excitatory input to the motoneurons, which in turn is thought to increase the activation of the working muscle and thus increase the force output. This rationale implies that there has to be an activation deficit in the working muscles to achieve an acute increase in force output by adding vibration to the exercise. The latter may explain the lack of effect of vibration in the recreationally strength trained group due to the degree of activation deficit in this coordinative easy exercise. **References** Hazell et al. Appl Physiol Nutr Metab 2007, 32:1156–63 Hazell et al. J Strength Cond Res 2010, 24:1860–5 Rønnestad. J Strength Cond Res 2009a, 23:2068–9 Rønnestad. J Strength Cond Res 2009b, 23:1309–15

## EFFECT OF WHOLE BODY VIBRATION TRAINING PLUS CREATINE SUPPLEMENTATION ON ANAEROBIC PERFORMANCE IN YOUNG VOLLEYBALL PLAYERS

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**Introduction** Whole body vibration (WBV) training (1) and creatine supplementation (CrS) (2,3) methods have been widely used to improve neuromuscular and athletic performance in athletes. Although there are many studies examining the effects of WBV training or CrS on athletic performance there is no study investigating the effect of WBV training plus CrS. Therefore, the purpose of this study was to determine the interaction effect of WBV training plus CrS on anaerobic performance (AP) in athletes. **Method** Forty trained male volleyball players (age:  $17.77 \pm 1.03$  y) were randomly assigned to four groups: Cr supplementation (Cr;  $n=10$ ), WBV training (V;  $n=10$ ), WBV training plus Cr supplementation (VCr;  $n=10$ ), or placebo (P;  $n=10$ ). Groups V and VCr were subjected to the WBV training daily for 7 days (5 sets of vertical sinusoidal vibrations lasting up to 100s each, for 8min daily, with a resting period of 30s to 45s between the sets). The frequency (30-50Hz) and the duration (50-100s) of vibration treatment have been increased progressively throughout the study. Groups Cr and VCr were supplemented with Cr monohydrate (4x5g/day) in a double-blind fashion. Group P was provided with an equivalent volume of placebo. All subjects continued their normal training program throughout the study. Anaerobic performance tests (vertical jump, leg squat and 45m sprint run) were performed at the baseline and at the end of the treatments. Two-way ANOVA (treatmentxtime) was used to analyze the data. **Results** All the three treatments (V, Cr, VCr) enhanced vertical jump and leg squat ( $p<0.05$ ). Significant group differences were found in vertical jump and leg squat ( $p<0.05$ ), VCr group exhibiting the most significant change. In addition, both V and VCr groups exhibited significant improvements in 45m sprint run ( $p<0.05$ ), V group showing the most significant improvement. There was no change in any parameter in P group ( $p>0.05$ ). **Discussion** Findings of the study showed that both WBV training and Cr supplementation

improves anaerobic performance. Interaction of WBV and Cr supplementations resulted in co-increment in vertical jump and leg squat. WBV training improves explosive power of lower limb muscles and speed, and this effect can be intensified by combining with Cr supplementation. In conclusion, a short period of WBV training can be used as a new approach for improving strength and power of lower limb muscles by itself alone or beside Cr supplementation. References 1.Bosco C, Iacovelli M, Tsarpela O, et al. (2000). *Eur J Appl Physiol*, 81(6):449-54. 2.Bosco C, Tihanyi J, Pucspk J, et al. (1997). *Int J Sports Med*, 18(5):369-72. 3.Bosco C, Cardinale M, Tsarpela O, et al. (1998). *Biology of Sport*, 15, 157-164.

### DOES THE WHOLE BODY VIBRATION ALTER MUSCLE ENERGY METABOLISM?

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**Introduction** It is well-known fact that whole body vibration results in acute residual enhancement of force generation and physical performance that is believed to be the consequence of neuromuscular and hormonal facilitation. In fact the EMG activity is elevated during vibration beyond a certain frequency. If EMG activity of a muscle is elevated than the muscle tension should also increase which may cause alteration of the content or ratio of the high energy phosphates. Up to now there is only one study investigating the effect of mechanical vibration on muscle metabolism using 20 Hz (Zange et al. 2009). They reported no significant change. Since it was reported that EMG activity is enhanced at higher frequency than 20 Hz (DiGiminiani et al. 2010). We aimed to investigate if 40 Hz vibration frequency might have specific alteration in muscle energetics due to the neuromuscular facilitation. **Methods** Fifteen trained person (7 female and 8 male) participated in this study (age: 19,8±0,77 years, Bw:69,6±9,09 kg, Bh:176,2±7,23 cm). Five subjects received 6x1 minute 20 Hz then 6x1 minute 40 Hz vibration standing in half squat position on a vibrating device (Nemes Bosco). Five subjects received similar treatment, but with 40 Hz first then 20 Hz. Five subjects served for control standing on the device in the same position without vibration. Before vibration, between the two vibration sets and after the intervention inorganic phosphate (Pi), ATP, creatine phosphate (PCr) and Pi/PCr ratio was determined using a 31P magnetic resonance spectroscopy (Philips Achieva 3.0T). **Results** The amount of inorganic phosphate (Pi) decreased in the vibration group, and also in the control group, there was no significant difference between the groups. The peak of creatin phosphate (PCr) and ATP were not change during the trainings. The ratio of the Pi/PCr changed similar than Pi. These change were significant, but there were no difference between the groups. **Discussion** After vibration Pi was depressed in all groups indicated that the change could be attributed to static squat position than to the vibration intervention. Because PCr and ATP remained unchanged the vibration did not resulted in muscle fatigue despite the increased muscle tension. It seems that the increased acute residual physical performance after vibration can be attributed neural facilitation may be in both motor cortex and level. **References** Zange J, Haller T, Müller K, Liphardt A, Mester J. 2009. *Eur J Appl Physiol* 105: 265 - 270. Di Giminiani R, Manno R, Scrimaglio R, Sementilli G, Tihanyi J (2010). *J Sports Med Phys Fitn.* 50(2):139-51

### EFFECTS OF WHOLE-BODY VIBRATION ON THIGH NEUROMUSCULAR ACTIVITY

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**EFFECTS OF WHOLE-BODY VIBRATION ON THIGH NEUROMUSCULAR ACTIVITY** Raimundo,A. 1,2, Malta, J1.Batalha, N.1, Fernandes,O.1,2, Tomas-Carus,P.1,2 1:University of Évora, Portugal, 2:Health Science and Technology Research Centre. **Introduction** The use of whole-body vibration (WBV) appears to influence in a positive way the performance of athletes in certain characteristics such as muscular strength, power and body balance. The aim of this study was to compare the acute neuromuscular activity caused by different vibration frequencies (15Hz and 25Hz), and different knee flexion angles (120° and 150°). **Methods** A total of 19 male university students underwent 4 sessions of WBV. The subjects were exposed randomly to four different WBV protocols using a vibration platform (Galileu 2000). The amplitude allowed by the vibration platform was (peak-to-peak) 3 mm. Each vibration session lasted 6 min and they accomplish a rest period of one day between sessions. The protocols used were: 15 Hz of vibration and 120° of knee flexion; 15 Hz and 150°; 25 Hz and 120°; and 25 Hz and 150°. Muscle activity exerted by the muscles Vastus Intermedius (VI), Vastus Lateralis (VL), Vastus Medialis (VM) and Biceps Femoris (BF) were evaluated by electromyographic analysis (Biopac MP 100, Biopac Systems Inc. Goleta, CA, EUA). Paired Samples T test with repeated measures was used to compare the main effects of muscle activity of each test. **Results** When comparing the two angles of knee flexion (120° vs 150°) with the 15Hz frequency, it was found a different EMG response of the VI (P=0,01), VL (P=0,00), VM (P=0,001) and BF (P=0,02) muscles. Conversely, when it was applied a 25Hz frequency, the angles of knee flexion showed no significant changes on neuromuscular response. Considering the two frequencies of vibration, the neuromuscular response showed significant differences in VI (P=0,046), VL (P=0,036), VM (P=0,028) e BF (P=0,025) muscles, only with 150° of knee flexion. **Discussion** The results of the present study suggest that in this specific position the increase on vibration frequencies, induce an increased on EMG activity on leg muscles. Similar results were observed by Hazell et col (2007). As suggest by Cardinale and Lim (2003), vibrations-induced increases in EMG activity and the consequent degree of motor unit synchronization have been shown to be dependent on the vibration frequency. It was concluded that exposing young people to low – frequency vibration, the neuromuscular activation decreases when increasing the degree of knee flexion. However, when using a degree of knee flexion of 150°, the electromyographic activity increases with the increasing frequency of vibration, more specifically, when increasing the vibration frequency from 15Hz to 25Hz. **References** 1. Hazel T.J., Jakobi J.M., Kenno K.A. (2007). *Appl. Physiol. Nutr. Metab.* 32: 1156-1163; 2. Cardinale M, Lim J. (2003) *Journal of Strength and Conditioning Research.* 17(3), 621–624

### EFFECT OF 6 WEEKS OF VIBRATION TRAINING ON BODY COMPOSITION, STRENGTH AND POWER, VARYING THE MECHANICAL AMPLITUDE AND FREQUENCY OF TRAINING

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**Introduction:** Strength, power and muscular mass are important components of health and physical condition. The vibrations transmitted to the whole body (WBV) are a method that potentially consumes less time to achieve a physical conditioning. But, vibration protocols to maximize the production of strength, power and increase of muscular mass have not still been defined. The aims of the study were to value the effects of: 1) two different amplitudes of vibration (4 mm y 6 mm); and 2) the variation of the weekly training frequency on strength, power and body composition. **Methods:** 52 participants recreationally actives (20.9 ± 3.5 years) took part in the study. Participants were divided in three experimental groups and a control (GC). The experimental groups realized an incremental vibratory training

during 6 weeks starting with 8 sets per session, and increasing one set every week. Frequency of vibration (50 Hz), time of work (60 s) and time of rest (60 s) were constant for the three groups. The first group (GL2) worked with amplitude of 4 mm, 2 days for week; the second group (GH2) worked with amplitude of 6 mm, 2 days for week; and the third group (GH3) worked with amplitude of 6 mm, 3 days for week. All participants were on the platform with the same static position. The maximum isokinetic force ( $60^{\circ}\cdot s^{-1}$  and  $270^{\circ}\cdot s^{-1}$ ) was evaluated at the beginning and at the end of the process. It was also evaluated: the corporal composition by densitometry and the performance in vertical jumps (SJ y CMJ). A repeated measures ANOVA was used to observe the effect of time, and a one-way ANOVA to establish differences between groups ( $p \leq 0.05$ ). Results: A significant increase of isokinetic strength was observed in the experimental groups for the angular velocity of  $60^{\circ}\cdot s^{-1}$  and  $270^{\circ}\cdot s^{-1}$ . Total fat free mass was increased in the groups GH2 ( $0.9 \pm 1.0$  Kg) and GH3 ( $1.5 \pm 0.7$  Kg), being established statistically significant differences among GH3 and GL2 ( $p = 0.02$ ), and among GH3 and GC ( $p = 0.05$ ). No changes were observed when the performance of the jumps was valuated in neither group. Discussion: The results seem to indicate that there is an improvement in the dynamic maximum strength and the explosive force in the muscles extensors of the knee. This is probably due mainly to an increase of the muscular mass. The power of the vertical jump did not improve in any of the groups submitted to study. This absence of improvement may be explained because of an unspecific transmission of vibration, which could interfere in the coordination needed to make activities such as the vertical jump (Fernández-Río et al., 2010). References: Fernández-Río J, Terrados N, Fernández B, Suman O. (2010). J Strength Cond Res, 24, 1373-1380.

## Poster presentations

### PP-PM14 Physiology: Performance in Sport

#### 'THE EFFECTS OF CHA CHA DANCE TRAINING ON CARDIO-RESPIRATORY PARAMETERS'

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Introduction Dance as an aerobic exercise is getting more interest not only developing cardio-respiratory performance but also developing flexibility and balance in all ages. In this study, we aimed to evaluate effects of 3 month Latin American 'Cha Cha' (LAD 'Cha Cha') training on anthropometric and cardio-respiratory functions. Methods Individuals between 18–25 ages who are first time started to a dance training programme and dancers who are dancing for 5–9 years ( $x = 7 \pm 0.65$  years). 24 (12 women, 12 men) individuals were divided into 3 groups in the study; group I: Sedanters, group II: Dance training group and group III: Dancer group. Group II and group III were undertaken into LAD 'Cha Cha' training. Anthropometric (body weight, body muscle index (BMI), fat mass (FM), fat free mass (FFM), body fat percent (BF %), total skinfold thickness) and cardio-respiratory (maximal oxygen uptake ( $VO_{2max}$ ), respiratory exchange ratio (R), minute respiration volume (VE), tidal volume (TV), minute respiration number (RR), heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP)) measurements were taken from the subjects before and after their 3 month training program. Skinfold measurements were done by Holtain brand skinfold caliper with 0,2 mm sensitivity. Exercise measurements were done by Sensormedics Vmax 29C. Anthropometric and cardio-respiratory values before and after 3 month training were compared within and among the groups by using t-test, ANOVA and Post Hoc Test for multiple comparisons if it is applicable. Results In conclusion, sedanter group with similar age and active living conditions but without regular exercise program did not show significant changes in their aerobic capacity. 3 months Cha Cha training both women and men of dance learning (beginner), and dancer groups caused significant progress in their aerobic capacity values measured as  $VO_{2max}$ ,  $R_{max}$ ,  $SBP_{max}$ ,  $HR_{max}$ ,  $HR_{rest}$ , body fat ratio. Discussion It can be stated that sedanter group with similar age and active living conditions but without regular exercise program did not show significant changes in their aerobic capacity. In conclusion, 3 month couple dance training ('Cha Cha') both women and men of dance learning, and dancer groups caused significant progress in their aerobic capacity values ( $p < 0.05$ ). The research findings correspond with those of an earlier study conducted by Schantz and Astrand (2004), Wyon and Redding (2005) supports our findings. References Schantz, PG., Astrand, PO. Physiological characteristics of classical ballet. The Journal of Strength & Conditioning Research, 2004; 18(3):646–9. Wyon, M., and Redding, E. Physiological monitoring of cardiorespiratory adaptations during rehearsal and performance of contemporary dance. The Journal of Strength & Conditioning Research, 2005; 19(3):611–614.

#### LONG TERM PLANNING IN TRIATHLON: FROM THE BEGINNING TO HIGH PERFORMANCE

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Ruiz, G. Complutense University (Madrid, Spain). Introduction In a controlled sports system it is necessary to set the stages for long term development. In this way, it would be possible an adequate progression to the highest achievements. Literature often reports different stages models with no empirical method. There are no models for triathlon, a special sport in which athletes come from other endurance disciplines related to triathlon (swimming, cycling and athletics) (Federation Française de Triathlon, 2003-04; Ruiz, Salinero, & Sánchez, 2008). The aim of this study is to establish the long term sports stages for triathlon from empirical data of a high level triathletes' group. Methods A sample of 48 Spanish high level triathletes ( $25.48 \pm 4.92$  years old) has been requested to complete a retrospective questionnaire about their sports career. Results A graphic figure including long term sports stages for triathlon has been created with these data: Starting age in previous discipline-swimming: ( $n = 27$ ):  $7.48 (\pm 2.72)$  Starting age in previous discipline-cycling ( $n = 5$ ):  $12.40 (\pm 4.98)$  Starting age in previous discipline-athletics ( $n = 6$ ):  $13.17 (\pm 4.83)$  Starting age straightforward in triathlon ( $n = 10$ ):  $13.90 (\pm 3.17)$  Starting age in triathlon from other endurance discipline:  $16.66 (\pm 4.5)$  Starting age in triathlon competitions:  $16.23 (\pm 4.29)$ . Starting age in triathlon national competition:  $17.77 (\pm 4.18)$  Starting age in triathlon international competition:  $19.90 (\pm 4.34)$  Achievement age of local/regional success in triathlon:  $17.11 (\pm 4.17)$ . Achievement age of national success in triathlon:  $18.85 (\pm 4.05)$ . Achievement age of international success in triathlon:  $21.29 (\pm 4.26)$ . Years of experience in triathlon:  $9.19 (\pm 4.01)$ . Discussion Starting ages in triathlon ( $16 \pm 4.38$ ) are higher than in other studies with other sports high level athletes: 10,26 years (Hill, McConnell, Tammie, & Moore, 2002) or less than ten years old for 50% of the sample (García Ferrando, 1996). It is necessary to know the real nature of triathlon to understand its evolutionary stages. The sporting past and the continuous flow of athletes are determining these natural periods. References Federation Française de Triathlon. (2003-04). Approches des Représentations Sociales en Triathlon: Analyse et Préconisations. Paris: [http://www.fftri.com/espace/doc/etude\\_representations.pdf](http://www.fftri.com/espace/doc/etude_representations.pdf). García Ferrando, M. (1996). Los deportistas olímpicos españoles: Un perfil sociológico. Madrid: Consejo Superior de Deportes. Hill, R., McConnell, A., Tammie, F., & Moore, J. (2002). The path to excellence: A

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### ANAEROBIC THRESHOLD AND CRITICAL VELOCITY PARAMETERS IN SLALOM KAYAK SPECIFIC TESTS, BEFORE AND AFTER MONITORED TRAINING

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**Introduction** The slalom kayak depends on aerobic and anaerobic conditioning (ZAMPARO et al., 2005). However, this modality shows deficiencies in physiological tests for determining these capacities. The aims of study were suggest a specific anaerobic threshold (AT) test for slalom kayak, comparing their results with the obtained using a non-invasive critical velocity (CV) model and also to verify these responses before and after 7-weeks monitored training. **Methods** Six well trained kayakers (K1) (17±4yrs) were submitted to specific tests on a lake, before and after training program. The AT was determined by a progressive kayak "shuttle" exercise (50-m course, 3min/stage) until exhaustion. The velocities adopted were 5,6,7,8,9 and 9.5Km/h, with blood sample collection after each stage. Individual curves 'intensity vs blood lactate' were plotted and the AT was obtained using visual inspection and intersection of the bi-segmental linear regression. From these tests, the individual total time (TT) between AT and exhaustion were obtained. The CV protocol consisted of 4 maximal exercises paddling at 150, 300, 400 and 600-m, with minimum 1hr rest among them. The slope and y-intercept of linear mathematical model 'distance vs time' were CV and anaerobic paddling capacity (APC), respectively. The training program was accomplished on a lake and river and the intensity sessions were obtained by the individual rating of perceived exertion (RPE). The product of daily volume (min) and RPE was considered the load training (FOSTER et al., 2001). The results were analyzed by t-student test, one-way Anova and Pearson correlation ( $P < 0.05$ ). **Results** The AT and CV were not different in initial tests ( $6.7 \pm 0.2$  and  $6.8 \pm 0.1$  Km/h) and there was not significant correlation among APC and TT. Despite volume training has showed changes, the intensity was not modified during this period and the load reduced only the last week. After program, the AT increased ( $7.3 \pm 0.2$  Km/h) without modified CV ( $6.7 \pm 0.0$  Km/h). APC and TT showed significant correlation ( $r = 0.66$ ). At both moments, the blood lactate at AT was similar ( $2.4 \pm 0.2$  and  $2.6 \pm 0.4$  mM). **Discussion** The AT specific protocol detected aerobic capacity increase after 7-weeks training characterized by small changes intensity and load. The same was not verified with CV and APC. Thus, the invasive protocol seems more appropriate to evaluate the effects of training applied to slalom kayakers. Supported by FAPESP, CAPES and CNPq **References** Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, Doleshall P, Dodge C. (2001). *J Strength Cond Res*, 15,109-15. Zamparo P, Tomadini S, Didonè F, Grazzina F, Rejc E, Capelli C. (2005). *Int J Sports Med*, 27, 546-552.

### THE EFFECT OF SAND-BASED TRAINING IN AGILITY OF PREPUBESCENT VOLLEYBALL PLAYERS

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**INTRODUCTION** Agility is believed to be an important physical component, necessary for successful performance in volleyball and recreational activities (1). Beach volleyball is characterized by short fast runs on sand and many vertical jumps and therefore its training consists of sprints and agility exercises on sand surface (1, 2). The purpose of the present study was to examine the effect of a sand-based training program in agility. **METHODS** Fifteen female prepubescent volleyball players (age:  $11.1 \pm 0.6$  yrs, height:  $151.6 \pm 1.8$  cm, weight:  $40.9 \pm 1.7$  kg) took part in this study. Subjects participated in a 10 week training program that included 3 organized court training sessions per week on sand surface. Measurements of agility (T-Test & Illinois test) were conducted before (pre) and after (post) the training period. Agility tests were performed on the land (L condition) and on the sand (S condition) in different days. Differences in agility pre - post training and between the conditions were analysed using T-test. Results are presented as mean  $\pm$  SE. **RESULTS** Agility T-Test differed significantly in both conditions (L and S) pre and post the 10-week training program (L pre:  $15.3 \pm 0.1$  vs. post:  $13.2 \pm 0.1$  sec,  $p < 0.001$  and S pre:  $18.0 \pm 0.1$  vs. post:  $15.0 \pm 0.1$  sec,  $p < 0.001$ ). Performance in Illinois test was significantly improved too (L pre:  $22.2 \pm 0.1$  vs. post:  $20.2 \pm 0.1$  sec,  $p < 0.001$  and S pre:  $23.5 \pm 0.2$  vs. post:  $21.4 \pm 0.2$  sec,  $p < 0.001$ ). Significant differences were also observed in the two conditions in T-Test (pre L:  $15.3 \pm 0.1$  vs. S:  $18.0 \pm 0.1$  sec,  $p < 0.001$  and post L:  $13.2 \pm 0.1$  vs. S:  $15.0 \pm 0.1$  sec,  $p < 0.001$ ) and in Illinois test too (pre L:  $22.2 \pm 0.1$  vs. S:  $23.5 \pm 0.2$  sec,  $p < 0.001$  and post L:  $20.2 \pm 0.1$  vs. S:  $21.4 \pm 0.2$  sec,  $p < 0.001$ ). **DISCUSSION** The results of the present study suggest that a 10-week training program on sand surface can significantly improve agility. Despite the fact that the whole training program was conducted on sand, agility was also improved when tests were performed on land. **REFERENCES** 1. Young, W.B., McDowell, M.H., Scariett, B.J. (2001). Specificity of sprint and agility training methods. *J. Strength Cond. Res.*, 15 (3), 315-9. 2. Bishop, D. (2003). A comparison between land and sand-based tests for beach volleyball assessment. *J. Sport Med. & Phys. Fitness*, 43: 418-23.

### PERFORMANCE FACTORS IN THE FIRST SERVE IN EXPERT TENNIS PLAYERS

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conditions that mimic competition, the training of psychological skills on the court and power. The coaches overemphasize the intrinsic factors over the extrinsic factors and the coaching is not directed to the functional motor variability.

### PROFILING FUNCTIONAL PERFORMANCE OF 14-16 YEAR OLD FEMALE VOLLEYBALL PLAYERS

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Profiling functional performance of 14-16 year old female volleyball players Mirkov D, Knezevic O, Jelic M, Sikimic M, Nesic G. Faculty of Sport and Physical Education, University of Belgrade, Serbia Introduction Profiling athletes is of importance for discerning anthropometric and physical characteristics that may distinguish studied group from other subjects' population (Kukolj et al., 2003). Volleyball is a highly specialized sport, with both anthropometric and physiological characteristics being distinctive at the various competition levels (Duncan et al., 2006). Despite the popularity of volleyball, there is a lack of data related to the player profiles, particularly those that compare young female competitors of different age. The aim of our study was to investigate the anthropometric and physiological characteristics of female adolescent volleyball players and to assess their age-associated differences in selected variables. Method The participants (girls of 14, 15 and 16 years of age - G14, G15 and G16; N=167) were selected from 4 regions in order to make a selection for the national team. They were assessed on a number of anthropometric and physiological variables. Body height (BH) and body fat (%BF) were assessed using surface anthropometry; body weight (BW), upper body power by a medicine ball chest pass (MBCP); leg power using various jumps (long jump, squat and countermovement jump, jump with reaction time), speed by 20m sprint (S20, with lap times at 5 and 15m) and agility by T test (TT). Results Significant differences ( $p < 0.05$ ) were found between groups G15 and G16 for the following variables: BH, BW, %BF, MBCP, TT and S15 and S20. Differences between G14 and G15 were present only for BH and MBCP ( $p < 0.05$ ). There were no differences in physiological variables between groups G14 and G16. When comparison was made between the girls who were afterwards selected for a national team, and those who were not, similar differences were found. The selected girls were significantly higher, and also demonstrated better results in MBCP and TT. There were no significant differences between both the age groups and selection groups in jumping performance (all  $p > 0.05$ ). Conclusion This study evaluated the anthropometric and physiological characteristics of a group of female adolescent volleyball players and provides an insight into these characteristics with respect to age and national team selection. The obtained results suggest that body height, upper body power, and agility are key physical performance characteristics of adolescent girls who play volleyball. These findings could allow coaches and athletes to identify the physical and performance characteristics specific to the age groups for purposes of evaluation, selection, and development. Acknowledgement: Study was supported in part by grants #175037 and #175012 from the Serbian Research Council References [1] Kukolj et al. J Hum Mov Stud 45:403-418 [2] Duncan et al. Br J Sports Med 2006;40:649-651

### SAFETY MEASURES IN GOLF-THE ACTUAL SITUATION CONCERNING ACCIDENTS AS REVEALED BY A QUESTIONNAIRE SURVEY OF GOLF COURSES A POSSIBLE MEASURES TO PREVENT THEM-

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[Objective] We have identified the actual situation concerning accidents and emergency medical services in golf course in the last time through questionnaire survey we sent to more than 2,200 Japanese golf courses during the 25 years. This time, in order to survey the safety situation in Australia district golf courses, we distributed questionnaires to 392 golf courses in Japan(kinki)district. [Method] The survey period was one year, between April 2008 and March 2009 Six questions posed were as follows: 1).Frequency of ambulances dispatched to the golf courses in a year (subdivided into the number of emergency calls per month), Reasons for calling an ambulance? 2). Established cooperative arrangement with neighboring hospitals (general and private hospitals)? Distance to recommended hospital departments and travel time? 3). Emergency medical care available at the golf course and crisis control system (designated person in charge, emergency training, qualified first aid persons, emergency equipment, fixtures, etc.), 4), Annual incidence or accidents among golfers (surgical accidents, deaths, etc)? [Results] 1) 「Ambulance calls」 : Out of 392golf courses,63 replied. The response rate was 16%. With respect to the month, there 11requests in January (17.4%), 9 in February (14.2%), 16 in March (17.2%), 14 in April (22.2%), 27 in May (42.8%), 7 in June (11.1%), 47 in July (65.0%), 19 in August (30.1 %), 6 in September (27%), 12 in October (19.0%), 9 in November (14.2%), 2in December (3.1%), respectively These results indicated that ambulance calls were most frequent in July and June in all regions Emergency medical care system: Concerning emergency medical care procedures at golf courses,14 golf courses(22.5%) said that "cooperative arrangements with a given medical institution are in place", while 49 courses (77.7%) replied that they had "no fixed cooperative arrangements". About half of the golf courses did not have an established system for cooperating with a given medical institution in case of an emergency. Looking at practical emergency care procedures in the case of an emergency on the golf courses, 7 golf courses (63.4%), the majority had a designated member of staff who would be expected to take charge.63.4 courses(36.5%) did seventy-seven 35 courses (55.5%) held training courses for their staff in emergency care, but 28 courses (44.4%), the majority, provided no emergency training 3). 「Accidents to golfers」 Accidents to golfers involving golf balls and clubs had been experienced at 36golf courses (57.1 %) and had not been experienced at27 (42.8%). 23 golf courses (47.6%). had experienced accidents due to falls and slips, while 34(53.9%) had not. There were 2 accidents resulting in death at 2 golf courses (3.1%) last year. Since the golf courses had been in operation, there had been 21 fatal accidents in total, 1 of them due to being struck by a thunderbolt (at 3 different courses). [References] 1) Gregory, R.T.S:Sussex Eye Hospital Sports Industries: British J.Ophtalmology748-750,1986

### MOVEMENT STRATEGIES OF TRAMPOLINE JUMPS COMPARED TO STANDARD JUMPS

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Different materials and properties of the ground as well as different goals of the movement determine the characteristics of a movement in stretch shortening cycle movements. So it is very interesting to have a look at different jump movements dealing with the same goal: jump as high as possible, and analyse their special movement patterns mechanically and from a neuromuscular view. In order to analyse such differences in movement strategies during jumping movements the jumps on a trampoline (TJ) were compared to the movements in squat (SJ), countermovement (CMJ) and drop jumps (DJ). Therefore 9 athletes of the german Olympic competition team (active

and juniors) in trampoline took part in a study. Ground contact times on the trampoline were recorded as described by REULE (2010) and performing the SJ, CMJ and DJ the ground reaction forces were recorded on a Kistler force platform. Surface EMG of 8 main leg muscles were depicted concerning to Seniam. Joint excursions were analyzed using Penny&Giles goniometers at the ankle and knee. Mechanical and neuromuscular data were time synchronized with respect to the takeoff of the jumps. The contact times compared between DJ and TJ reveal similar contact times for both jumps but the correlation between the two jumps was very low ( $r=0.29$ ). Analyzing the jump heights of the different jumps it can be seen, that a high correlation between the SJ, CMJ and DJ on one hand and the TJ on the other hand indicates that the capability to jump high on the trampoline can also be found in the jump performance of SJ, CMJ and DJ. Comparing the activation intensity of the neuromuscular parameters using iEMG data of the depicted muscles between the different jump conditions it can be seen that the main difference is observable in the m. rectus femoris. This muscle is clearly lower activated during the TJ condition. Analyzing the maximal joint excursions with respect to the take off it can be seen that during the TJ clearly lower angles were observable. The moment of the maximal angle was comparable between SJ, CMJ und TJ. Although it can be seen that the jumping performance performing SJ, CMJ and DJ in terms of jumping heights is reliable to the jumping height on the trampoline, this study reveals clearly different activation characteristics between the standard jumps (SJ, CMJ and DJ) and the trampoline jump. So it is questionable if training the standard jumps is the adequate training stimulus for enhancing the jumping performance on the trampoline. These results indicate that from a special point of view the control of the different movements occurs in different ways. So it must be the question of further studies if discriminating all jumps only in the three types of standard jumps is good enough to explain different movement control strategies.

### THE RELATIONSHIP BETWEEN LOWER LIMB POWER AND GOLF DRIVE BALL DISTANCE IN ELITE GOLFERS.

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THE RELATIONSHIP BETWEEN LOWER LIMB POWER AND GOLF DRIVE BALL DISTANCE IN ELITE GOLFERS. Haslam, S.J.<sup>1,2</sup>, Clark, D.<sup>2</sup>, Hunter, A.M.<sup>1</sup>  
<sup>1</sup>University of Stirling (Stirling, Scotland), <sup>2</sup>SportScotland Institute of Sport (Stirling, Scotland) Introduction Distance achieved in a golf drive directly depends upon the ability of the golfer to transfer the greatest amount of kinetic energy (ground reaction force (GRF)) throughout the body to accumulate at the club head, via a kinetic link sequence (Nesbit and Serrano, 2005). The energy required to produce the large GRF has thought to be a result of the work done by the legs and hips in pushing against the ground (e.g., Hume et al. 2005). In turn, an increased power output from the lower limb would result in a significant increase in club head velocity, and thus striking distance. However, despite the relative importance of increasing lower limb power to enhance striking distance, there is a relative lack of research investigating this relationship, especially for an elite cohort. As a result, the aim of this study was to objectively determine if there is a relationship between lower limb power and distance achieved to a golf drive in elite amateur golfers, by correlating the execution of a counter-movement jump (CMJ) to striking distance and examining the related GRF's. Methods Twenty-seven right-handed elite level golfers; mean age 19.8 (2.4) yrs, mass 74.8 (12.6) kg, height 178.0 (12.6) cm, and handicap 0.26 (2.5), took part in the study, following ethical approval being granted. The study consisted of each participant performing twenty golf drives on a force plate (hitting the ball as far possible) and three maximal CMJ's. The intervention was repeated to allow a measure of reliability. Results There was a significant positive correlation between distance and CMJ height ( $P < 0.01$ ;  $r^2$  0.483). A similar positive relationship was also shown between distance and maximal vertical GRF ( $P < 0.001$ ;  $r^2$  0.593), and mass and distance ( $P < 0.001$ ;  $r^2$  0.679). All variable outcomes of the golf swing and CMJ demonstrated good day-to-day reliability ( $r^2 > 0.80$ ;  $P < 0.001$ ; CV < 5%). Discussion The significance found between distance and CMJ provides convincing evidence that lower limb power is directly related to striking distance. Further evidence for the above statement is also afforded by the positive relationship between maximum vertical GRF and striking distance. A strong positive relationship was also noticed between subjects' mass and distance. However, due to the positive relationship between CMJ and ball distance it is likely that this mass will be proportionately composed of lean efficient tissue (Kawashima et al, 2003). As a consequence, lower limb power, and possibly hypertrophy, training may have performance benefits for elite level golfers. References Hume PA, Keogh J, Reid D. (2005). Sports Med, 35, 429-449. Kawashima K, Kato K, Miyazaki M. (2003). J Sports Med Phys Fitness, 43, 334-341. Nesbit, SM, Serrano, M. (2005). J Sport Sci Med, 4, 520-533.

### GENDER DIFFERENCES IN PHYSIOLOGICAL CHARACTERISTICS OF JUNIOR TENNIS PLAYERS.

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Introduction Gender differences in aerobic capacity and muscle strength during growth have been studied thoroughly (1, 2). Previous studies have also examined anthropometric and somatotype characteristics of junior tennis players, but not the physiological ones (3). Therefore, the purpose of the present study was to examine the gender differences in physiological characteristics of junior tennis players. Methods 17 male (group M) and 14 female (group F) tennis players (age:  $16.5 \pm 1.2$  vs  $15.1 \pm 0.5$  yrs, height:  $174.1 \pm 2.0$  vs  $164.6 \pm 1.7$  cm, body mass:  $67.4 \pm 3.9$  vs  $55.9 \pm 1.2$  kg, mean  $\pm$  SE) participated in this study. Sit and reach (SR) flexibility test, maximum handgrip strength, agility T-test and 20m shuttle run test (for the prediction of VO<sub>2</sub>max) were measured. Differences between the two groups in VO<sub>2</sub>max, agility T-test, SR and handgrip strength were analyzed using T-Test, while relationships between variables were assessed using the Pearson's product moment correlation coefficient (r). Results are presented as mean  $\pm$  SE. Results VO<sub>2</sub>max differed significantly between groups ( $M = 38.8 \pm 2.7$  vs  $F = 28.6 \pm 1.9$  ml/kg/min,  $p < 0.01$ ) and so did the handgrip strength levels ( $M = 33.1 \pm 2.1$  vs  $F = 24.8 \pm 0.9$  kg of force,  $p < 0.001$ ). On the other hand, group F performed significantly better in SR test compared to group M ( $F = 20.6 \pm 1.6$  vs  $M = 13.1 \pm 2.0$  cm,  $p < 0.01$ ). Furthermore VO<sub>2</sub>max and agility T-test were significantly correlated in group M ( $r = 0.63$ ,  $p < 0.01$ ), but not in group F ( $r = 0.11$ , n.s.). Discussion The results of the present study are inconsistent with previous studies outlining significant gender differences in flexibility, aerobic capacity and muscle strength (1, 2). However further research is needed in the case of tennis players. 1. Pate, RR., Wang, CY., Dowda, M., Farrell, SW., O'Neill, JR. (2006). Cardiorespiratory fitness levels among US youth 12 to 19 years of age: findings from the 1999-2002 National Health and Nutrition Examination Survey. Arch Pediatr Adolesc Med., 160 (10), 1005-1012. 2. Dore, E., Martin, R., Ratel, S., Douche, P., Bedu, M., Van Praagh, E. (2005). Gender differences in peak muscle performance during growth. Int J Sports Med. 26 (4), 274-280. 3. Munoz, C.S., Sanz, D., Zabala, M. (2007). Anthropometric characteristics, body composition and somatotype of elite junior tennis players. Br J Sports Med. 41 (11), 793-799.

## IMPACT OF PHYSICAL PERFORMANCE ON TENNIS RANKING IN JUNIORS –RESULTS FROM THE NATIONWIDE GERMAN TENNIS TEST

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**Introduction** The German Tennis Test consists of a two times annual physical testing of all 300 junior squad players including basic (e.g. abdominal strength endurance), semispecific (e.g. 10 m sprint) and specific tests (e.g. service velocity). Data feedback is given with individualized training advices. In the present study we compared the physical performance testing results with the positions of all players on the German junior ranking list. This age independent list (under 12 to under 18) includes more than 2000 male and female junior players and the players position depends on the number and quality of tournament match wins. **Methods** 178 boys (m14: n=75, m16: n=63 and m18: n=40) and 105 girls (f14: n=57, f16: n=30, f18: n=18) were tested for biometric data (body height, body weight, BMI, range of arms, skin fold thickness), flexibility (stand and reach, internal and external shoulder rotation), strength (hand grip, push-ups, back extension, crunches), upper body power (medicine ball throw, forehand and backhand side throw, service velocity), speed, agility and jumping ability (10, 20 m linear sprint, counter movement jump, horizontal jump, foot tapping frequency, repetition jump efficiency, tennis specific shuttle sprint) and tennis specific endurance (Hit & Turn Tennis Test (Ferrauti et al. 2011)). Pearson's product moment correlations were calculated between the test results and the German junior tennis ranking for male and female under 14, under 16 and under 18 players. **Results** Service velocity (m14: r=.506, m16: r=.397, m18: r=.558, f14: r=.554, f16: r=.688, f18: r=.314) and medicine ball throw (m14: r=.482, m16: r=.301, m18: r=.333, f14: r=.432, f16: r=.513) showed the highest correlation to the players ranking position. Further significant correlations were found between rankings and the Hit & Turn endurance test performance, especially in females (f16: r=.594), as well as for hand grip force and body height. Semi- and tennis-specific agility, speed and jumping ability were less correlated to the ranking. No correlations were found between basic tests (e.g. core strength endurance) and rankings. **Discussion** Our results underline the importance of the upper body power for junior tennis player's performance. Coaches should concentrate more on the development of these capacities, since in professional tennis the service velocity increased significantly during the last decade (Weber et al. 2010). More research should be focused on the development and evaluation of upper body power intervention programs. **References** Ferrauti A, Kinner V & Fernandez-Fernandez J. (2011). The Hit & Turn Tennis Test: An acoustically controlled endurance test for tennis players. *J Sports Sci* [epub ahead of print] Weber K, Exler T, Marx A, Pley C, Röbbel S & Schöffkes C. (2010). Schnellere Aufschläge, kürzere Ballwechsel und höherer Zeitdruck für Grundschnitte in der Tennis-Weltspitze – Darstellung am Beispiel der Herren. *Leistungssport*, 40 (5):36-42.

## PSYCHOBIOLOGICAL MARKERS OF STRENGTH TRAINING IMPACT IN YOUNG TENNIS PLAYERS

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**Introduction** Training load individual control and its effect on performance is one of the most important issues nowadays in the field of sport science (Borresen & Lambert, 2009). The aim of this study was to evaluate the individual capacity to respond or adapt to a strength training program based on maintenance of mechanical power rather than an absolute measure of changes in physiological variables that occur with training. **Methods** Ten young male tennis players (mean age: 15.60 ± 0.70) with no experience in strength training programs (STP) took part in this study. The intervention period was 6 weeks (2 d/w) where they worked a bench-press exercise with free weights and semi-squat in the Smith machine (steady load of 60% of the MDS). Before and after the intervention period, the players' upper and lower limb power was direct and indirectly assessed. During the study subjects completed a training diary that included these variables: hours of sleep, morning weight and heart rate, a muscle soreness scale, RPE and POMS. To determine testosterone (T) and cortisol (C) three saliva samples/week were collected, on the same day of the week at different hours: 8:00, 11:00 and 18:00. **Results** Statistical analysis was divided in 2 parts: a related samples t-test to the kinetic and dynamic variables, and an analysis of repeated measures for the biological and psychological training data diary. The t-test revealed that the STP significantly improved the CMJ in 15" (p<.05); maximum acceleration and strength in bench press (p<.01); maximum power, average power of the propulsive phase, and maximum speed in semi-squat (p<.05) and distance reached and output speed with medicine ball (p<.01). Repeated measures analysis showed an increase in muscle soreness (weeks 2-3, p=0.038; F=6,493) in RPE (weeks 3-4, p=0.027; F=7,822) in the tension subscale of POMS (weeks 4-5, p=0.025; F=8,018). Decreases were found in the total score of POMS (weeks 5-6, p=0.014; F=10,500), saliva T at 8.00 (weeks 5-6, p=0.042; F=5,609), saliva T at 11.00 (weeks 5-6, p=0.019; F=8,169) and T average day in saliva (weeks 5-6, p=0.026; F=7,077). There were no significant differences in saliva C. **Discussion** STP based on maintenance of mechanical power with training frequencies of 2 d/w, appear to be appropriate to improve some kinetic and dynamic variables (Legaz-Arrese et al., 2007). Moreover, some biological markers (T) and psychological (muscle soreness, RPE, tension subscale and total score of the POMS) seem to be sensitive to training load changes and record the impact in young tennis players. **References** Borresen J, Lambert M. (2009). *Sports Med*; 39 (9): 779-795. Legaz-Arrese, A., Reverter-Masía, J., Munguía-Izquierdo, D., y Ceballos-Gurrola, O. (2007). *J Sport Med Phy Fit*, 47, 427-436

## Poster presentations

### PP-PM15 Physiology: Bone and Muscle

## BONE QUALITY OF THE CALCANEUS IN YOUNG FEMALE GYMNASTS TRAINING ON HIGH VERSUS LOW IMPACT LOADING SURFACES

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**Bone quality of the Calcaneus in Young Female Gymnasts Training on High versus Low Impact Loading surfaces** Gerrits K.H.L., Crins M.H.P., Van der Eb J. and De Haan A. Research Institute MOVE, Faculty of Human Movement Sciences VU University Amsterdam, the Netherlands **Introduction.** Gymnastics is a demanding sport characterized by high volume loading and high impact loading of both the upper and lower extremities. High impact loading sports are associated with increased risk of injuries and stress fractures. Opposite, high impact loading is associated with higher bone health and higher values of bone quality compared to controls. The purpose of this study was to examine the differences in bone quality between young female gymnasts training on high versus low impact loading surfaces and age-matched control subjects. **Methods.** The local ethical committee approved this study The study included 82 young female

subjects; 18 gymnasts training on high impact surfaces (Hi-group), 26 gymnasts training on low impact surfaces (Li-group) and 38 age-matched control subjects. To determine bone quality, all subjects underwent Quantitative UltraSound (QUS) measurements of the calcaneus with use of the CUBAclinical (McCue CUBAclinicalTM, Contact Ultrasound Bone Analyser). The Broadband Ultrasound Attenuation (BUA), the Speed of Sound (SoS) and the stiffness index (SI) were determined as indices of bone quality. Before examining the effects of different impact loading surfaces on bone quality, the reproducibility of the apparatus was assessed. Results. This study showed that QUS measurements with use of the CUBAclinical are reproducible (ICC .72 - .99), and showed that SoS is influenced by activity shortly before the measurement. Besides, the present study showed that both the Hi-group and the Li-group had higher SoS ( $1685 \pm 32$  m/s and  $1664 \pm 22$  m/s respectively) and SI values ( $105 \pm 19$  and  $93 \pm 17$  respectively), compared to the control group ( $1614 \pm 27$  m/s,  $74 \pm 20$ ,  $P < 0.05$ ), indicating higher bone quality of the calcaneus of gymnasts compared to controls. Moreover, the Hi-group had higher SoS values than the Li-group ( $P < 0.001$ ). To correct for a possible influence of menarche on bone quality, each of the Hi-, Li-, and control group were separated into 2 groups with subjects who did menstruate and those who did not. As a result, differences in bone quality between gymnasts training on high versus low impact loading surfaces disappeared. These results suggest that possibly there is no effect of different degrees of impact loading on QUS parameters of the calcaneus in gymnasts. Conclusion. The present study shows that young female gymnasts have higher bone quality of the calcaneus than controls, suggesting that skeletal loading produces positive adaptive responses in the growing skeleton subjected to repetitive impact loading. Furthermore, the results of this study provide no evidence for a differential effect on these adaptive responses between subjects training on different impact loading surfaces.

### DOES PHYSICAL ACTIVITY INFLUENCE BONE STATUS IN PREPUBERTAL AGE?

BOSNYÁK, E., SZMODIS, M., FARKAS, A., TRÁJER, E., UDVARDY, A., KOMKA, ZS., PROTZNER, A., SZÓTS, G., TÓTH, M.

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Introduction Lifestyle, genetics and environmental factors are established determinants of bone density. The aim of this pilot study was to examine how the influence of football on bone tissue was reflected by the acoustic parameters of bone, measured by calcaneal quantitative ultrasound (QUS) at both heels, whether intensive training causes higher bone density even in childhood and to assess the correlation of stiffness index (SI) with activity level. Methods 78 prepubertal boys, members of a Hungarian football academy and 37 non-athletic controls participated in this pilot study. Calcaneal QUS parameters were examined with a Sonost 3000 bone densitometer. The measurements included speed of sound (SOS, m/s), broadband ultrasound attenuation (BUA, dB/MHz), and a calculated stiffness index (SI, %). Anthropometric data as body weight and height were recorded and body mass index was calculated (BMI, kg/m<sup>2</sup>). Statistical analysis was made by Statistica for Windows 9.0 software, linear correlation, Student t-test were used to compare the groups. Results The mean age of athletes was  $9.97 \pm 1.20$  years, while  $11.03 \pm 1.03$  in the control group. The means of BMI in the two groups were  $16.66 \pm 1.89$  vs.  $19.70 \pm 4.13$ , ( $p < 0.05$ ). Significant correlations were found comparing bone density values to the age in decimal years (SOS right side:  $0.38$ ; BUA right:  $0.28$ ; SI right:  $0.34$ ). Control group had significantly higher SOS values measured on the right heel, than those of the soccer players ( $1499.14 \pm 10.86$  vs.  $1493.31 \pm 10.7$ ,  $p < 0.05$ ). There was no difference between the two groups examining BUA on the right heel ( $75.54 \pm 11.47$  vs.  $71.83 \pm 11.25$ ). The mean SI on the right foot was  $47.58 \pm 9.70$ . Football academy children had significantly lower SI than control children ( $46.25 \pm 9.51$  vs.  $50.37 \pm 9.69$ ,  $p < 0.05$ ). The football players showed higher SOS on the right than on the left side, whereas the BUA differed the opposite way: the rates on the left side were slightly higher than on the right. There was no significant difference between the right and left foot of the soccer players' SI (SI right  $46.26 \pm 9.49$  and SI left  $47.17 \pm 9.93$ ). Discussion The result of the present study shows that no influence of physical activity is observed in prepubertal boys at bone status. Bone density of prepubertal boys is principally determined by the age, and not by the physical activity. Our aim is a longitudinal examination to observe if the high level of physical activity induce any improvement in bone density among the analysed sample. Future data will be required to support our expectations. References Holi MS, Radhakrishnan S, Swaranamani S, Jayavelan NA: Quantitative ultrasound technique for the assessment of osteoporosis and prediction of fracture risk. J Pure Appl Ultrason 2005, 27:55-60.

### A SURVEY OF BONE HEALTH OF PREMENOPAUSAL RUNNERS IN RECREATIONAL LEVEL FOCUSING ON UCOC, PHYSICAL FUNCTION AND NUTRITION

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Introduction Exercise and nutrition primarily play an important role in the strategy for reducing the risk of osteoporosis. Exercise has an anabolic effect to bone, and improves the bone strength indices of the femoral neck in children. Regarding nutrition, not only calcium and vitamin D but also vitamin K is known to be important nutritional elements for maintaining bone health. Vitamin K is a cofactor for  $\gamma$ -carboxylation of osteocalcin (OC). Under the vitamin K insufficiency, OC loses an ability to bind the mineral to hydroxyapatite, and then becomes undercarboxylated osteocalcin (ucOC), which is released into blood. Thus, vitamin K status in the bone can be evaluated by measuring the serum ucOC level. It has been reported that Vitamin K supplementation reduces the serum ucOC level, and improves the bone strength indices of the femoral neck in postmenopausal women. Therefore, we hypothesized that both vitamin K supplementation and exercise may contribute to improve bone metabolism and increase bone strength. In this study, a cross-sectional study was conducted to evaluate the relationships among ucOC, physical function and nutritional status of premenopausal runners in recreational level. Methods Forty-two premenopausal women (mean age: 37.9 years) who had habitual running activities at a recreational level (mean quantity: 26.7 km/week) were participated in the study. Serum ucOC was evaluated to assess vitamin K status in the bone. Serum OC and bone-specific alkaline phosphatase (BAP) as bone formation markers, and urinary levels of cross-linked N-terminal telopeptides of type I collagen (NTX) as a bone resorption marker, were also evaluated. Physical function parameters such as muscle strength, muscle power and aerobic capacity were measured and nutritional status was assessed using questionnaires. The relationships among variables were assessed by the Pearson's correlation coefficients focusing on ucOC. Results Significant negative correlations were found between ucOC and age ( $r = -0.415$ ), daily intakes of vitamin D ( $r = -0.425$ ) and vitamin K ( $r = -0.328$ ). Significant positive correlations were found between ucOC and OC ( $r = 0.742$ ) and BAP ( $r = 0.313$ ). However, no significant correlation was found between ucOC and physical function parameters. Discussion It was found that daily intakes of vitamins D and K and bone formation markers, but not physical function parameters, were relevant factors of vitamin K status, evaluated by ucOC, in the bone. These results suggest that age and vitamins D and K intakes may influence ucOC, and that vitamin K insufficiency may be related to an increased bone turnover. Vitamin K nutrition and physical function may independently contribute to bone health in different manners.



## BONE OSTEOGENIC RESPONSES IN SHORT-TERM RESISTANCE TRAINING UNDER HYPOXIA

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**Introduction & Purpose** It is widely known that physical training, such as jump and resistance training, increases BMC and BMD. However, as it takes several months to observe bone quantitative changes by training, there have been few studies that have investigated the effects of short-term training on osteogenic responses. In addition, previous studies reported that acidosis inhibited bone formation. Training under hypoxia induced higher lactate production, i.e. acidosis, compared to under normoxia. Therefore, we hypothesized that training under hypoxia had adverse effects on osteogenic responses. The purpose of this study was to investigate this hypothesis by short-term resistance training under hypoxia. **Methods** Subjects were 16 healthy male, and they were randomly divided into 2 groups; NT (normoxic training, n=7) and HT (hypoxic training, n=9). Subjects performed bench-press and leg-press, 10 time × 5 set for each at 70 % 1RM, 2 times/week for 8 weeks. HT group exercised in hypoxic training room (O<sub>2</sub> = 14.4%), and stayed under the condition for 1 h in each session. At pre and post training, BMD of whole body, neck and total proximal in right femur were measured by DXA. Additionally, at the first and last session, subjects had blood samplings taken at rest under normoxia, baseline, 0, 15, 30 and 60 minutes after training under their condition to analyze serum BAP, OC, ICTP, NTx, and plasma IL-6. All measurements were performed in the morning after overnight fast. Two-way ANOVA was used to examine the main effect and interaction. **Results & Conclusion** The body mass and lean body mass significantly increased in both groups with training. BMD of all sites did not change with training and hypoxia. The rest levels of BAP, OC, and ICTP at the last session were significantly higher than those at the first session, and NTx and IL-6 did not change. Additionally, though all parameters except for NTx at the first session showed significant changes over time, the patterns of changes were similar between the two groups in both training session. There were no significant hypoxia main effects in all parameters, and no significant interactions except for the change of OC at the last session. In conclusion, we demonstrated that short-term resistance exercise increased bone metabolic, especially bone formation though BMD did not change. Additionally, these results indicated that hypoxia did not affect osteogenic responses, contrast to our hypothesis.

## THE EFFECT OF ROWING ON BONE CONTENT REDISTRIBUTION

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**THE EFFECT OF ROWING ON BONE CONTENT REDISTRIBUTION** Mourtakos S.P, Kavouras S.A, Bardis K.N, Vasiliou S, Tenta R, Sidossis L.S, Laboratory of Nutrition & Clinical Dietetics, Department of Nutrition and Dietetics, Harokopio University, Athens, Greece **Introduction** The bone response to exercise is site-specific and load-dependent. There is also evidence that elevated levels of bone turnover markers in blood may be found in athletes compared to less active individuals (Maimoun et al., 2004). This research investigated the long term effect of rowing on bone density in elite rowers. **Methods** Forty men assigned into two groups of twenty. The first consisted of world class rowers, while the second of twenty active but no athletic men. Bone mineral density (BMD), body mineral content (BMC) and areal bone mineral density (aBMD) were measured by dual-energy X-ray absorptiometry (DXA). Blood samples were analyzed for bone turnover markers RANKL (Receptor Activator of NF-κB-Ligand) and OPG (Osteoprotegerin). **Results** The results, revealed no statistical difference in total bone density TBMD, total body mineral content TBMC and areal bone mineral density aBMD in most body parts between the elite level rowers and the control group. BMC Trunk (11.5%, p=0.02) and BMC Trunk/ TBMC ratio (6.1%, p=0.01), was statistically higher in rowers than in the control group while BMC legs/ TBMC ratio (3.7%, p=0.007) was statistically higher in the control group. Furthermore the bone turnover markers OPG (20.5%, p=0.03) and RANKL (80%, p=0.01) were statistically higher in rowers than in control group, while OPG/RANKL ratio (32.3%, p=0.01) was statistically higher in the control group. **Discussion** The current indicated that rowing exercise does not induce any significant increase in the TBMD. Nevertheless, rowing may increase BMD at site-specific bone areas (Magkos F., et al 2007). In particular, rowing is associated with an apparent redistribution of bone mass from the lower limbs to the trunk as also seen in other sports like water polo (Kavouras S.A., et al 2006). On the other hand, biochemical markers demonstrated that bone remodeling was more evident in rowers than in the control group. Even though the serum levels of both markers were higher in rowers, RANKL levels were found even higher, indicating substantial rates of bone resorption (Ziegler S., et al 2005, Jurimae J, et al 2006). **References** Jurimae J, Purge P, Jurimae T, von Duvillard SP. (2006). Eur J Appl Physiol, 97, 127-32. Kavouras SA, Magkos F, Yannakoulia M, Perraki M, Karipidou M, Sidossis LS. (2006). Eur J Appl Physiol 97, 316-21. Magkos F, Kavouras SA, Yannakoulia M, Karipidou M, Sidossi S, Sidossis LS. (2007). Clin J Sport Med, 17, 123-8. Maimoun L, Mariano-Goulart D, Couret I, Manetta J, Peruchon E, Micallef JP, Verdier R, Rossi M, Leroux JL (2004). J Sports Sci, 22, 875-883. Ziegler S, Niessner A, Richter B, et al. (2005). Metabolism, 54, 935-8.

## VISUALIZATION FOR ANATOMICAL AND PHYSIOLOGICAL CHARACTERISTICS OF ACTIVE MOTOR UNITS BY SIMULATION AND INVERSE ANALYSIS OF SURFACE MUAPS

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**Introduction** In order to investigate the activity of motor units (MUs) recorded with non-invasive surface EMG method during muscle contraction, we must calculate the surface-EMG-variables such as averaged rectified value, median frequency and muscle fibre conduction velocity (MFCV) from the surface EMGs. These calculation methods supply indirectly the information about the averaged tendency of activities of many MUs, but can not reveal the anatomy and physiology of active MUs recruited during the muscle contraction. In this study, we tried to construct the procedure that could visualize the information about anatomy and physiology of active MUs recruited during muscle contraction. **Methods** The procedure in this study consisted of three parts. First was the part in which the parameters such as location and strength of current source, firing time and MFCV were estimated from measured surface motor unit action potentials (MUAPs) through the inverse analysis. Second was the part which reproduced the surface MUAP train by using the parameters estimated in the first part and the surface MUAP model. The last part was for comparison between measured surface MUAPs and surface MUAPs reproduced in second part. This study used alternative surface MUAPs generated with simulation as measured surface MUAPs which were needed in the first part. The surface MUAP trains were simulated with one to ten models of MUs which were defined about size, depth of centre, current strength, fibre density, muscle fibre conduction velocity and firing rate. **Results and Discussion** In this study, cross correlation coefficients (CC) were used for comparison between alternative surface MUAP trains and reproduced surface MUAP trains. For example, in the case of using one MU model whose size, depth of centre, number of muscle fibres, fibre density and firing rate were 2.0 mm, 6.0 mm, 20 fibres, 6.8 fibre/mm<sup>2</sup> and 20 Hz respectively, CC between the alternative MUAP train and the reproduced MUAP

train was 0.980. The MUAP train was reproduced by MU model whose depth of centre, current strength and MFCV were 5.0 mm, 2.51 nAm and 4.034 m/s, respectively. In the case of using two MUs model, the CC declined to 0.958 with influence of another MU. The possibility of visualization of the anatomical and physiological information for active MUs was shown under the condition of a few MUs recruited. The issues that this system can reveal how many MUs active and the methods how to separate activities of those MUs are still open. References Farina D. et al. (2002). *Biol. Cybern.*, 86, 445-456. De Luca C.J. et al. (2006). *J. Neurophysiol.*, 96, 1646-1657. Keenan K.G. et al. (2006). *J. Appl. Physiol.*, 100, 1928-1937.

### IS THE USE OF ULTRASOUND-DERIVED PREDICTION EQUATIONS FOR ADULTS USEFUL FOR ESTIMATING TOTAL AND REGIONAL SKELETAL MUSCLE MASS IN JAPANESE PREPUBERTAL CHILDREN?

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**Introduction** Skeletal muscle (SM) mass has been used as a very important index for predicting exercise performance and estimating nutritional status during different growth stages. However, there are very few effective field methods to accurately and non-invasively estimate SM mass in children. Recently, we have developed ultrasound-derived prediction equations for estimating total and regional (i.e. arm, trunk, thigh and lower leg) SM mass in adult males and females (Sanada et al. 2006). Ultrasound itself is a non-invasive, safe measure of muscle thickness of the extremities and trunk in children. However, it is unknown whether these adult based equations, which include height and muscle thicknesses, are a valid method to estimate SM mass in children. Thus, the purpose of the present study was to investigate the validity of the adult based equations for total and regional SM mass in Japanese prepubertal children. **Methods** A total of 91 healthy Japanese prepubertal children aged 6-12 years participated in this study (46 boys and 45 girls). Contiguous MRI images with a 1-cm slice thickness were obtained from the first cervical vertebra to the ankle joints as reference data. The SM volume was calculated from the summation of digitized cross-sectional areas. The regional SM volume was determined by anatomical landmarks visible in the scanned images. The volume units were converted into mass by an assumed SM density (1.041g/cm<sup>3</sup>). Muscle thickness was measured by B-mode ultrasound at 9 sites on different muscles (lateral forearm, anterior and posterior upper arm, abdomen, subscapular, anterior and posterior thigh, anterior and posterior lower leg). **Results** When total and regional SM mass were estimated using adult prediction equations, mean values between measured and predicted total and regional segments of SM mass were significantly different for prepubertal children except for the thigh segment for boys. **Conclusion** These results suggest that the adult ultrasound-derived prediction equations are limited availability in prepubertal children. Therefore, a larger study for developing a SM mass prediction model is needed in prepubertal children. **Reference** Sanada K, Kearns CF, Midorikawa T, Abe T. (2006) Prediction and validation of total and regional skeletal muscle mass by ultrasound in Japanese adults. *Eur J Appl Physiol* 96, 24-31.

### STUDY OF BONE AMMOUNT IN FEMALE STUDENTS-A LOOK AT THE RELATIONSHIP AMONG NONE AMOUNT, HIP-JOINT MUSCLE STRENGTH, AND PHYSICAL ACTIVITY-

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**Intoroduction:**This study investigated the bone amounts and exercise levels of female students and examined the data based on statistical analysis. It produced some interesting findings concerning the relationship between bone amount and exercise. **Method:**The subjects (female students) were surveyed with respect to the following factors: body measurements, daily activity, bone amount, and hip joint muscle strength. The data obtained were then statistically analyzed. **I Measuring instruments:** (1) Ultrasound bone densitometer, (2) body composition scale, and (3) hip joint muscle strength measuring instrument. **Results:**The subjects were examined as to their physical characteristics,daily activities,bone amount ,and hip-joint muscle strength. The data obtained were used coefficients to carry out various statistical analyses. The analyses. resulted in the following findings:1)The correlation anlysis showed a significantly positive correlation between bone area ratio and the hip-joint abductor strength( $r=.55, p<.01$ ). 2)In the variance analysis, there was a tendency for the abductor strength of subjects who used to play sports in school to be higher on average, among subjects with a very high or very low level of satisfaction with their walking distance and among subjects with particularly high bone amount. However, only the results obtained from subjects with a very low level of satisfaction with their walking distance were statistically significant. 3)In the cluster and cross-sectional analyses, the 39 subjects could be divided into three groups: those with low muscle strength and low bone amount(26 subjects), those with high adductor strength(8 subjects), and those with high abductor strength and high bone amount (5 subjects). No significant variance was seen among the three groups in regard to the proportion of subjects who used to play sports in school. However, four out of the five subjects with high abductor strength and high bone amount used to play sports in school. The ratio is far higher than the comparable ratio for all subjects combined(38.5%). 4)Combining the results of the above three sets of analysis, it was found that there is a close correlation between bone amount,physical activity, and muscle strength. **Discussion/Conclusion:**If exercise is necessary to increase bone amount, and if sufficient bone amount is necessary to improve motor ability and muscle strength, physical education instructors may need to maintain a stronger awareness of the importance of diet, which supports the development of bones and the overall body. In addition to providing better coaching to students on skills and training, it may be necessary to provide guidance on diet while seeking the cooperation of experts in the field. **References:**Yamamoto Tadahiro et al(2008)Research about the masurement of the torque - Comparison of Hip-and Elbow-Joint Muscle Strength Measurements, The12th Annual Congress of the EUROPEAN COLLEGE OF SPORT SCIENCE ,Estoril

### LONGITUDINAL CHANGES IN BONE MASS IN ADOLESCENT CYCLISTS.

GUILLÉN-BALLESTER, A., OLMEDILLAS, H., GONZÁLEZ-AGÜERO, A., GÓMEZ-CABELLO, A., BUENO-FENERO, S., MORENO, L.A., CASAJÚS, J.A., VICENTE-RODRÍGUEZ, G.

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Longitudinal changes in bone mass in adolescent cyclists. Guillén-Ballester Aab, Olmedillas Hab, González-Agüero Aab, Gómez-Cabello Aab, Bueno-Fenero Sd, Moreno LAac , Casajús JAab and Vicente-Rodríguez Gab a GENUD "Growth, Exercise, NUtrition and Development" Research Group. Universidad de Zaragoza, Spain. b Faculty of Health and Sport Science (FCSD), Department of Physiotherapy and Nursing. Universidad de Zaragoza, Ronda Misericordia 5, 22001-Huesca, Spain. c School of Health Science (EUCS). Universidad de Zaragoza, C/ Domingo Miral s/n, 50009-Zaragoza, Spain. dHospital Clínico Universitario Lozano Blesa. (Zaragoza) Servicio Cirugía B

**Introduction:** Adolescence is a critical period to improve bone mass and conserve it for lifelong (1). Cross-sectional studies have shown that professional cyclists had low bone mineral density (BMD) (2), which has also seen to decrease during one year of cycling in adults (3). Therefore, the aim of this study was to analyze the changes in bone mass during a one year season of cycling training in adolescence. **Methods:** A total of 16 male adolescents [9 cyclists and 7 controls;  $15.8 \pm 1.4$  years (mean  $\pm$  SD)] participated in this study. The cyclists trained as a mean 14 h/week. Control group continued with their usual activities. Bone mineral content (BMC), BMD and area were determined in the whole body, lumbar spine, hip and hip subregions by dual-energy X-ray absorptiometry (DXA). Two-way repeated-measures ANOVAs were used to evaluate differences in BMD and BMC, adjusted for age and changes in height, lean mass. **Results:** Cyclists were lighter and had less lean and fat masses than the controls at the baseline and after one season period (all  $p \leq 0.05$ ). At initial, cyclists had lower levels of BMC at whole body, pelvis, lower extremities and femoral neck; lower BMD at pelvis, lower extremities and hip; and lower area at whole body and lower extremities (all  $p \leq 0.05$ ). From pre- to off cycling season cyclists increased significantly less the BMC at whole body, pelvis, lower extremities; the BMD at pelvis, lower extremities; and the area at the pelvis (all  $p \leq 0.05$ ). **Discussion:** Adolescent cyclists had lower BMC, BMD and area than normo-active counterparts, also showing decreased bone mass accumulation. Cycling participation during adolescence may negatively affect bone health, involving peak bone mass acquisition. **Acknowledgements:** Funding by Ministerio de Ciencia e Innovación, Instituto de Salud Carlos III (DPS2008-06999) and Presidencia del Gobierno de España, Consejo Superior de Deportes (21/UPB20/10). **REFERENCES** 1. Vicente-Rodriguez G. How does exercise affect bone development during growth? *Sports Med.* 2006;36(7):561-9. 2. Campion F, Nevill AM, Karlsson MK, Lounana J, Shabani M, Fardellone P, et al. Bone status in professional cyclists. *Int J Sports Med.* Jul;31(7):511-5. 3. Barry DW, Kohrt WM. BMD decreases over the course of a year in competitive male cyclists. *J Bone Miner Res.* 2008 Apr;23(4):484-91.

### WEAK BONE STRUCTURE IN ADOLESCENT CYCLIST

GUILLÉN-BALLESTER, A., OLMEDILLAS, H., GONZÁLEZ-AGÜERO, A., GÓMEZ-CABELLO, A., BUENO-FENERO, S., MORENO, L.A., CASAJÚS, J.A., VICENTE-RODRÍGUEZ, G.

UNIVERSIDAD DE ZARAGOZA

**Weak bone structure in adolescent cyclists.** Guillén-Ballester Aab, Olmedillas Hab, González-Agüero Aab, Gómez-Cabello Aab, Bueno-Fenero Sd, Moreno LAac, Casajús JAab and Vicente-Rodríguez Gab a GENUD "Growth, Exercise, Nutrition and Development" Research Group. Universidad de Zaragoza, Spain. b Faculty of Health and Sport Science (FCSD), Department of Physiotherapy and Nursing. Universidad de Zaragoza, Ronda Misericordia 5, 22001-Huesca, Spain. c School of Health Science (EUCS). Universidad de Zaragoza, C/ Domingo Miral s/n, 50009-Zaragoza, Spain. dHospital Clínico Universitario Lozano Blesa. (Zaragoza) Servicio Cirugía B Aim: Determine the status of bone structure in adolescent male cyclists. **Methods:** nineteen male adolescents (9 cyclists and 10 controls),  $15.8 \pm 1.4$  years old (mean  $\pm$  SD) voluntarily participated in this study. The cyclists group trained at a mean of 7 hours per week for ~3 years. Maximum oxygen uptake, ( $\text{VO}_2\text{max}$ ) was measured in a maximal cicloergometric test. Peripheral quantitative computed tomography (pQCT) was used to analyze the total bone mineral content (TotC), volumetric density (TotD) and area; trabecular and cortical density and area; and cortical thickness and bone/muscle ratio at the diaphysis and epiphysis of tibia and radius. **Results:** cyclists had higher  $\text{VO}_2\text{max}$  than controls ( $59.7 \pm 8.9$  vs.  $48.0 \pm 8.9$  ml/kg/min,  $p < 0.05$ ). Cyclists showed a 25% less TotC, 11.5% lower TotD and 14% lower trabecular density at the diaphysis of the tibiae compared to controls (all  $p < 0.05$ ). Similarly, cyclists exhibited lower cortical area (18%), cortical density (1.8%), and cortical thickness (17.9%); with a bone-muscle ratio 1 point of percentage lower than the control group (all  $p < 0.05$ ). No significant differences were found at the radius except for bone-muscle ratio, which was 0.6 points of percentage lower than in controls ( $p < 0.05$ ). **Conclusion:** these results suggest that cycling during adolescence may be associated with low bone mineral content and density and weaker bone structure compared to adolescents who do not practice cycling. This may negatively affect peak bone mass development and increase the risk of bone fracture later in life. **Funding** This study has been funded by Ministerio de Ciencia e Innovación, Instituto de Salud Carlos III (DPS2008-06999) and Presidencia del Gobierno de España, Consejo Superior de Deportes (21/UPB20/10).

### IMPACT OF PHYSICAL FITNESS ON BONE DENSITY IN A FEMALE GREEK ADOLESCENT POPULATION

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1:1ST DEPARTMENT OF PEDIATRICS, ATHENS UNIVERSITY, AGIA SOPHIA CHILDREN'S HOSPITAL, CENTRE FOR HEALTH AND PREVENTION IN ADOLESCENCE; 2: FACULTY OF PHYSICAL EDUCATION & SPORTS SCIENCES, UNIVERSITY OF A

**Introduction** Although peak bone mass is 60% to 85% is genetically determined (Ralston H.S., 2007), environmental and lifestyle factors such as physical activity, have a great impact and they should not be ignored in the prevention and management of osteoporosis, as they are the ones that can be truly modified even since adolescent years. The purpose of this study was to determine the effect of several parameters of physical fitness on total hip bone density in a Greek female adolescent population (Vaughn EJ et al., 2009). **Methods** Sixty healthy female adolescents with a median age of 13.70 (12.00, 15.80) years, recruited at the Centre for Health and Prevention in Adolescence of the 1st Department of Pediatrics, of Athens University, were included. Bone mineral density (BMD) was measured at the upper femur by Dual-Energy X-ray Absorptiometry (DEXA). The European physical fitness test battery (EUROFIT) was used for the assessment of physical fitness parameters (flexibility, explosive and static strength, trunk strength and cardio respiratory endurance). Anthropometric measurements such as: height, weight, Body Mass Index (BMI), and % body fat were also included. Statistical analysis was performed by using the statistical package Stata 10.1. Statistically significant were considered all the results with a two sided  $p < 0.05$ . **Results** Adolescent girls had a mean ( $\pm$  SD) BMD values at the upper femur of  $0.947 \pm 0.144$  g/cm<sup>2</sup>. BMD of the upper femur was positively correlated to weight, height, body mass index (BMI), sum of Skinfold thickness and handgrip strength. Body fat percentage and lean mass were also correlated to higher BMD. There was a negative correlation between  $\text{VO}_2\text{max}$  and BMD. Handgrip strength, BMI and the hours that adolescents devoted to regular exercise were positive and independent predictive factors of bone density. **Discussion** Physical fitness status is an indicator of good health and certain parameters of physical fitness are related to bone health. Such parameter is strength which seems to have predictive value for bone mineral density in female adolescents (Vicente-Rodriguez G. et al., 2008). It is of great importance to specify if these parameters can be used for the early detection of those adolescents with potential risk of osteoporosis later in their life. **References** Ralston HS. (2007), *Proc Nutr Soc.*; 66(2): 58-65. Vicente-Rodriguez G, Urzanqui A, Mesana MI, Ortega FB, Ruiz JR, Ezquerro J, Casajús JA, et al. (2008), *J Bone Miner Metab*; 26: 288-294. Vaughn EJ, Lam MA, Hawker GA, McGowan J, Papaioannou A, Cheung AM, et al. *Osteoporos Int.* 2009; 20: 1-21.

## COMPARABLE EFFECTS OF SLOW RESISTANCE TRAINING AND BRISK WALKING ON BODY COMPOSITION AND BONE HEALTH STATUS IN YOUNG ADULT WOMEN

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**Introduction** Regardless of age or gender, children and adults who maintain an active lifestyle have significantly greater body composition and bone mass than sedentary counterparts. The aim of this study is to assess the effects of resistance training (RT) and walking exercise (WK) on body composition, bone and mental health status in sedentary young adult women. **Methods** Thirty-two subjects (Mean age 20.8 yrs.) were divided into RT group (n=12), WK group (n=13) and control group (CN; n=7). RT group trained four exercises (squat, bent-leg sit-ups, push-up, back extension) using body weight as a load, with slow maneuver four times per week. WK group instructed to wear a pedometer, and walked briskly, more than 10,000 steps a day four times per week. We evaluated body composition, bone status (ultrasound parameters of the calcaneus and urinary deoxypyridinoline (DPD) levels), and mental health parameters, at baseline and after 12 weeks of training session. **Results and Discussion** RT group showed significant changes in fat mass, waist, hip, thigh and upper arm circumferences, and triceps, abdominal and thigh thickness. WK group showed significant changes only in thigh circumference, and abdominal and thigh subcutaneous fat thickness. RT group showed significant changes in ultrasound parameters, such as speed of sound and stiffness. WK group showed small changes in these three items, but the changes were not significant. There was a significant decrease in DPD only in RT group. A significant improvement in RT group was seen in regard to subjective health, everyday feelings, human relations and subjective happiness. The subjective health and subjective happiness increased significantly in WK group. CN group shows no significant changes in any measurements. **Conclusions** It suggest that slow resistance training using body weight as a load was effective to improve body composition and bone health status, and that it is an available method for improving mental health parameters, such as subjective health and life satisfaction, in which resistance training indicated different changes from walking exercise.

## Poster presentations

### PP-PM16 Physiology: Respiratory

#### EFFECT OF ACUTE SPRINT INTERVAL EXERCISE ON POST-EXERCISE OXYGEN UPTAKE, SUBSTRATE METABOLISM AND BLOOD PRESSURE

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**Introduction** Recent data suggest sprint interval exercise may improve metabolic and vascular risk factors in both normal-weight (Rossow et al., 2010) and overweight (Whyte et al., 2010) individuals with some of the benefit coming from acute rather than training effects. We aimed to examine the effect of acute sprint interval exercise on post-exercise oxygen uptake, substrate metabolism and blood pressure. **Methods** Following ethical approval, eight healthy males (aged  $23.2 \pm 1.2$  y, height  $1.73 \pm 0.07$  m, body mass  $68.5 \pm 9.5$  kg, mean  $\pm$  SD) completed two trials, exercise and control, in a random balanced order. On the exercise trial participants reported to the laboratory at 0830 after a 10-h overnight fast. After 15-min of seated rest each participant performed four 30-s maximal sprints on a cycle ergometer against a resistance equivalent to 6.5% of their body mass. Each sprint was separated by 3-min of active recovery and 1.5-min of passive recovery. Upon completion of the fourth sprint participants were seated in a chair to recover for 2-h. Measurements of oxygen uptake and respiratory exchange ratio (RER) were made continuously for 15-min at baseline and for 2-h post-exercise via a metabolic cart. Blood pressure was measured at baseline and 0, 15, 30, 60, 90 and 120-min post-exercise. On the control trial participants rested in the laboratory with oxygen uptake, RER and blood pressure measured at corresponding times. Baseline measurements were compared between trials using paired t-tests. Two-way ANOVA (repeated measures) was used to determine differences between trials and over time in post-exercise oxygen consumption, RER and blood pressure. Data are mean  $\pm$  SD. **Results** No differences were seen in oxygen uptake, RER or blood pressure at baseline. Oxygen consumption was significantly higher post-exercise than control (exercise:  $45.9 \pm 7.2$  L vs control:  $30.9 \pm 5.5$  L, main effect of trial,  $P < 0.001$ ) with the elevation in oxygen consumption lasting for 30-mins post-exercise (trial  $\times$  time interaction,  $P < 0.001$ ). The RER was significantly raised immediately after exercise but was lower on exercise than control from 30-90-min (trial  $\times$  time interaction,  $P < 0.001$ ). Systolic blood pressure was elevated immediately post-exercise but was significantly decreased on the exercise trial compared with control from 60-120-min post-exercise (trial  $\times$  time interaction,  $P < 0.001$ ). **Discussion** These data demonstrate potential for sprint interval exercise to be considered as an intervention in obesity management and for the prevention of high blood pressure in adults. **References** Rossow L, Yan H, Fahs CA, Ranadive SM, Agiovlaitis S, Wilund KR, Baynard T, Fernhall B (2010). Am J Hypertens. 23:358-367. Whyte LJ, Gill JMR, Cathcart AJ (2010). Metabolism. 59:1421-1428.

#### SIGNIFICANT RELATIONSHIP BETWEEN SLOW COMPONENT OF OXYGEN UPTAKE KINETICS AND PULMONARY GAS EXCHANGE VARIABLES DURING INCREMENTAL EXERCISE

JEON, Y.1, IM, J.2, KANG, Y.3, KIM, D.4, AHN, M.5, KIM, C.6, KIM, B.7

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**Introduction** : The objects of this study were (1) to confirm the correlation between the  $\Delta VO_2$  (6th-3rd min) value as a  $VO_2$  slow component and other pulmonary gas exchange variables such as  $VO_{2max}$ ,  $VO_2$  at MRT and  $VO_2$  at AnT, and (2) to obtain the linear regression equation for  $VO_{2max}$  by using  $VO_2$  slow component. **Methods** : Thirty college students performed incremental exercise on treadmill until exhaustion by Bruce protocol. Respired gas fractions at the mouthpiece were continuously measured by mass spectrometry breath-by-breath. **Results** : We verified that the  $\Delta VO_2$  (6th-3rd min) as a  $VO_2$  slow component is closely correlated with  $VO_{2max}$  ( $r = 0.890$ ;  $P < 0.01$ ),  $VO_2$  at MRT ( $r = -0.824$ ;  $P < 0.01$ ),  $\Delta VO_2$  (End of exercise (EE)-6th min) ( $r = -0.821$ ;  $P < 0.01$ ),  $\Delta VO_2$  (EE-3rd min) ( $r = -0.695$ ;  $P < 0.01$ ), and  $VO_2$  at AnT ( $r = -0.688$ ;  $P < 0.01$ ), having inverse proportional relationship. The  $VO_{2max}$  could be estimated with a linear regression analysis;  $[VO_{2max} = -0.049 \times (VO_2 \text{ slow component}) + 68.593, SEE = \pm 2.48, r = -0.890]$ . Other linear regression equations of variables were also gained;  $[VO_2 \text{ at MRT} = -0.041 \times (VO_2 \text{ slow component}) + 52.039, SEE = \pm 2.72, r = -0.824]$ ,  $[\Delta VO_2 \text{ (EE-6th min)} = -3.034 \times (VO_2 \text{ slow component}) + 2769.847, SEE = \pm 205.31, r = -0.821]$ ,  $[\Delta VO_2 \text{ (EE-3rd min)} = -2.034 \times (VO_2 \text{ slow component}) + 2769.847, SEE = \pm 205.31, r = -0.695]$ , and  $[VO_2 \text{ at AnT} = -0.028 \times (VO_2 \text{ slow component}) + 43.222, SEE = \pm 2.87, r = -0.688]$ . **Discussion** : We conclude that the  $VO_2$  slow

component could be the important variable of regression analysis of VO<sub>2</sub>max. The association between VO<sub>2</sub> slow component and VO<sub>2</sub>max can be better predictive of aerobic performance than VO<sub>2</sub>max alone. Also, we can find out the physiological mechanism of VO<sub>2</sub> slow component through exploring the physiological relationship between VO<sub>2</sub> slow component and pulmonary gas exchange variables that have strong correlation with VO<sub>2</sub> slow component.

### ARE STRENGTH AND PULMONARY PARAMETERS RELATED TO SEASONAL PERSONAL BEST IN ELITE YOUTH ROWERS?

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**INTRODUCTION:** Ergometer rowing has widely been used in training and preparation of athletes for many years. By the use of spirometric devices with these rowing ergometers a more detailed analysis of performance during their career becomes possible. Further, measuring the development of strength is an essential part of screening the training progress of youth and elite athletes. We hypothesized that the performance on the water of an athlete is correlated with his strength and his pulmonary conditions. To test this hypothesis elite youth rowers of the North Rhine-Westphalia (NRW) squad were tested. **METHODS:** 30 rowers (18 male and 12 female) of the NRW youth squad ( $16.7 \pm 0.9$  yrs;  $184.5 \pm 7.7$  cm;  $78.1 \pm 9.0$  kg) participated in the study. 20 of them took part in international competitions in the last year prior to the study. The athletes performed a ramp test protocol on an indoor rowing ergometer (Concept 2, Model D) to measure VO<sub>2</sub>max (nSpire, Zano 600). The intensity of the first step were oriented to the personal best of the athlete. The first step lasted 2min. After the initial step the resistance was increased by 30 Watt every 30 s until exhaustion. Additionally the maximal isometric and dynamic strength for the m. latissimus dorsi and the m. quadriceps femoris were measured. **RESULTS:** The mean value of rel.VO<sub>2</sub>max was 58.5 ml/kg/min (range 42.2 – 72.2). Rel.VO<sub>2</sub>max as well as the peak power output achieved during the ramp test on the ergometer showed positive significant correlations with the seasonal 500m personal best (pb) (rel.VO<sub>2</sub>max vs. pb:  $p < 0.003$ /  $r = 0.55$ ; PPO vs. pb:  $p < 0.001$ /  $r = 0.92$ ). The isometric and the dynamic strength of the two muscles measured showed significant correlations with the seasonal 500m pb as well (lat.: dyn/iso vs. pb:  $p < 0.001$ /  $r = 0.78$ /  $0.82$ ; quadr.: dyn/iso vs. pb:  $p < 0.001$ /  $r = 0.84$ /  $0.68$ ). **DISCUSSION:** We could show that the correlation between rel.VO<sub>2</sub>max determined on a common rowing ergometer and the performance on the water is on a high level. Vogler et al. (2010) support our results indicating that ergometer rowing simulates rowing on the water on a very high level regarding the used energy systems during maximal and submaximal rowing. The high correlation between the seasonal 500m pb and the results of the isometric and the dynamic strength of the two most important muscles during rowing show that screening these strength conditions could help to increase performance of the athlete and should be taken into account during testing procedures. **REFERENCES** Vogler AJ, Rice AJ, Gore CJ. Physiological responses to ergometer and on-water incremental rowing tests. *Int J Sports Physiol Perform.* 2010 Sep;5(3):342-58.

### THE INFLUENCE OF TRAINING WITH REDUCED BREATHING FREQUENCY ON PERFORMANCE WITH THIS KIND OF BREATHING AND ON CO<sub>2</sub> SENSITIVITY

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**Introduction** Due to simple regulation of breathing during exercise, reduced breathing frequency (RBF) has been often used during regular swimming training since 1970's. Most of previous studies investigated the acute effects of RBF during exercise. According to our knowledge only one study has examined the influence of training with RBF. Kapus et al. (2005) obtained that swimmers decreased their breathing frequency during a maximal 200 meters front crawl with an optional breathing pattern, due to four weeks of the training with RBF (taking a breath every fourth stroke cycle during front crawl swimming). However, the mechanisms responsible for this training adaptation have been still unclear. Therefore, the purpose of the study was to examine the influence of training with RBF on ventilation during exercise with RBF and on ventilatory sensitivity to inhaled CO<sub>2</sub>. **Methods** Cycle ergometry was used for testing and training. RBF was defined as 10 breaths per minute and was regulated by a breathing metronome. Before and after six weeks of training (three training sessions per week) twelve healthy male subjects (average: age 24, height 180, weight 79, Vo<sub>2</sub>peak 43.3 ml\*kg<sup>-1</sup>\*min<sup>-1</sup>) performed: 1) incremental test with spontaneous breathing (SB) and with RBF to obtain peak power output (PPO) in both breathing conditions (PPOSB and PPORBF), 2) constant test at 50 W with breathing ambient air and hypercapnic gas mixture (3% carbon dioxide, 21% oxygen and 76% nitrogen) to determine CO<sub>2</sub> sensitivity. Subjects were randomly assigned to two groups: experimental (the E group) and control (the C group). At each interval training session subjects in the E group completed from two to eight intervals with RBF of duration equal to 60% and 75% of T<sub>max</sub> (time to exhaustion at PPORBF). The C group performed similar interval set, however, with SB and at PPOSB. Results Both groups increased PPORBF (the E group:  $42 \pm 11$  %, the C group:  $11 \pm 9$  %). However, these improvements were significantly greater in the E group than the C group. Furthermore, the E group had significantly higher peak values of VE ( $39.24 \pm 4.55$  vs.  $28.29 \pm 5.61$  l/min) obtained during incremental test with RBF and lower CO<sub>2</sub> sensitivity ( $18.16 \pm 13.23$  vs.  $31.46 \pm 21.56$  l/min\*kPa) after the training in comparison with pre-training conditions. There were no significant training effects on these parameters at the C group. **Discussion** The results of the present study indicated that the training with RBF increased VE during the exercise with this kind of breathing and decreased sensitivity to higher CO<sub>2</sub>. Both adaptations could be the reasons for greater improvement in PPORBF in the E group in comparison with the C group. **References** Kapus J, Ušaj A, Kapus V, Štrumbelj B. (2005). *KinSi*, 11, 17-24.

### AN INVESTIGATION OF THE ENDOGENOUS COMPONENT OF THE CIRCADIAN VARIABILITY OF MUSCLE FORCE.

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**Introduction:** Previous findings of time-of-day differences in muscle force output could be confounded by diurnal fluctuations in environmental and behavioural 'masking' factors such as prior sleep, time awake, ambient temperature and energy intake. The purpose of this study was to examine whether there is a circadian rhythm in muscle force that is independent of these masking factors. **Methods:** Ten male trained individuals were assessed for 24-h consecutively in the laboratory. The participants followed a 6-h 'ultra-short' sleep-wake cycle (2-h of sleep in darkness and 4-h of wakefulness in dim light). This protocol distributes behavioural and environmental masking factors equally across the 24-h period and reduces effects due to time awake. After 90-min of each 240-min wake period, participants consumed a standardised meal (~500 Kcal) so that the daily energy intake on test days was controlled (~2500 Kcal). There were four experimental sessions (at 09:00, 15:00, 21:00 and 03:00 h), administered in a counter-balanced design to minimise any learning effects, and there were 72 hours between each trial. Core body temperature was measured rectally, and Perception of Mood State (POMS) questionnaires were completed during each experimental session. The performance measures employed were Biodex isokinetic dyna-

ometry (flexion and extension at 60 and 240° s<sup>-1</sup>) and maximal contractions via isometric percutaneous stimulation of the quadriceps muscles (eight single square-wave electrical impulses, 100  $\mu$ s, over an 8s sampling period, two impulses delivered before and after the contraction with four impulses delivered during contraction). Muscle temperature was taken after the 5 minute warm-up, prior to the isokinetic dynamometry and then prior to the maximal isometric contractions. Data were analysed by cosinor analysis and analysis of variance models. Results: Rectal and muscle temperatures showed significant circadian rhythms ( $P < 0.0005$ ) with acrophases at 16:37 h and 15:31 h, respectively, this is the first time that a circadian rhythm for muscle temperature has been observed. There was a significant time-of-day effect for the POMS variables fatigue and vigour ( $P < 0.05$ ); vigour, which paralleled the rhythm of core temperature, showed an inverse profile to that of fatigue. Discussion: Participants were able to muster physical efforts that were similar to those produced when fatigue was perceived to be less. However, the main finding of this study was that circadian rhythms of the investigated measures of muscle force were weak ( $P > 0.05$ ). Since this protocol minimised fatigue related to time awake, we conclude that conventionally-measured circadian rhythms of muscle force might be considerably influenced by time-awake effects.

### STABILITY OF RATING OF PERCEIVED EXERTION AT LACTATE THRESHOLD

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**Introduction** The sensation of physical effort has been tried to be quantified in a number of ways. The scales developed by Gunnar Borg have been widely used for recording perceived physical exertion under different conditions (Noble and Robertson, 1996; Borg and Borg, 2002). The lactate threshold is an entity for intensity description that is used much, and the rating of exertion at this point has been investigated by several researchers (Noble and Robertson, 1996). However, is this rating stable if another protocol was to be used? Therefore the purpose of this study was to investigate how stable the rating would be if the protocol for reaching the threshold point was manipulated. **Methods** 20 trained subjects participated, mean (range) age 40 (24 to 65 yr). Firstly they performed a standard threshold test, warming up at 1.67 m/s for 10 min, then increasing the speed every 5th minute with 0.42 m/s. This test was extended until voluntary exhaustion for recording of maximal oxygen uptake. After the threshold speed had been calculated, the subjects performed two tests in random order; a short protocol that brought them up to their threshold speed in 15 min (3 steps) and a long protocol of 30 min duration (six steps). At each stage rating of perceived exertion (RPE), oxygen uptake and heart rate were recorded. Mean differences were analysed with paired t-tests. Level of significance was set to  $p \leq 0.05$ . **Results** RPE scores differed significantly between the short and the long protocol: mean (95% confidence interval) 13.2 (12.6–13.9) vs. 14.0 (13.3–14.7),  $p < 0.04$ , despite that oxygen uptake: 43.2 ml/kg/min [32.1  $\mu$ mol/kg/s] (41.9–44.5 ml/kg/min) vs. 44.6 ml/kg/min [33.2  $\mu$ mol/kg/s] (43.5–45.7 ml/kg/min), heart rate: 157 beats/min (154–160) vs. 160 beats/min (156–164), lung ventilation: 82.9 L/min (77.5–88.3) vs. 79.7 L/min (73.2–86.2) and breathing frequency: 0.72 Hz (0.67–0.77) vs. 0.72 Hz (0.67–0.77) being equal in the two protocols. Significant correlations ( $p < 0.05$ ) were found between percentage of maximal RPE and both the percentage of maximal pulmonary ventilation ( $r = 0.91$ ) and percentage of maximal breathing frequency ( $r = 0.80$ ). **Discussion** The findings indicate an effect of duration on the subjective sensation of effort also in step protocols. The longer protocol allowed for more heat to accumulate, and the time spent near the threshold velocity was longer due to the smaller increases in velocity of that protocol. Such factors may be important for the sense of effort. Lung ventilation and breathing frequency was strongly correlated with RPE, and with a longer time with elevated respiration, the perceived effort increased. This is important knowledge when designing training programmes based on RPE scores, as even small differences in RPE might give critical differences in intensity. **References** Borg, E, Borg, G. *Acta Psychol (Amstl)*. (2002).109, 157-175. Noble, BJ, Robertson, RJ. *Perceived Exertion*. (1996).*Human Kinetics: Champaign*, p. 272.

### VARIATIONS OF PERCEIVED EXERTION IN RELATION TO HEART RATE RESPONSES IN AN INTERNATIONAL LEVEL RACE WALKERS BEFORE A 50-KM RACE

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**Introduction** The ability to accurately control and monitor exercise intensity (EI) during training sessions plays a key role in planning the athletic season. This can be achieved by means of rating of perceived exertion (RPE) (Borg, 1998) and heart rate (HR) (Achten and Jeukendrup, 2003). Over the years several RPE- and HR-based methods have been proposed to quantify global EI. However, to date no study has been conducted with regards to race walking (RW). Thus, this case study aimed to investigate the typical RPE and HR seasonal variations of an international level race walker training for a 50-km race and to examine the relationship between RPE and HR to further confirm the use of RPE to assess EI during RW-specific training. **Methods** Training data were collected during the competitive season 2009 (127 training sessions) consisting of four macrocycles of intense training interspersed by one week of tapering before the Italian 50-km championship. The Borg's 6-20 RPE scale (Borg, 1998) was used to measure the athlete perception of effort referred to the whole training session. HR was recorded using a short-range telemetry system and expressed relative to the maximum value (%HRmax) of the athlete determined during an incremental maximal test. The relationships between RPE and %HRmax were analysed using Pearson's product moment correlation. Statistical significance was set at  $P < 0.05$ . **Results** The athlete completed the event in 4h 14min 02s (personal best time, 39min 48s slower than the World Record). The mean RPE was 11.1 (1.6), 13.1 (1.3), 13.2 (1.5), 12.4 (1.3) and 11.4 (1.0), 13.5 (0.8), 12.7 (0.4), 12.0 (1.5) for the training and tapering period, respectively. The mean %HRmax was 83.7 (2.0), 85.3 (4.6), 84.8 (4.1), 85.7 (3.8) and 83.0 (0.7), 85.7 (4.5), 84.8 (1.6), 85.4 (2.5) % for the training and tapering period, respectively. The correlation between the mean RPE and %HRmax showed a very large significant relationship ( $r = 0.74$ ,  $P = 0.04$ ). **Discussion** The result found indicates that a very large and significant relation exists between RPE and HR. This finding is in line with previous studies which showed how RPE is correlated with many physiological variables, such as HR (Chen et al., 2002), and provides evidence which confirms that RPE can be considered a simple and valid method for quantifying the global EI during RW-specific training. **References** Achten J, Jeukendrup AE. (2003). *Sports Med*, 33, 517-538 Borg G. (1998). Borg's perceived exertion and pain scale. *Human Kinetics, Champaign, IL* Chen MJ, Fan X, Moe ST (2002). *J Sports Sci*, 20, 873-899

### FLUCTUATING DYNAMICS OF PERCEIVED EFFORT IN CONTINUOUS EXERCISE PERFORMED UNTIL EXHAUSTION

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**Introduction** Recent studies have opened a debate about the neurophysiological bases of the perceived effort (PE) (Marcora, 2009). The fluctuations dynamics of the parameter during exercise might give a hint on the type of interaction existing between the different inputs

which form it. Our aim was to study the fluctuations dynamics of the PE during a continuous cycle ergometer test performed until the exhaustion point. Methods Nine physically-active students, who were previously familiarized with the experiment protocol, performed a continuous cycle ergometer test at a previously determined intensity (rate of 4 on the modified Borg scale) until they were unable to maintain the established pedalling frequency for more than 30 s. During the test they reported every change in their PE (any increase or decrease) at least every 15 s. The obtained data series of these changes were integrated and divided into ten non-overlapping temporal windows. The median probabilities of finding either an increase or a decrease in PE were calculated for these windows and for each participant, and were then compared using the Friedman ANOVA test. The Kendall's coefficient of concordance was also calculated with aim to test the behavioural consistency of probabilistic measures among temporal windows. Results The instability of PE dynamics was observed throughout the trial and was manifested in two different time scales (tenths of minutes and minutes). The analysed data series revealed significant differences between the probabilities of fluctuations ( $p < 0.01$ ), as well as low consistency ( $r = 0.39$ ) among the ten windows. Three main portions were distinguished, coinciding with the initial, middle and end part of the test. The median probability of finding an increase in PE was high in the first period (85%), reached a plateau in the middle periods (60%), and then rose progressively to 100% in the last two periods. Discussion The greater probability of finding increases in the PE in the first and, especially, the last portion may correspond, respectively, to the uneasiness that accompanies the change of exercise intensity (also known as second breath) and to the closeness of the termination point. The observed dynamics in the different time scales point towards complex links between the psychological and neuromuscular activation during fatiguing exercise (Hristovski & Balagué, 2010). In conclusion, PE seems to show fluctuating dynamics in different time scales during continuous cycle ergometer exercise performed until the exhaustion point. References Hristovski & Balagué (2010). *Human Mov. Sci.*, 29, 483–493. Marcora, S. (2009). *J. Applied Physiol.*, 106, 2060–2062.

### CHANGES IN RESPIRATORY FUNCTIONS DURING SNOW SHOVELING WITH PAST MEDICAL HISTORIES OF BRONCHIAL ASTHMA

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Introduction: The purpose of this study was to investigate changes in respiratory functions during snow shoveling with past medical histories of bronchial asthma. Methods: 7 Japanese males (age:  $23.3 \pm 2.4$  years, weight:  $67.3 \pm 9.7$  kg, height:  $174.1 \pm 7.8$  cm) with a past medical history of bronchial asthma (=Asthma group) and 6 controls (=Non-asthma group, age:  $24.3 \pm 3.7$  years, weight:  $75.2 \pm 16.3$  kg, height:  $171.5 \pm 6.6$  cm) volunteered to remove snow (15 minutes) in December 2010. Changes of participant's FEV%, FEV1.0, and SpO2 were measured at rest time (room) and after a lapse of 5 minutes from end of snow shoveling (Ex 5). Ambient temperature was set 21.0 degrees C, and atmospheric temperature was  $1.5 \pm 1.1$  degrees C. Results: There were no significant changes in measured value at rest between groups. Significant reductions in FEV% ( $78 \pm 7\%$ ), FEV1.0 ( $3.75 \pm 1.09$  L) and SpO2 ( $95 \pm 2\%$ ) were observed at Ex5 in Asthma group ( $p < 0.05$ ). No significant differences were found on them (FEV%:  $88 \pm 7\%$ , FEV1.0:  $4.51 \pm 0.76$  L, SpO2:  $96 \pm 1\%$ ) in Non-asthma group. Asthma group demonstrated lower each measurement at Ex5 as compared with the values of Non-asthma group. Discussion: Based on the results, stress on respiratory functions was indicated greater after snow shoveling in Asthma group. It was considered that caused significant decrease in FEV%, FEV1.0 and SpO2 were enhanced airway reactivity by synergistic effects of increase of oral-breathing from high-intensity intermittent work and exposure to cold temperature. Though conditions in Asthma group after snow shoveling indicates mild asthma attack in clinical estimation, it was safety range of work. Conclusion: These data suggest that stress on respiratory functions was indicated greater when removing snow for 15 minutes in cold environment in individuals with past medical histories of bronchial asthma. Reference: Richard H. Strauss, M.D., E. R. McFadden, Jr., M.D., R. H. Ingram, Jr., M.D., James J. Jaeger, Ph.D., and David R. Stearns: Enhancement of exercise-induced asthma by cold air. *N Engl J Med* 1977; 297(14):743-74

## Poster presentations

### PP-PM17 Physiology: Circadian/Precooling

#### THE EFFECT OF SUPPLEMENTAL OXYGEN, WATER IMMERSION OR MASSAGE THERAPY ON POST-EXERCISE INFLAMMATION, PERCEPTUAL RECOVERY, AND NEXT DAY PERFORMANCE.

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Introduction The effect of different recovery modalities on post-exercise inflammatory responses, perceptual recovery, and subsequent day performance was investigated. Methods Eight trained athletes completed four swimming sessions consisting of 20 x 200 m efforts, in a repeated-measures, counterbalanced design. At the conclusion of each session, athletes undertook a 30 min recovery modality, including either; contrast water therapy (CWT), massage therapy (MT), supplemental oxygen (HYP), or passive rest (CON). Venous blood samples were collected pre- and post-swim, and immediately after the 30 min recovery intervention, which were analysed for levels of Interleukin-6 (IL-6). Additionally, athletes were asked to rate their perceived recovery at the conclusion of the 30 min intervention, and upon returning to the pool 12 h later, after which, a 200 m time-trial was completed as a measure of next day performance. Results The results showed that there was a significant increase in IL-6 at the completion of exercise, which persisted after 30 min of recovery ( $p < 0.05$ ); however, there were no differences between groups. The athletes perception of recovery recorded immediately after the 30 min recovery period was significantly lower in the CON trial when compared to the other three modalities ( $p < 0.05$ ); however, there were no differences in the 12 h post-recovery 200 m time-trial performances. Discussion These results suggest that a 30 min recovery intervention using CWT, MT or HYP has limited influence on reducing the inflammatory response or on improving subsequent day performance. However, athletes may acutely perceive their recovery to be greater when some form of intervention is implemented.

**PRECOOLING LEG MUSCLE PRIOR TO AND DURING WARM-UP FOR INTERMITTENT SPRINT EXERCISE IN THE HEAT.**

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**Introduction** Twenty minutes of thigh muscle precooling has shown to improve intermittent sprint performance in the heat by ~4% (Castle et al. 2006). Central fatigue mechanisms have been proposed for reduced performance in prolonged activities in the heat in comparison to a temperate environment (Kay et al. 2001). Precooling may influence central activation of exercising muscles, leading to improved self-paced endurance exercise (Duffield et al. 2010). The influence of a warm-up following precooling, including cooling during this period has however, received little attention. This study investigated the effect of precooling and warm-up cooling of the thigh on central activation of the rectus femoris muscle during intermittent sprint exercise in the heat. **Methods** Seven males performed four cycling intermittent sprint protocols (CISP) in hot, humid (30°C, 50% relative humidity) conditions following 20 minutes localised thigh precooling (PRE), 7 minutes warm-up cooling (W-UP), precooling and warm-up cooling (COMB) or no cooling (CON) in a randomised order. The CISP consisted of twenty, 2 minute periods (10s passive rest, 5s maximal sprint, 105s active recovery). Maximum voluntary contraction of the rectus femoris muscle was performed to normalise sprint EMG data. Muscle temperature of the vastus lateralis (Tm) was also measured. Results Average peak power output (PPO) showed an 8% increase in PRE (982±166W) over CON (911±161W P<0.05). No such increase was evident for COMB or W-UP (928±161W, 930±160W respectively P>0.05). Resting Tm (33.5±2.4°C) was reduced by precooling in PRE and COMB to 19.3±2.1°C and 20.2±2.9°C respectively (P<0.05). Prior to the CISP, Tm was 35.1±1.8°C, 33.3±2.9°C, 31.3±2.7°C\* and 29.9±1.6°C\* for CON, PRE, W-UP and COMB respectively (\*P<0.05 in comparison to control). There was no difference in post CISP Tm across all conditions (P>0.05). Localised thigh cooling did not influence central activation of the rectus femoris during the CISP for any condition. **Discussion** Twenty minutes of precooling the leg muscles improved intermittent sprint performance in the heat (PRE) by 8%, supporting findings of Castle et al. (2006), and occurred without a concomitant increase in EMG activity. Continuing cooling in the warm-up (COMB) did not further enhance intermittent sprint exercise in the heat but did blunt the rise in Tm seen in PRE. Precooling followed by a warm-up (PRE) improves the Temperature-Force relationship of muscle and enhances intermittent sprint exercise in the heat. **References** Castle P, MacDonald A, Philp A, Webborn A, Watt P, Maxwell, N. 2006. *J Appl Physiol*, 100, 1377-84. Duffield R, Green R, Castle P, Maxwell N. 2010. *Med Sci Sports Exerc*, 42, 577-84. Kay D, Marino F, Cannon, J, St Clair Gibson A, Lambert M, Noakes, T. 2001. *Eur J Appl Physiol*, 84, 115-21.

**COMPARISON OF DIFFERENT PRECOOLING TECHNIQUES AND THEIR EFFECT ON REPEAT SPRINT ABILITY IN NON HEAT ACCLIMATISED TEAM SPORT ATHLETES**

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**Introduction** The effect of precooling on repeat sprint performance has had limited research attention. Wearing an ice jacket and the ingestion of an ice slushy prior to performance represent convenient methods of precooling and have been separately shown to enhance exercise performance (Arngrimsson et al., 2004; Siegel et al., 2010; Uckert and Jock, 2007; Ishan et al., 2010). Using multiple cooling methods simultaneously as a precooling strategy has yet to be researched. Therefore, the aim of this study was to compare different precooling methods, both individually and in combination, on repeat sprint performance. **Methods** Twelve male team sport players were randomly assigned (counterbalanced) to four experimental conditions, including a cooling jacket with phase change material (PC25), ingestion of an ice slushy (IS), the combination of the cooling jacket and ice slushy (PC25 + IS), and a control condition (CONT). Experimental sessions consisted of a 30 min precooling period followed by a 70 min repeat sprint cycling protocol that consisted of 2 x 30 min periods of exercise and a 10 min (half time) cooling period. Each half comprised 30 x 4 s maximal sprints interspersed with exercise at varying intensities. Exercise was completed in hot and humid conditions (~35.0°C and 60% RH). Physiological measures included core (TC) and skin temperature (TSk), heart rate, nude body mass, rating of perceived exertion and thermal sensation. Performance measures obtained were peak and mean power and work done. Results Total mean power and work performed were significantly higher in the PC25 + IS compared to IS condition. Effect sizes indicated a trend for lower TC in PC25 + IS compared to PC25 and CONT conditions (precooling) and compared to the IS condition (half time). The change in mean TSk over half time was significantly greater during the PC25 condition compared to IS, and showed a tendency for a greater change compared to all other conditions. Total sweat loss was significantly greater in the IS and PC25 + IS conditions compared to the PC25 and CONT conditions. **Discussion** This study shows that intermittent sprint performance in hot and humid conditions, was enhanced by using two methods of precooling simultaneously, perhaps facilitated by a trend for a lower TC in the PC25 + IS condition. The use of an ice jacket containing phase change material and the ingestion of an ice slushy provide convenient methods of precooling which are easily applied within the time constraints of team sports in field settings. **References** Arngrimsson S, Petitt D, Stueck M, Jorgensen D, Cureton K. (2004) *J Appl Physiol*, 96, 1867-1874. Ishan M, Landers G, Brearley M, Peeling P. (2010) *Int J Sports Physiol Perform*, 5, 140-151. Siegel R, Mate J, Brearley M, Watson G, Nosaka K, Laursen P. (2010) *Med Sci Sports Sci*, 42(4), 717-725. Uckert S, Joch W. (2007) *Br J Sports Med*, 41, 380-384.

**COLD WATER IMMERSION DOES NOT INFLUENCE MUSCLE GLYCOGEN RE-SYNTHESIS FOLLOWING EXHAUSTIVE EXERCISE**

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Cold water immersion does not influence muscle glycogen re-synthesis following exhaustive exercise Warren Gregson<sup>1</sup>, Robert Allan<sup>1</sup>, Susan Holden<sup>1</sup>, Padraic Phibbs<sup>1</sup>, Iain Campbell<sup>1,2</sup>, Sarah Waldron<sup>1,3</sup>, Chang Hwa Joo<sup>1</sup>, James Morton<sup>1</sup> <sup>1</sup> Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, UK <sup>2</sup> Department of Anaesthesia, University Hospital of South Manchester NHS Foundation Trust, UK <sup>3</sup> Lancashire Teaching Hospitals NHS Trust, UK. **Introduction** Cold water immersion (CWI) enhances post-exercise recovery (Bailey et al., 2007). Potential mechanisms include cold induced reductions in limb blood flow (Gregson et al., in press) which may reduce muscle damage and inflammation following exercise. However, this reduction in limb blood flow may also be problematic as it could result in reduced substrate delivery thereby reducing the efficacy of post-exercise nutritional interventions. The aim of the present study was to therefore test the hypothesis that post-exercise CWI reduces muscle glycogen re-synthesis following exhaustive exercise. **Methods** Nine healthy males (24±4 years) performed exhaustive cycling (on the morning after having completed intermittent exhaustive cycling the evening before) on two separate occasions in a counterbalanced randomised crossover design. On each occasion, subjects rested passively (CON) or undertook 10-min of CWI (8oC) 20-min after the completion of exercise. Carbohydrates were consumed at hourly intervals (0.6 g/kg body mass) during the 4h recovery period. Muscle biopsies, rectal, muscle and skin temperature



were taken at regular intervals during the 4h recovery period. All data were analysed using a two-factor (condition x time) within participants general linear model (GLM). Results Rectal temperature was similar between conditions during the 4 h recovery period ( $p = 0.30$ ), however, skin and muscle temperature were significantly lower in the CWI condition compared to CON ( $p < 0.001$ ). Muscle glycogen levels were similar at exhaustion ( $\sim 75$  mmol/kg dw;  $p = 0.72$ ) and increased by similar amounts after 1 h (CWI,  $99 \pm 29$ ; CON,  $91 \pm 34$  mmol/kg dw) and 4h (CWI,  $157 \pm 59$ ; CON,  $160 \pm 34$  mmol/kg dw) of recovery ( $p < 0.01$ ). Discussion Data demonstrate that reduced limb blood flow in response to CWI (Gregson et al., in press) does not influence rates of muscle glycogen re-synthesis following exhaustive exercise. Cold water immersion is therefore unlikely to have adverse effects on athletes where short recovery periods between successive bouts of training and competition necessitates the rapid replenishment of muscle glycogen stores. References Bailey DM, Erith SJ, Griffin PJ, et al., (2007). Influence of cold-water immersion on indices of muscle damage following prolonged intermittent shuttle running. *J Sports Sci*, 25, 1163-1170. Gregson, W, Black, M, Jones, H, et al., The influence of cold water immersion on lower limb and cutaneous blood flow. *Am J Sports Med*, in press, DOI, 10.1177/0363546510395497.

## DOES RAISING MORNING RECTAL TEMPERATURE TO EVENING LEVELS OFFSET THE DIURNAL VARIATION IN MUSCLE FORCE PRODUCTION?

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**Introduction** Muscle force production and power output in active males, regardless of the site of measurement (hand, leg or back), is higher in the evening than the morning. This diurnal variation is attributed to motivational, peripheral and central factors and higher core temperatures in the evening. Therefore, the purpose of this study was to investigate whether increasing morning rectal temperatures to evening resting values, by active or passive warm-up, leads to muscle force production and power output becoming equal to evening values in motivated subjects. **Methods** Ten healthy active males (mean  $\pm$  SD: age,  $21.2 \pm 1.9$  years; mass,  $75.39 \pm 8.32$  kg; height,  $175.6 \pm 6.0$  cm) completed the study. The subjects were familiarized with the techniques and protocol and then completed four sessions (separated by  $>48$  h): control morning (07:30h) and evening (17:30h) sessions and then two further sessions at 07:30h but preceded by active or passive warm-ups to raise core temperature to evening values. The sessions were counterbalanced in order of administration. During each trial, 3 measures of handgrip, isokinetic leg strength measurements (of knee flexion and extension at  $1.05 \text{ rad.s}^{-1}$  and  $4.19 \text{ rad.s}^{-1}$  through a  $90^\circ$  range of motion) and 4 maximal voluntary contractions (MVC) on an isometric ergometer (utilizing the twitch-interpolation technique) were performed. Rectal temperature, rating of perceived exertion (RPE) and thermal comfort (TC) were measured. Measurements were made after the subjects had reclined for 30min at the start of the protocol and after the warm-ups and prior to the measures for strength. Warm-ups were either active (cycle ergometer at 150W) or passive (resting in a room at  $35^\circ\text{C}$ ). Data were analysed using ANOVA models with repeated measures. Results Rectal temperatures were higher at rest in the evening ( $\sim 0.53^\circ\text{C}$ ;  $p < 0.05$ ) but there were no differences after the active or passive warm-ups, the subjects' ratings of TC reflecting this. Right grip strength, isokinetic knee flexion for peak torque and peak power at  $1.05 \text{ rad.s}^{-1}$  and knee extension for peak torque at  $4.19 \text{ rad.s}^{-1}$ , all showed higher values in the evening. All other measures of strength and power showed a statistical trend to be higher in the evening than in the morning ( $0.10 > p > 0.05$ ). There was no significant effect of 'warm-ups' on any strength and power variables, and subjects reported maximal values for effort and RPE for each strength measure. In summary, effects of time of day were seen in some measures of muscle performance, in agreement with past research. However, in this population of motivated subjects, there was no evidence that increasing morning rectal temperature to evening values by active or passive warm-up increased muscle strength to values found in the evening.

## EFFECTS OF MORNING OR EVENING WHEEL-RUNNING ON THE PHASE OF CIRCADIAN RHYTHM AND THE EXPRESSION OF CLOCK-CONTROLLED METABOLIC-RELATED GENES IN MICE

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**Introduction** It is known about the good effects of exercise on our health and energy expenditure, however we do not know the best clock time of day for exercise. Mammals including human have circadian clock systems which are operated by clock genes expressed in the brain, peripheral organs and skeletal muscles. Therefore, it is interesting to know (1) that time-dependent exercise can reset circadian rhythm similar to light-induced reset, and (2) that time-dependent exercise can cause anti-obesity effect. So, we studied whether morning exercise or evening exercise can reset mice peripheral clock and can reduce weight gain through the expression of clock-controlled metabolic-related genes in liver, adipose and muscles under high fat diet feeding conditions. **Materials & Methods** We accomplished 2 experiments. Firstly, we examined the effects of voluntary wheel-running with fixed-time (ZT0-4, or ZT12-16) on the phase of liver bioluminescence rhythm in the mouse carrying with Per2::luciferase knock-in. ZT0 is lights-on time and ZT12 is lights-off. Secondly, we examined the effects of voluntary wheel-running on the expression of clock-controlled metabolic-related genes in the liver and soleus muscle. Mice were applied to exercise for 4 weeks with wheel running during early night (ZT23.5-0) or early morning (ZT12-12.5). Mice were kept under LD condition (L:D=12h:12h) and allowed free access to drinking water and High Fat Diet (25% fat). **Results** (1) No phase-shifting effect was observed by fixed-timed wheel-running, suggesting that physical activity itself does not influence the liver and soleus clocks. It means that the entraining effect of the exercise on Per2, Bmal-1 rhythm is weaker than that of light simulation. (2) The numbers of wheel-running was comparable between morning exercise group and evening exercise groups suggesting the same exercise load between two groups. Whereas, body weight gain and size of visceral and subcutaneous fat was lower in evening group than morning group. The expression levels of Ppar $\alpha$ , mUCP3, Rev-erba were higher in evening group than in morning group. Thus, evening exercise more strongly promoted the expression of metabolic-related genes. **Discussion** We found that evening exercise promotes energy expenditure more than morning one in mice, and that evening exercise increases the expression of metabolic-related genes. These results suggest that people can make more metabolic activation with evening physical exercise without phase-shift of peripheral clock. Exercise program considering clock time of exercise may be useful for the prevention and improvement of obesity in human. References C.Canto et al.(2009) *Nature*, Apr 23;458(7241):1056-60. Yamazaki S et al.(2000) *Science*, 288, 682-5, 2000

### TEMPERATURE CIRCADIAN VARIATIONS IN WORKER IN HOT ENVIRONMENT

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**Introduction:** Body core temperature follows a circadian rhythm. This rhythm is endogenous with an acrophase around 18h00 in temperate environment. This rhythm persists at rest in hot countries but the acrophase can be advanced according sunrise and sunset time. However, the effect of working in hot conditions on this rhythm is not known. **Research questions:** Does core temperature follow circadian variations under working conditions in hot environment? What are the characteristics of these variations? Does this affect the health and safety of worker having shift work? **Methods:** 29 employees from the aluminum industry participated in this preliminary study. These participants worked indoors where the temperature was typically in excess of 40°C; however, there were isolated areas above 70°C. Additionally, each worker wore protective clothing consisting of suit, gloves and mask. Core temperature (ingestible pill) data covering a 24-h circadian cycle were obtained in 10 workers during morning, afternoon and night shifts over three separate days. Circadian variation in temperature was characterized using a cosinus function (cosinor model). The mesor (average) and acrophase (time of the peak) of the function have been calculated for each participant as well as for the entire population. **Results:** Body core temperature at work fluctuates during the day with an acrophase at 15h50 and a mesor of 37.45°C. This represent an average core temperature half a degree higher than generally observed in general population at rest. There are large differences between the individual acrophase times probably due to different working activities as well as the influence of synchronization/shift from the previous days. However, core temperature was consistently higher in the afternoon than during the morning or the night. Peak values of core temperature showed an acrophase at 14h57. **Discussion:** The current data showed that workers from the aluminum industry present relatively elevated average core temperature with the highest values being reached during the afternoon shift. This suggests that special attention should be given to the afternoon shift and that break/cooling procedure should be implemented if necessary. These preliminary observations have to be completed by clinical and behavioral observations.

### DOES RAISING MORNING RECTAL TEMPERATURE TO EVENING LEVELS OFFSET THE DIURNAL VARIATION IN MUSCLE FORCE PRODUCTION?

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**Introduction** A plethora of research has shown distinct cyclic variation to be present in core temperature throughout the solar day (Drust et al., 2005: Chronobiol Int. 22:21–40). It is well documented that muscle strength and power output, regardless of the site (grip, leg, back etc.), are higher in the evening than the morning and thus display circadian rhythmicity in phase with the rhythm of core temperature (Reilly and Waterhouse, 2009: Eur J Appl Physiol. 106:321-332). The purposes of the present study were to investigate whether muscle contraction (using a muscle lab force-velocity transducer) displays diurnal variation and whether increasing morning rectal temperatures to evening values by an active warm-up leads to an increase in muscle contraction in the morning to evening values in motivated subjects. **Methods** After having been familiarized with the techniques and protocol, ten healthy active males (mean  $\pm$  SD: age 21  $\pm$  1.3 yrs, height 176.5  $\pm$  5.9 cm and body mass 82.8  $\pm$  15.7 kg) completed three sessions (separated by at least 48 h); a morning (07:30 h) session, an evening (17:30 h) session, and a further morning (07:30 h) extended active warm-up session, where rectal temperatures were increased to evening levels. During each trial, 3 measures of handgrip strength, bench press and back squat were performed. Rectal (T<sub>rec</sub>) and intra-aural temperatures, thermal comfort and effort were measured throughout. Three measures of muscle temperature were also taken. The local Ethics Committee of the University approved the study. **Results** Values of T<sub>rec</sub> (~0.63°C) and intra-aural (~0.50°C) values were higher at rest in the evening compared to the morning (P<0.05) and there was no difference from the evening resting values after the active warm-up in the morning (P>0.05); these differences were reflected by the subjects' ratings of thermal comfort. Muscle temperatures also displayed significant diurnal variation, with higher values in the evening (P<0.05). Left and right isometric grip strength, average power and force and peak velocity at 20 kg load for bench press, and average power and peak velocity at a 40 kg load for bench press, all showed diurnal variations with evening values greater than in the morning (P<0.05). All other measures of strength and power showed no diurnal variation. There was no effect of active warm-up on any strength or power variable, these still remaining below evening values, and subjects reported maximal values for effort and RPE for each strength measure. **Discussion** These results suggest that the muscle lab force-velocity transducer used in this study might not be sensitive enough to detect diurnal variation in all strength measures. In addition, in this population of motivated subjects, there was no evidence that increasing morning rectal temperature by an active warm-up to evening values increased muscle strength to that found in the evening. This result agrees with Reilly and Waterhouse (2009), who suggested that the rhythm of muscle strength might not be wholly mediated by core temperature variation.

### RELATIONSHIP BETWEEN DAILY PHYSICAL ACTIVITY LEVELS AND BEDTIME MELATONIN CONCENTRATIONS IN SCHOOL-AGE CHILDREN

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**Introduction** In recent times, the bedtimes of school-age children in Japan have gradually extended, and their total sleep time has decreased. From the viewpoint of growth and development, it is very important that school-age children have sufficient sleep at suitable hours. Exercise has been considered a synchroniser of human circadian rhythms (Miyazaki et al. 2001, Shibata et al. 2010), and an inactive lifestyle may cause retreatment of circadian rhythms. The purpose of this study was to determine the effect of daily physical activity (DPA) levels on the circadian rhythm of melatonin in school-age children. **Method** The study population comprised 55 boys (age, 9–11 years). We determined their DPA levels, melatonin levels at bedtime, waking times, and bedtimes over a 1-week period. DPA was defined as the number of steps taken daily and was determined using accelerometry. Saliva samples were collected at bedtime on 2 week-nights, and the saliva melatonin concentrations were determined. We thought that bedtime melatonin concentrations would be affected by the childrens' social schedules, e.g. the waking time and the bedtime; therefore, we analyzed the subjects whose waking times and bedtimes were within the range of 1 standard deviation (SD) of the mean waking time and bedtime of all the subjects. **Results** The grand means of the waking times and bedtimes were 6:36 (SD, 26 min) and 22:06 (SD, 35 min), respectively; therefore, we analyzed the data for the 24 subjects who woke up between 6:10 and 7:02 and went to bed between 21:31 and 22:41. The mean (SD) values for DPA levels and bedtime melatonin concentrations were 17,163 (3,330) steps and 8.6 (5.3) pg/ml, respectively. A significant positive correlation ( $r = 0.63$ ,  $p$

< 0.01, n = 24) was observed between the DPA levels and bedtime melatonin concentrations. Discussion In this study, the subjects had similar social schedules; however, the bedtime melatonin concentrations were correlated with DPA levels. Our results suggest that lower DPA levels cause retreatment of the circadian rhythms of melatonin and that increased DPA levels contribute to synchronization of circadian rhythms in children. References Miyazaki T, Hashimoto S, Masubuchi S, Honma S, Honma KI (2001) Am J Physiol Regul Integr Comp Physiol, 281, R197-205 Shibata M, Tanida K, Kuzuhara K, Shimamoto H, Wakamura T (2010) 33rd NSCA National Conference Suppl, 735

### **SLEEP AND REST-ACTIVITY CIRCADIAN RHYTHM AFTER CONTINUOUS SPORT COMPETITIONS LASTING THREE TO SEVEN DAYS. COMPARISON BETWEEN THREE DIFFERENT RACES.**

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**Introduction.** Rest-activity circadian rhythm is strongly linked to the organism's entrainment. Sleep loss and prolonged fatigue might affect the circadian system, inducing neuro-behavioral deficits. Finnmarksløpet (FL) is Europe's longest sled-dog race, with a 500km and a 1000km category. The competition lasts up to 7-days; the participants (mushers) are physically active most of the time, having little and fragmented rests. The same is the situation in the about 5-days 700km biking event OffroadFinnmark (OF). FL and OF provide interesting conditions for investigating the effects of strenuous physical activity and sleep loss. The aim of this study was to investigate the rest-activity circadian rhythm (RACR) and sleep patterns in mushers and off-road bikers after they participated in the competitions lasting 3- to 7-days. **Methods.** 16 subjects (5 participants at the FL-500km, 5 at the FL-1000km, and 6 bikers in the OF-700km) underwent continuous actigraph monitoring (AW4, CNT) for 5-days before and after the race. The actigraphy data were analyzed by Non-Parametric Circadian Rhythm Analysis (NPCRA), Activity Analysis and Sleep Analysis (Actiwatch Activity and Sleep Analysis software, CNT). The parameters of rest-activity rhythm and sleep quality were analyzed for variance by 2-way ANOVA, and t-test was used for post-hoc analysis. **Results.** In all the races the participants had the chance to sleep for about 3/4-h per day. The long lasting physical activity with fragmented sleep induced a mild phase delay for the athletes of all the races, but a proper free-running effect was not evident. The RACR showed reduced amplitude: there were significant differences between the races, and the reduction was greatest after the race with the largest degree of sleep loss (FL-1000km). The intradaily stability (IS) of the RACR was significantly reduced for the FL-1000km mushers; while the interdaily variability (IV) was significantly increased for the FL-500km mushers, and there was a tendency for the OF-700km bikers. Reduced sleep quality was found only among the FL-1000km mushers. **Discussion and Conclusion.** A period of 3-days of little and fragmented sleep (3-4 hours/per day), in which the subjects were engaged in a prolonged physical effort in intensity zone 1, affected the RACR's structure. A longer period (5/7-days) in such a condition induced even more accentuated alterations, with disturbance in the nocturnal sleep. This induced a sort of vicious circle that made the re-adjustment of the RACR difficult; while increased IV in the 500km mushers and the bikers might indicate a faster re-adjustment.

## **Poster presentations**

### **PP-PM18 Physical Activity: Methods**

#### **SURVEY OF INDUSTRY AND CONSUMER VIEWS ON FITNESS**

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**Introduction** The current survey is a part of the European Transfer of Innovation project – № 2009 – BG1-LEO05-01602, funded by the Lifelong Learning Program of the European commission. One of the aims of the project was to perform national need analysis in order to provide an overview of the training needs and the users' requirements in the fitness and health industry. One of the major conclusions of survey performed on the EU health and fitness industry is that the fitness Industry will need a better qualified workforce in the future. In respond to this statement, our effort is focused on transfer, upgrade and creation of program for sport centres employees (Hanna RK, Subic A., 2008). **Methods** The systematic literature review, paper and web-based questionnaires, consultations for obtaining expert opinions, discussions with university authorities have been used. The 200 sports and physical education students and 500 consumers of fitness services were investigated by the specially developed questionnaires based on business requirements for improving employability in the sector. Descriptive statistics were completed to determine the frequencies and percentages. **Results** Organizing and managing the training process in the field of sport for health and recreation (23%) and Planning, programming and organization of sports events, fitness activities and competitions (15%) are the two highly rated skills and abilities from the students. About the consumers the organisational skills also leading (18%) and in the second place is competency connected to the organisation of the training process (17%). For the personal qualities ranking, the students determine the responsible (22%) and easy to make contact (15%) and the consumers also stress the responsibility as a most important personal skill (18%) closely following by communication abilities (17%). **Discussion** The abilities and skills related to all aspects of the training process are ranged as the two most important. On third place is the ability to motivate the clients. This result is correlating with the 'communication' from the personal qualities, which is ranked as second. The other leading personal qualities are responsibility, motivation for professional growth, and team work abilities (Ryan, P. 2003). The results represented show the need of new approach in the design of training programs with greater stress on the training process. **References** 1. Hanna RK, Subic A. (2008). Towards sustainable design in the sports and leisure industry. International Journal of Sustainable Design 1:60-74. 2. Ryan, P. (2003). 2002 IDEA Fitness Industry Compensation Survey. IDEA Health & Fitness Source, 21 (1), 51.

#### **RELIABILITY AND VALIDITY OF ACCELEROMETER DEVICES WHEN USED TO DETECT DIFFERENCES IN ACTIVITY INTENSITY AND ESTIMATE ENERGY EXPENDITURE IN LEAN AND OVERWEIGHT ADULTS.**

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Reliability and validity of accelerometer devices when used to detect differences in activity intensity and estimate energy expenditure in lean and overweight adults. Khalid S. AlJalood, Adrienne R. Hughes, Stuart D.R. Galloway. Health and Exercise Science Research Group,

School of Sport, University of Stirling, FK9 4LA, SCOTLAND, U.K. Introduction: Many devices are available for monitoring of free living physical activity. These devices can detect movement but also posture or physiological variables such as heart rate or heat flux. More information is required on the reliability and validity of these devices under laboratory conditions to judge their value as free living activity monitoring tools. Methods: 61 adults (n= 30 lean and n= 31 overweight/obese) attended for 3 lab sessions. On the first session body mass, height, BMI, body fat and resting heart rate (HR) were recorded, and familiarisation with equipment and procedures was performed. On the 2nd session they were instrumented with three accelerometer devices (ActiGraph, ActivPAL and SenseWear Pro) and then asked to walk on a treadmill at three speeds (3km/h, 4.5km/h and 6km/h) for 5 minutes each at 0% grade. After a 10 min seated recovery period these speeds were replicated on an incline (5% grade). This protocol was repeated on the 3rd session. HR, indirect calorimetry (for energy expenditure determination) and outputs from the three accelerometer devices were recorded throughout. Results: All accelerometers were reliable on the flat and on an incline across all speeds. ActiGraph, ActivPAL and SenseWear Pro gave strong intra-instrument reliability (ICC)  $r = 0.99$ ,  $r = 0.99$  and  $r = 0.96$  all at  $p < 0.001$ , respectively. ActiGraph was valid on more occasions (speeds, gradients) for lean and overweight/obese than the other devices. ActiGraph and SenseWear were able to detect differences in activity intensity between all of the walking speeds on 0% and 5% grade in lean and overweight/obese adults. The ActivPAL was unable to detect differences in activity intensity in overweight/obese adults. All devices had problems with validity of energy expenditure estimates during walking. Conclusion: All of the studied devices are reliable. The ActiGraph and SenseWear Pro were also sensitive enough to detect differences in activity intensity across all speeds examined. ActivPAL could detect differences in activity intensity for lean but not for overweight / obese adults. None of the devices could accurately quantify energy expenditure across all speeds and gradients studied but ActiGraph was considered valid at more speeds on level ground than the other devices. Caution must be taken when using these devices to measure differences in activity intensity or energy expenditure in free living situations, particularly in overweight/obese adults.

### CHANGES OF PHYSIOLOGICAL PARAMETERS IN A SPORTIVE DRUMS ALIVE®-DRUMMING ACTIVITY AND ITS EFFECTS ON CONCENTRATION AND AWARENESS PERFORMANCE

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Objectives This article will discuss the interim results of a study that investigated a fitness trend that uses elements of drumming and aerobics called Drums Alive®. The focus of the analysis lies on the behaviour of physiological parameters during this intervention in adults of different ages. This should produce information on the typical work intensity of this exercise. Furthermore, the effects on acute concentration and awareness performance after a session of Drums Alive® in students were investigated. The here presented study is part of a bigger project „THE DRUM BEAT – Chemnitz Drumming Project“, which evaluates the possibilities of using this type of drumming exercise in various areas of fitness, education and therapy. Methodology The study design included two sessions to allow the subjects to get used to the movement patterns of Drums Alive® and a third testing session with 27 adults (14 students, 18-22 years and 13 older adults who were between 30 and 65 years of age, described here as AC 30-65). During the testing session physiological data was collected which included heart rate, blood lactate, range of perceived exertion and exemplary spirometry data in two subjects as well as concentration and awareness tests using the d2-test in the students group only (N=16; the d2 students intervention group had two more subjects in this group compared to the physiological data). In order to compare the latter data (concentration performance) a control group of 17 students was used. Results All physiological parameters showed a significant increase compared to the resting values. The intervention can therefore be described as an effective exercise. The blood lactate values showed a mean increase from  $1.16 \pm 0.31$  to  $3.75 \pm 1.91$  [mmol/L] in the overall group (students and AC 30-65, N=27), which corresponds with the changes in heart rate. An increase from  $84 \pm 14$  to  $155 \pm 16$  could be shown. This is also reflected in the high RPE-values of 16 towards the end of the main phase of the Drums Alive® session. The results of the d2-tests showed a slightly better performance in the intervention group (students) compared to the control group, but no significant difference. Conclusions This study proved significant physiological effects in the Drums Alive® exercise session and gave hints on a positive effect on concentration performance. However, more research is necessary before a final statement on the effects of this type of sportive drumming exercise can be given.

### ACCELEROMETER MEASURED PHYSICAL ACTIVITY DIFFERS BETWEEN WRIST AND HIP PLACEMENT SITES IN CHILDREN AGED 10-11 YEARS

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Introduction The Actiwatch 4 accelerometer (AW4) has been validated as a measure of physical activity (PA) in children (Puyau et al., 2004), however the variance in PA that may be attributable to monitor placement site is not known, despite this being marketed as a wrist worn accelerometer. The purpose was to investigate whether AW4 measured PA counts and time spent in moderate-to-vigorous physical activity (MVPA) differed between the hip and wrist, worn on the dominant and non-dominant sides in children aged 10-11 years. Methods Sixteen boys and 9 girls (Mean  $\pm$  SD Age:  $11.1 \pm 0.5$  ys; Ht:  $141.8 \pm 7.2$  cm; Wt:  $37.5 \pm 8.5$  kg; BMI:  $18.6 \pm 3.3$  kg/m<sup>2</sup>) wore an AW4 on the dominant hip (DH), non-dominant hip (NDH), dominant wrist (DW) and non-dominant wrist (NDW) for 4 hours during a school day, including recess and lunchtime. Side dominance was assessed through writing preference. Mean PA counts (counts/10sec), and minutes of MVPA using hip derived cut-off's derived by Puyau et al., (2004) were calculated. Results One-way repeated measures ANOVA, revealed a significant placement effect for mean PA counts ( $F(1.5, 30.6) = 53.6$ ,  $p = 0.01$ , partial  $\eta^2 = 0.72$ ) and minutes of MVPA ( $F(1.9, 39.0) = 109.5$ ,  $p = 0.01$ , partial  $\eta^2 = 0.84$ ). Post hoc paired t-tests with Bonferroni correction revealed differences between DH and DW ( $85.6 \pm 50.5$  vs.  $154.5 \pm 42.2$  counts/10sec, 95% CI:  $-89.1$  to  $-48.6$  counts/10sec,  $p = 0.01$ ,  $d = -1.5$ ;  $55.3 \pm 24.0$  vs.  $100.3 \pm 26.9$  mins, 95% CI:  $-54.5$  to  $-35.6$  counts/10sec,  $p = 0.01$ ,  $d = -1.7$ ) and NDH and NDW ( $85.0 \pm 44.7$  vs.  $147.0 \pm 37.6$  counts/10sec, 95% CI:  $-74.4$  to  $-49.6$  counts/10sec,  $p = 0.01$ ,  $d = -1.5$ ;  $54.3 \pm 22.9$  vs.  $99.0 \pm 23.3$  mins, 95% CI:  $-50.2$  to  $-39.1$  counts/10sec,  $p = 0.01$ ,  $d = -1.9$ ). No differences in mean PA counts or minutes of MVPA were found between DH and NDH or DW and NDW ( $p > 0.05$ ). Discussion Neither mean PA counts nor minutes of MVPA differed between the D and ND placement at either the wrist or hip which is consistent with previous data in other devices (Van Hilten et al., 1993) and shows that side dominance is not an important monitoring issue. Wrist measured PA counts and minutes of MVPA were, however, considerably greater than those derived from the hip. Physical activity data derived from wrist and hip placements are therefore not comparable and further investigation is required to develop suitable cut-off points for wrist measured physical activity if such devices, which are inherently more participant friendly, are to be used in future physical activity research. References Puyau, M. R., Adolph, A.L., Vohra, F.A., Zaker, I., & Butte, N.F. (2004). Med Sci Sports Ex, 36, 1625–1631. Van Hilten, J.J., Middelkoop, H.A., Kramer, C.G., & Roos, R.A. (1993). Electro and Clin Neurophys, 89(5), 359–562.

## PILOT STUDY OF THE FITNESS SERVICE QUALITY DELIVERY

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**Introduction** This pilot study is a part of the European Transfer of Innovation project – № 2009 – BG1-LEO05-01602, funded by the Liveling Learning Program of the European commission. One of the aims of the overall project was to perform national need analysis in order to provide an overview of the training needs and the users' requirements in the fitness and health industry. Yet the lack of studies regarding the status of the health and fitness industry of Bulgaria such as the credentials of education and certification of the fitness professionals surges the fitness industry into the unknown. The purpose of this study was to investigate the clients' opinion about the quality of fitness services. **Methods** The web-based questionnaire and interview with open-ended questions have been used. The 500 consumers of fitness services from more than 120 fitness centers were investigated. Descriptive statistics were completed to determine the frequencies and percentages. Results 32% from the surveyed chooses the fitness venue from the quality of the equipment following by the abilities of the instructors (20%) and quality of services offered (16%). At the same time 32% from the clients are not interested at all of the qualification of the instructors and 28 % are absolutely sure that their instructors are not certified. In the same time clients stress on the professional qualification as being the most important factor (35%). **Discussion** The findings of the study demonstrate that although the industry seems to be in a rapid growth phase, there are problems that would not allow the future success of the industry (Sekendiz, B., 2005). The consumers underestimate the credentials of the fitness professionals and at the same time quickly withdraw if their goals are not met. The industry lacks standardization, and regulations are not adequate to save it from abuse (McDonnell, A. B. (2004). Although the Bulgarian health and Fitness Association emerged as the major certification body, it holds less than 1/3 of the industry. The major part of the Fitness centers does not meet the national and European standards. Base on the findings, the clients must be more demanding towards their fitness instructors. In turn this will motivated the instructors and fitness centers itself to be certified. In general this will improve the quality of Fitness industry in Bulgaria. **References** 1. McDonnell, A. B. (2004). Retention: It's All About Customer Service. *Fitness Management*. Retrieved on March 10, 2004. 2. Sekendiz, B. (2005). Pilot study in determining the status of the health and fitness industry in Turkey. Master thesis.

## INTERNET-BASED VERSUS PRINT-BASED BEHAVIORAL INTERVENTION FOR PHYSICAL ACTIVITY PROMOTION AMONG UNIVERSITY STUDENTS – A RANDOMIZED CONTROLLED TRIAL

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**Background:** A considerable proportion of university students cannot meet the recommendation criteria for physical activity (PA) (Seo et al., 2007). Most university students are familiar with computer use; the Internet may have the potential for delivering behavioral program for PA promotion. **Purpose:** The study examined the effectiveness of using Internet to a deliver behavior change program for PA promotion among the university students. **Methods:** A total of 111 Hong Kong university students were randomly assigned to one of the three groups, i.e. the Internet-based group (IB), print-based group (PB), and control group (C). Participants of the IB group received the online behavior change program entitled "Active Living Every Day (ALED)" (Blair et al., 2001). Participants of the PB group received the same program through face-to-face classes. Participants of group C did not receive any intervention treatment. The assessment of PA level and meeting the ACSM criteria of sufficient PA were carried out at baseline, 3rd month and 6th month. Results: Increased in PA ( $P < 0.05$ ) was found in the print-based and Internet-based groups at the 3rd and 6th month assessments. Increased in the proportion of participants meeting the ACSM criteria of sufficient PA was found in the IB group at the 3rd month assessment **Conclusion:** Internet-based PA programs may be an effective channel for promoting PA among university students. **References:** Blair, S. N., Dunn, A. L., Marcus, B. H., Carpenter, R. A., & Jaref, P. (2001). Active living every day: get active with a 20-step program. *Human Kinetics*, Champaign, IL. Seo, D-C., Nehl, E., Agley, J., & Ma, S-M. (2007). Relations between physical activity and behavioral and perceptual correlates among Midwestern college students. *Journal of American College Health*, 56, 187-197. This study was funded by the Direct Grant for Research of the Chinese University of Hong Kong.

## VALIDITY OF THE ACTISmile WORN AT TWO MEASUREMENT SITES

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FEDERAL OFFICE OF SPORTS

**Introduction** The aim of the present study was to validate the measurement characteristics of a device that gives the user a feedback in terms of performed health-enhancing physical activity (HEPA). **Method** The ActiSmile (Actismile, Bern-Liebefeld, Switzerland) is a device that measures time spent walking and running and classifies it as HEPA and assigns the remaining time to non-active time. The integrated monitor gives a feedback to the user in terms of a smiley whether the minimum of the recommended amount of HEPA (1,2) is achieved. Five women ( $39.9 \pm 15.3$  y,  $169.5 \pm 47.4$  cm,  $63.3 \pm 18.8$  kg) and six men ( $41.1 \pm 12.2$  y,  $180.3 \pm 7.4$  cm,  $81.3 \pm 10.5$  kg) participated in the study. They wore one ActiSmile on a belt at the hip (AS-hip) and one in the trouser pocket (AS-pocket). The following six activities were performed: moderate and fast level walking, moderate walking uphill and downhill, level running and level biking. All activities were performed for 3 min and 25 s: as the ActiSmile records only one-minute activity blocks, i.e. blocks of 60 s, this allows some tolerance at the beginning and ending of the activities. Data of the ActiSmile was downloaded after every single activity to determine the proportion of time recognised as walking, running or non-active time. Recognition rates of the device worn at the hip and the one carried in the trouser pocket were compared using a Chi2-test. Another bout of moderate level walking was performed for 5 min to validate the smiley that is given at the achievement of the HEPA recommendation. The amount of time until the smiley appeared was measured and compared to the 5-min level by a Wilcoxon-signed-rank-test. **Results** Recognition rate of moderate level walking was 100% and 97% in the AS-hip and the AS-pocket, respectively. Recognition rate of walking uphill (downhill) was 100% (100%) and 96% (87%) in the AS-hip and the AS-pocket device, respectively. 10% of walking downhill was assigned to running activities by the AS-pocket. 96% (AS-hip) and 84% (AS-pocket) of fast walking was assigned to walking. 4% (AS-hip) and 12% (AS-pocket) of fast walking was assigned to running activity. 87% and 86% of running was assigned to running activity, 10% and 14% to walking activities by the AS-hip and the AS-pocket, respectively. There were no significant differences between the two devices in all activities ( $p > 0.05$ ). The smiley appeared after 4 min 59 sec  $\pm 11$  sec. There was no significant difference to the 5 min level after which the smiley should appear. **Discussion** The ActiSmile is a small and easy manageable feedback device that measures precisely time spent in continuous walking and running when worn at the hip or in a trouser pocket. It gives the user a valid feedback on the achievement of HEPA recommendations. **References** (1) Pate RR et al. Physical activity and Public

Health. *Jama*, 273 (5), 402-07,1995. (2) Martin BW et al. Physical activity and health – what are the recommendations and where do we find the Swiss population? *Schw. Z. Sportmed. Sporttraumat.* 57 (2), 37 -43, 2009.

### INTRA- AND INTER-INSTRUMENT RELIABILITY OF THE ACTIWATCH 4 ACCELEROMETER IN A MECHANICAL LABORATORY SETTING

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**Introduction** The Actiwatch 4 (AW4) has been proposed as a valid measure of physical activity in children (Puyau et al., 2004), yet no studies have investigated its reliability. The purpose was to investigate in the AW4 in a controlled mechanical setting, the intra- and inter-instrument reliability of mean physical activity counts and time spent in moderate (MPA), vigorous (VPA), and moderate-to-vigorous physical activity (MVPA), which is the most frequently employed outcome in physical activity epidemiology studies in children (Janssen and LeBlanc, 2010). **Methods** Twenty seven AW4 were attached to an isokinetic dynamometer (Computer Sports Medicine Inc., Stoughton, MA, US) and subjected to constant speed angular movement for 30 mins at 50 deg/sec representing MPA (Condition A) & 200 deg/sec representing VPA (Condition B), with a repeat trial conducted. Reliability was assessed using coefficient of variation (CV), absolute percent error (APE), and intraclass correlation coefficients (ICC). Results Mean physical activity counts displayed acceptable reliability according to CV in both conditions, however the APEinter in Condition A was greater than the inter-unit threshold of 5% suggested by Esliger & Tremblay (2006) (A: CVintra=4.6%, APEintra=6.6%, CVinter=6.4%, APEinter=5.2%; B: CVintra=3.9%, APEintra=5.6%, CVinter=5.9%, APEinter=4.7%). Time spent in MPA and VPA displayed better reliability with low CV values observed and APEinter values of <5% (A: CVintra=3.2%, APEintra=2.3%, CVinter=4.3%, APEinter=3.2; B: CVintra=0.0%, APEintra=0.0%; CVinter=0.0%; APEinter=0.0%). Time spent in MVPA displayed excellent reliability (CVintra, APEintra, CVinter, & APEinter=0.0%) in both conditions. Discussion Mean AW4 activity counts exhibit reliability statistics that are comparable to other accelerometers (Esliger & Tremblay, 2006). Reliability is improved when activity counts are categorised as time spent in MPA and VPA, with MVPA displaying the greatest reliability. As MVPA is the subcomponent of physical activity most associated with health benefits in children (Janssen and LeBlanc, 2010), it would appear that the Actiwatch 4 is a reliable accelerometer for measuring time spent in this health enhancing physical activity category, at least from testing in a mechanical laboratory setting. References Esliger, D. W., & Tremblay, M. S. (2006). *Med Sci Sports Ex*, 38, 2173-2181. Janssen, I & LeBlanc, A.G. (2010). *IJBNPA*, 7, 40. doi:10.1186/1479-5868-7-40. Puyau, M. R., Adolph, A.L., Vohra, F.A., Zaker, I., & Butte, N.F. (2004). *Med Sci Sports Ex*, 36, 1625–1631.

### CRITERIA FOR USE OF PHYSICAL BEST AND FITNESSGRAM FOR ANALYSIS OF BODY MASS INDEX AND AEROBIC FITNESS IN CHILDREN AND ADOLESCENTS

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**CRITERIA FOR USE OF PHYSICAL BEST AND FITNESSGRAM FOR ANALYSIS OF BODY MASS INDEX AND AEROBIC FITNESS IN CHILDREN AND ADOLESCENTS** Oliveira, AR.1,2, Arruda, GA.1,3, Greca, JPA.1, Neri, FS.1, Cabral, L.I, Teixeira, M.1, Pires Jr, R.1 1: UEL (Londrina, Brazil), 2: CNPq, 3: CAPES (Brasilia, Brazil) **Introduction** The aim of this study was to assess the agreement between the criteria of the Physical Best (AAHPERD, 1988) and Fitnessgram (Meredith; Welker, 2004) for the Body Mass Index (BMI) and 1600m Run/Walk according to gender. **Methods** The subjects belonged to the same elementary school in Londrina (Parana, Brazil) and the Perobal Project at the State University of Londrina, a partnership with the Ayrton Senna Institute/AUDI:AG, Sao Paulo-SP. The sample involved 73 individuals, 39 boys 12.66 (1.56) years old; body mass 42.21 (13.22) kg, height 149.84 (9.82) cm; and 34 girls 12.34 (1.57) years, body mass 46.97 (12.60) kg, height 150.45 (7.99) cm. Only 43 participated in the Walking/1600 m run (N=73), with 23 boys 12.12 (1.47) years, body mass 42.24 (15.66) kg, Height 147.42 (9.37) cm; and 20 girls, 11.79 (1.41) years, body mass 45.17 (13.44) kg, height 148.30 (7.64) cm. Body mass and height were measured according to Gordon et al (1988) and calculated the BMI. The cardiorespiratory function was assessed through the walk/1600m (AAHPERD, 1988). The Kolmogorov-Smirnov test was used to analyze the distribution of variables. Mean and standard deviation were used to characterize the sample. The agreement level was evaluated by the percentage. Results The BMI mean was 18.55 (4.29) kg/m<sup>2</sup> in boys and 20.53 (4.26) kg/m<sup>2</sup> for girls. The mean time for the Run/Walk test was 12.32 (1.86) min. for boys and 14.77 (2.36) min. for girls. The BMI propositions agreed in 76.9% of cases for boys. Among the 74.4% of subjects who responded to the Physical Best 23.1% did not attend the Fitnessgram. The propositions mutually classified 70.6% of cases for girls. The 76.5% who attended the Physical Best 20.6% did not attend the Fitnessgram. Propositions classified in agreement 78.3% of individuals in the Run/Walk 1600m test. Among the 21.7% that met the criterion on the Fitnessgram no one attended the Physical Best. The proposals agreed on 100% of cases. Only 5% of girls met both criteria, and 95% did not attend any of the criteria. Discussion The proposals seem to agree on the predominant part of cases for both BMI (> 76.5%) and for aerobic fitness (> 78.3%). However for the BMI cutoff points of Fitnessgram were responsible for a higher proportion of non-attendance and the Run/Walk 1600 m test cutoff points of Physical Best. The use of different cutoff points for the same individual should be used with caution especially for the morphological component. References American Alliance for Health, Physical Education, Recreation and Dance (1988). Physical Best, AAHPERD. Meredith MD, Welk GJ. (2007) Fitness Activitygram Test administration Manual. 4th Ed. The Cooper Institute.

### VALIDITY OF THE ACTISmile WORN AT TWO MEASUREMENT SITES BY CHILDREN

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FEDERAL INSTITUTE OF SPORT

**Introduction** The aim of the present study was to validate the ActiSmile (Actismile, Bern-Liebfeld, Switzerland), a device that gives feedback to the user in terms of physical activity (PA) for children. **Method** The ActiSmile is a device that measures time spent in walking and running. The remaining time is classified as no activity. Nine children (7 girls and 2 boys, 8.8 ± 2.9 y, 1.38.1 ± 0.25 cm, 33.4 ± 13.7 kg) participated in the study. They wore one ActiSmile on a belt on the hip (hip device) and one in the trouser pocket (pocket device) except for biking, where the pocket device was moved into the sock of the subject. Five activities were performed such as moderate and fast level walking, moderate running, kickboarding and level biking. All activities were performed for 3 min and 25 s: as the ActiSmile records only one-minute activity blocks, i.e. blocks of 60 s, this allows some tolerance at the beginning and ending of the activities. Data of the ActiSmile was downloaded after every single activity to determine the proportion of time recognised as walking, running or no activity. Recognition rates of the two devices were compared using a Chi2-Test. Results Recognition rate of moderate level walking was 97% in the hip

device and the pocket device, respectively. Fast walking was mainly assigned to walking (hip device: 63%, pocket device: 75%) whereas a smaller part was assigned to running activity (hip device: 33% and pocket device 18%). The remaining time was classified as no activity. 79% and 72% of running was assigned to running activity, 14% and 21% to walking activities. The remaining time was assigned to no activity by the hip and the trouser device, respectively. 96% (hip device) and 100% (pocket device) of the activity kickboarding was assigned to walking. 6% was classified as no activity by the hip device. 90% of biking was classified as walking by the pocket device whereas the hip device classified 48% as walking. 52% (7%) of biking was assigned to no activity by the hip (pocket) device. A significant difference between the two devices was not found for any activity. Discussion The ActiSmile measures precisely time spent in continuous walking and running when worn on the hip or in a trouser pocket. It classifies frequent children-specific activities such as kickboarding and biking mainly as walking. Conclusion The ActiSmile is a small and easy manageable feedback device for children that recognises not only walking and running activities. It is able to identify other children-specific activities such as biking and kickboarding as moderate activities by assigning them to the activity walking.

#### UTILIZATION OF WORK RATE INCREMENT AS IMPORTANT PARAMETER OF AEROBIC FUNCTION DURING INCREMENTAL TREADMILL EXERCISE

IM, J.1, JEON, Y.2, KIM, D.3, KANG, Y.4, AHN, M.5, KIM, C.6, KIM, B.7

1,2,3,4,5:KAIST(S.KOREA), 6,7:DAEJEON U.(S.KOREA).

In this study, we verify  $VO_{2\text{gain}}(\Delta VO_2/\Delta \text{work rate})$  is useful parameter which can determine aerobic capacity through finding close correlation with Anaerobic Threshold( $AnT$ ) and Maximal Oxygen Uptake( $VO_{2\text{max}}$ ). As a result of this study, we certain that  $VO_{2\text{gain}}$  can be alternative variable for  $AnT$  and  $VO_{2\text{max}}$ , and also  $VO_{2\text{gain}}$  can be important mediator of regression equation for  $AnT$  or  $VO_{2\text{max}}$  estimation. For this way, we don't need to do further exercise testing for obtaining accurate  $AnT$  and  $VO_{2\text{max}}$ . Thirty seven male college students performed incremental treadmill exercise test. We derived regression equations and found significant correlations of  $VO_{2\text{max}}$  with  $VO_{2\text{gain}}$  ( $VO_{2\text{gain}} = 0.064(VO_{2\text{max}})+33.201$ ,  $SEE=\pm 23.35$ ,  $r=0.843$ ,  $P<0.01$ ),  $\Delta VO_2(VO_{2\text{gain}}(EE-3rd \text{ min}) = 0.068(VO_{2\text{max}})+32.717$ ,  $SEE=\pm 29.27$ ,  $r=0.801$ ,  $P<0.01$ ), and  $\Delta VO_2(VO_{2\text{gain}}(EE-6th \text{ min}) = 0.087(VO_{2\text{max}})+15.536$ ,  $SEE=\pm 59.68$ ,  $r=0.641$ ,  $P<0.01$ ). By analyzing relationship between  $VO_{2\text{gain}}$  and  $VO_2$  at  $AnT$ , we found brilliant correlation between them ( $VO_{2\text{gain}}=0.077(VO_2 \text{ at } AnT)+68.46$ ,  $SEE=\pm 29.65$ ,  $r=0.730$ ,  $P<0.01$ ). For these reasons,  $VO_{2\text{gain}}$  can widely use with other variables in oxygen uptake kinetics such as  $AnT$  and  $VO_{2\text{max}}$ . Finally we conclude  $VO_{2\text{gain}}$  has significant reliability in oxygen uptake kinetics.

## Poster presentations

### PP-PM19 Sports Nutrition: Supplements 2

#### ACUTE SUPPLEMENTATION WITH LEUCINE REDUCES A MARKER OF SKELETAL MUSCLE DAMAGE IN UNTRAINED RATS SUBJECTED TO AN ACUTE BOUT OF EXERCISE TO EXHAUSTION

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Introduction Recent studies have associated unusual high intensity physical exercise with subsequent muscle injuries. In this regard, amino acid supplementation stands out as an effective strategy in controlling cell damage, and researchers have demonstrated the potential of branched chain amino acids (BCAA) supplementation in reducing the extent of damage, and promoting muscle recovery (Anthony et al., 1999). As leucine plays an important role in regulating anabolic mechanisms stimulating the rate of mRNA translation mediated by the protein kinase mTOR (Anthony et al., 2001; Kimball e Jefferson, 2006), it is speculated what would be the possible effects of exclusive leucine supplementation in a model of strenuous and unusual physical activity. Thus, the aim of the present study is to evaluate the effect of leucine supplementation on serum creatine kinase levels – a marker of muscle damage – and on phosphorylation of proteins involved in mTOR pathway in the skeletal muscle of untrained adult rats subjected to an exercise session to exhaustion. Methods Therefore, 17 male adult Sprague-Dawley rats were divided into two groups receiving supplementation with either leucine (135 mg/100 g) or a mix of non-essential amino acids (43.35 mg/100 g) at the end of a session of acute exercise. The animals were killed 3 hours after the exercise session for blood sampling and excision, freezing and storing of skeletal muscle samples. Creatine kinase levels were obtained by spectrophotometry using a commercial kit and the protein phosphorylation was quantified by Western Blotting. Results We observed a significant reduction on serum creatine kinase levels in response to leucine supplementation. However, no effect was observed in the phosphorylation of mTOR, 4E-BP1 and S6K1. Discussion Stock et al., (2010) examined the effects of adding leucine to pre and postexercise carbohydrate beverages on selected markers of muscle damage and conclude that the leucine supplementation didn't reduce serum creatine kinase levels, but we observed that leucine supplementation caused a possible reduction on muscle damage in untrained rats subjected to acute exercise and, as no change was observed in mTOR activity, this effect does not seem to be associated with this pathway. References Stock MS, Young JC, Golding LA, Kruskall LJ, Tandy RD, Conway-Klaassen JM, Beck TW (2010) J Strength Cond Res;24,2211-9. Anthony JC, Anthony TG, Layman DK (1999) J Nutr;129,1102-6. Anthony JC, Anthony TG, Kimball SR, Jefferson LS (2001) J Nutr;131,856S-860S. Kimball SR, Jefferson LS (2006) Am J Clin Nutr;83, 500S-507S.

#### SHORT-TERM EFFECTS OF BCAA, ARGININE AND CLA SUPPLEMENTATION ON REST ENERGY EXPENDITURE AND BODY COMPOSITION.

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Background – Previous works assumed that the BCAA (branched- chain amino acids), L- arginine and CLA (conjugated linoleic acid) supplementation may affect rest energy expenditure (REE) and the decrease of fat rate.1,2,3,4 This study aims at testing whether these substances can actually increase rest energy expenditure and improve body composition. Methods and results – 25 healthy volunteers, aged 18-44 years have been tested. (Twenty-two men and three women among athletes, sportsmen/sportswomen, sports-practicing subjects and inactive subjects: in general all active). All subjects started a normocaloric and balanced diet 1 week before the first calorimetry test, keeping it on till the 2° test. They began the supplementation with two products available in the market: X-Treme CLA and X-

Treme NOX, (Inkospor Italy Ltd). One, CLA, contains conjugated linoleic acid and the other, NOX, contains branched-chain amino acids, arginine, green tea extracts, caffeine and vitamin C. Volunteers have been given the above mentioned integrators for two weeks. Rest energy expenditure (REE kcal/day), free mass rate (FFM %), fat mass rate (FM %), body weight (Kg) and BMI (Kg/m<sup>2</sup>), have been monitored before and after the two week cycle. Results - The supplementation intake has led to significant results as it follows: (\*p<0,005) (-1,24%) body weight, BMI (-1,25%), FM (-4,28%) and FFM(+1,07%). The REE hasn't led to significant results (p=0,0179) despite a 10,9 % increase. Beyond the results we need to highlight that six subjects were excluded from the REE average as the tests were not reliable for different reasons. Discussion - The results about REE and slight variations on body composition due to the two supplements intake are consistent with this study. We are convinced that the action of the ingredients taken singularly is not clear/evident. Even if the calorific increase of rest energy expenditure (REE) is slight, we think that it can help subjects control their weight. The combination between balanced diet and adequate physical activity may benefit the fat mass decrease and the improvement of body composition in sportsmen and inactive subjects. Even though the results are encouraging, medium- and long- term studies on these data are required in particular on rest energy expenditure and its variables affecting calorimetry. References: 1) She P, et al. Cell Metab. 2007 Sep;6(3):181-94. 2) McKnight JR, et al. Amino Acids. 2010 Jul;39(2):349-57. 3) Gaullier, J-M. et al. The American Journal of Clinical Nutrition Vol. 79(6):1118-1125, Jun 2004 4) Westerterp-Plantenga MS, et al. Obes Res. 2005 Jul;13(7):1195-204. 5) Lee MS, et al. Ann Nutr Metab. 2009 Apr 22 Thanks to: INKOSPOR (Itd); COSMED Italy

## EFFECT OF SUPPLEMENTATION WITH ASTAXANTHIN ON THE MUCOSAL IMMUNITY IN YOUNG ELITE SOCCER PLAYERS

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Introduction Prolonged physical exertion may lead to post exercise suppression of mucosal immune parameters. We investigated the effect of astaxanthin (Asx) supplementation on salivary IgA (sIgA) responses in young soccer players following 2 hours of forced training. Methods 35 soccer players (age 17.9±0.72 years), were randomly divided into 2 groups: astaxanthin (Asx) and placebo (P) group. The Asx group was supplemented with 4 mg of Asx. Saliva samples were obtained before and after the forced training. We have done analysis before, after 45 and after 90 days of supplementation. Saliva samples were analyzed for sIgA concentrations by ELISA test. sIgA secretion rate (mg/min) was determined by multiplying the absolute sIgA concentration (mg/ml) with saliva flow rate (ml/min). Results: In the pre-supplemental period training induced significant decrease in sIgA concentration and sIgA secretion rate in young elite soccer players (p<0.05). Significant pre- to post-training decrease in sIgA concentration and sIgA secretion rate was also observed after 45 and 90 day of supplementation in both Asx and P group (p<0.05). However, significant effect of Asx supplementation was observed in pre-training sIgA concentrations and sIgA secretion rate. In Asx group, these parameters remained unchanged after 45 days of supplementation, but increased significantly over the remaining time (p<0.05). In P group, we detected decrease in sIgA response after 45 days and 90 days of observational period, but without statistical difference. Conclusion: Asx supplementation did not attenuate exercise-induced decrease in sIgA response. However, increase in resting IgA concentrations and sIgA secretion rate in Asx group suggest that the astaxanthin supplementation could improve mucosal immunity after a minimal period of 90 days of regular taking of Asx. Glesson M, Pyne D. (2000). Immunology and Cell Biology, 78, 536–544. Higuera-Ciapara I, Félix-Valenzuela L, Goycoolea F. (2006) Critical Reviews in Food Science and Nutrition, 46(2), 185-196.

## BRANCHED-CHAIN AMINO ACID SUPPLEMENTATION ON EXERCISE-INDUCED MUSCLE DAMAGE: A PILOT INVESTIGATION

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Introduction Branch chain amino acids (BCAA) are a substrate for protein synthesis and have been shown to conserve muscle mass and be beneficial to conditions characterised by protein loss and catabolism (1). Evidence suggests BCAA to be of benefit in recovery from heavy endurance activity (3). However only one investigation (2) has examined the efficacy of BCAA following a damaging bout of eccentrically biased resistance exercise that was designed specifically to cause temporary muscle damage; this was conducted with untrained individuals using an isolated muscle group. Therefore the aim of this study was investigate the effect of BCAA supplementation on recovery from a damaging bout of sport specific eccentrically biased exercise in resistance-trained individuals. Methods Twelve volunteers were supplemented with either 20 g of BCAA or placebo for 7 days prior to, and 4 days following a damaging bout of eccentric biased exercise in a double blind, randomized trial. Additional BCAA or placebo (20 g) was administered before and following the exercise. The damaging bout consisted of 100 drop-jumps from a 60 cm platform. Indices of muscle damage; creatine kinase (CK), maximum isometric voluntary contraction (MVC), vertical jump (VJ), muscle soreness (DOMS) and thigh and calf limb girth were taken pre-exercise, 24, 48, 72 and 96 h post-exercise. Results There was significantly less CK (P = 0.028; 95% CI – 5-67 IU/L) and DOMS (P < 0.001; 95% CI – 11-32 mm) in the BCAA group). In addition, the decrement in MVC was less (73% vs. 82%) in the BCAA group (P = 0.01; 95% CI – 1.4-8.4%). There were no differences between groups for VJ, or limb girth. Discussion Twelve days of BCAA supplementation taken before and following a damaging bout of heavy plyometric exercise provides a protective effect from the negative signs and symptoms of muscle damage. Although the mechanisms of action are not fully understood, it has been postulated that BCAA supplementation modulates protein and/or the secondary inflammatory process associated with heavy exercise (1). Our observations support others (2,3) that demonstrated a positive effect with BCAA supplementation following heavy exercise. The current data extend this knowledge to support the efficacy of BCAA supplementation before and following high intensity plyometric exercise. References 1. Bianchi G, Marzocchi R, Agostini F. & Marchesini G. (2005). Update on nutritional supplementation with branched-chain amino acids. Cur Opin Clin Nut Met Care, 8, 83-87 2. Jackman SR, Witard OC, Jeukendrup AE, Tipton KD. (2010). Branched-chain amino acid ingestion can ameliorate soreness from eccentric exercise. Med Sci Sports Exerc, 42, 962-967 3. Matsumoto K, Koba T, Hamada K, Sakurai M, Higuchi T, & Miyata. (2009). Branched-chain amino acids supplementation attenuates muscle soreness, muscle damage and inflammation during an intensive training programme. J Sports Med Phys Fitness, 49, 424-31



## READINESS TO INVEST EFFORT IS AUGMENTED FOLLOWING INGESTION OF A CAFFEINE CONTAINING ENERGY DRINK PRE AND POST RESISTANCE EXERCISE

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**Introduction** Recent research has suggested that there is a need to examine the effects of caffeine containing supplements on resistance exercise performance (Beck et al., 2008) and that scientists examine psychological variables, such as readiness to invest effort, alongside performance with caffeine ingestion (Astorino and Roberson, 2010). The aim of this study was to examine the effect of a caffeine containing energy drink 'Quick Energy' on repetitions to failure and readiness to invest effort pre to post resistance exercise. **Methods** Following ethics approval and informed consent, 11 resistance trained individuals underwent assessment of 1 repetition maximum testing (1RM) in the bench press, deadlift, barbell row and back squat. Participants then completed two trials (caffeine and placebo) separated by 72 hours and 72 hours post 1RM testing. Participants ingested solutions containing 'Quick Energy', an energy drink containing 125mg caffeine or a placebo diluted into 250ml artificially sweetened water in a double blind, randomised order. 60mins post ingestion, participants completed a resistance exercise session comprising of repetitions to failure at 60%1RM in each of the 4 exercises separated by 5mins rest. Prior to ingestion, prior to exercise and post exercise participants also completed measures of readiness to invest physical (RTIPE) and mental (RTIME) effort (Tenenbaum et al., 2001). **Results** Participants completed significantly more repetitions to failure and reported significantly greater RTIME ( $P = .05$ ) in the presence of caffeine compared to placebo ( $P = .05$ ). A significant solution X time interaction ( $P = .05$ ) for RTIPE indicated a greater increase in RTIPE pre ingestion to pre exercise and higher RTIPE post exercise in the presence of the caffeine containing energy drink compared to placebo ( $P = .05$ ). **Discussion** These results support prior claims that caffeine containing supplements can enhance resistance exercise to failure (Beck et al., 2008). This study indicates consumption of a caffeinated solution also resulted in greater readiness to invest effort, agreeing with prior data (Tenenbaum et al., 2001). In this case of RTIPE, ingestion of caffeine not only resulted in increased RTIPE before exercise but also a smaller decline in RTIPE post resistance exercise compared to placebo. The results of the present study suggest that consuming the energy drink 'Quick Energy' can augment readiness to invest effort over consumption of a placebo solution pre and post exercise. **References** Astorino TA, Roberson DW. (2010). J Strength Cond Res, 24, 257-265. Beck TW, Housh TJ, Malek MH, Mielke M, Hendrix R. (2008). J Strength Cond Res, 22, 1654-1658. Tenenbaum G, Hall HK, Calagnini K. (2001). J App Soc Psych, 31, 1582-1626.

## THE EFFECT OF A CAFFEINE CONTAINING ENERGY DRINK 'QUICK ENERGY' ON REPETITIONS TO FAILURE, PERCEIVED EXERTION AND PAIN PERCEPTION FOLLOWING RESISTANCE EXERCISE

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**Introduction** The effect of caffeine on endurance performance is well reported but less research is available in relation to resistance exercise performance (Duncan and Oxford, 2011). Research has suggested that scientists examine the effect of caffeine containing supplements on multiple resistance exercises rather than examining one exercise only as is common (Duncan and Oxford, 2011). The aim of this study was to examine the effect of a caffeine containing energy drink 'Quick Energy' on repetitions to failure, perceived exertion and pain perception following a bout of resistance exercise. **Methods** Following ethics approval and informed consent, 11 resistance trained individuals underwent assessment of 1 repetition maximum testing (1RM) in the bench press, deadlift, barbell row and back squat. They then completed two trials (caffeine and placebo) separated by 72 hours. Participants ingested solutions containing 'Quick Energy', an energy drink containing 125mg caffeine or a placebo diluted into 250ml artificially sweetened water in a double blind, randomised order. One hour post ingestion, participants completed a resistance exercise session comprising of repetitions to failure at 60%1RM in the 4 exercises separated by 5mins rest. Rating of perceived exertion (RPE) and pain perception were assessed following each exercise using the Borg (1970) 6-20 scale and Cook (1998) pain scale. **Results** Participants completed significantly more repetitions ( $P = .02$ ) and RPE was significantly lower in the caffeine condition compared to placebo ( $P = .002$ ). Irrespective of solution ingested, RPE was lower ( $P = .001$ ) for upper body compared to lower body exercises. Pain perception was also lower with caffeine compared to placebo ( $P = .001$ ). **Discussion** These results support claims that caffeine ingestion enhances resistance exercise to failure and dampens RPE (Duncan and Oxford, 2011). In this case the dose of caffeine ingested, in the form of an energy drink, was lower than doses previously found to be ergogenic (Astorino and Roberson, 2010). Prior research has also suggested caffeine ingestion reduces pain perception during aerobic exercise (Cook et al., 1998). The current study supports suggestions (Astorino and Roberson, 2010), that this is also the case for resistance exercise. The results of the present study suggest that consuming the energy drink 'Quick Energy' results in enhanced resistance exercise performance and dampened perceptions of pain and exertion. **References** Astorino TA, Roberson DW. (2010). J Strength Cond Res, 24, 257-265. Borg G. (1970). Scand J Rehab Med, 2, 92-98. Cook DB, et al. (1998). Int J Neurosci, 95, 183-202. Duncan M, Oxford S. (2011) J Strength Cond Res, e-pub head of print.

## EFFECTS OF CAFFEINE, SODIUM BICARBONATE AND THEIR COMBINED INGESTION ON HIGH-INTENSITY CYCLING PERFORMANCE

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**EFFECTS OF CAFFEINE, SODIUM BICARBONATE AND THEIR COMBINED INGESTION ON HIGH-INTENSITY CYCLING PERFORMANCE** Kilding, A.E., Overton, C. and Gleave, J. Sport Performance Research Institute New Zealand, AUT University, Auckland, New Zealand **Introduction** In recent years, the practice of consuming potentially performance enhancing nutritional ergogenic aids by athletes has become increasingly prevalent. Previous studies have documented that caffeine and sodium bicarbonate, amongst other substances, can enhance exercise performance (e.g. Jenkins et al 2008; Requena et al 2005). However, research considering the effects of simultaneous ingestion of caffeine and sodium bicarbonate prior to high-intensity exercise is limited (Pruscino et al 2008). Thus, the aim of the present study was to compare the effects of ingesting caffeine and sodium bicarbonate on 3 km laboratory time trial (TT) performance when taken individually and simultaneously. **Methods** Adopting an acute, double-blind, crossover design, 10 well-trained cyclists (age  $24.2 \pm 5.4$  yrs) completed four 3 km TT's on a laboratory-based cycle ergometer. At specific times prior to each TT, participants ingested either: 3 mg/kg body mass (BM) of caffeine (CAFF); 0.3 g/kg BM of sodium bicarbonate (SB); a combination of both (CAFF+SB); or a placebo (PLAC). Prior to and during each 3 km time trial, physiological, perceptual, and performance measurements were determined. **Results** In CAFF, SB, and CAFF+SB, mean power output during 3 km TT's was improved compared to PLAC (2.4, 2.6, and 2.7% respectively), resulting in a faster

time to completion (-0.9, -1.2, and -1.2% respectively). Effects sizes (ES) for all trials were similar (0.21 to 0.24). A significant increase in post-TT blood lactate, pH, and NaHCO<sub>3</sub> was noted in SB and in CAFF+SB when compared to CAFF and PLAC trials ( $P < 0.05$ ). No significant differences between conditions were observed with regards to perceived gastric discomfort ( $P < 0.05$ ). Discussion When ingested individually, both caffeine and sodium bicarbonate enhanced high-intensity exercise performance in trained cyclists. However, simultaneously ingesting caffeine and sodium bicarbonate prior to high-intensity exercise trials did not further enhance the ergogenic effect and therefore this practice is not recommended. References Jenkins NT, Trilk JL, Singhal A, O'Connor PJ, Cureton KJ. (2008). Int J Sport Nutr Exerc Metab; 18, 328-342 Pruscino CL, Ross ML, Gregory JR, Savage B, Flanagan TR. (2008). Int J Sport Nutr Exerc Metab; 18, 116-130 Requena B, Zabala M, Padial P, Feriche B. Sodium bicarbonate and sodium citrate: ergogenic aids? J Strength Cond Res 2005; 19: 213-224

### GLYCEROPHOSPHOCHOLINE INTAKE ENHANCES GROWTH HORMONE SECRETION AND FAT METABOLISM IN YOUNG SUBJECTS

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Background: Choline is an important nutrient, which relates to cholinergic neuronal action as well as fat and cholesterol metabolism. Since choline is not synthesized in vivo, it needs to be ingested from food, such as beans and eggs. Glycerophosphocholine (GPC) synthesized from bean, has been used for medicines and supplement. GPC is a putative acetylcholine precursor, which could potentially enhance growth hormone (GH) secretion through acetylcholine-induced catecholamine. Purpose: The primary aim of the study was to clarify whether an acute intake of GPC enhances GH secretion. Furthermore, the secondary aim of the study was to investigate whether GPC-induced change in GH secretion concomitantly affects fat metabolism in the liver. Methods: To reveal GH and fat metabolism responses by an acute intake of GPC, eight healthy male ( $25 \pm 1$  years) subjects participated in the study. Fasting blood samples were obtained before and additional samples were taken at 30, 60 and 120 min after 1000 mg GPC intake. Moreover, all subjects repeated an identical protocol with placebo intake on another. Blood samples were analyzed for hormones and metabolites. Results: Plasma total choline levels significantly increased at 60 and 120 min after GPC intake. In response to a single dose of GPC, plasma GH secretion was enhanced significantly after 60min, whereas no significant change was observed for the placebo intake. Additionally, plasma free fatty acid (FFA) was raised at 120 min after GPC intake as compared with the placebo intake. Plasma acetoacetate and 3-hydroxybutyrate levels, which are the indexes of fat metabolism in the liver, both increased at 120 min after GPC intake, but no change was seen after placebo intake. GH, FFA, acetoacetate and 3-hydroxybutyrate alterations are greater at GPC intake compared with the placebo intake. No significant change in plasma glucose level was observed in either group. Conclusion: In response to an acute intake of GPC, GH secretion was enhanced in concomitant with plasma choline level. Furthermore, significant increase in FFA and concomitant increase in acetoacetate and 3-hydroxybutyrate were observed only after the choline intake. These findings suggest that a single dose of GPC intake may enhance GH secretion and fat metabolism in concomitant increase with choline level in young subjects. Grants: Supported by KAKENHI of the Japan Ministry of Education, Culture, Sports, Science and Technology (MEXT).

### EFFECTS OF CAFFEINE SUPPLEMENTATION ON THE INFLAMMATORY RESPONSE INDUCED BY A 15 KM-RUN COMPETITION

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Introduction Caffeine is commonly used by endurance athletes to improve performance. In addition to the ergogenic effects, caffeine could influence the inflammatory response induced by exercise because of its effects on catecholamines and because immune cells are one of the targets of caffeine. The aim of the study was to determine the effect of caffeine supplementation on the inflammatory response induced by physical activity in a competition. Methods A double-blinded study of supplementation with caffeine was performed. Athletes participating in the study ( $n=33$ ) completed a 15-Km run competition. Before competition athletes took 6 mg/kg body weight of caffeine (caffeine group,  $n=17$ ) or a placebo (placebo group,  $n=16$ ). Blood samples were taken before competition, immediately after finishing the competition and, also, two hours after finishing the competition. White blood cell counts, plasma AST and CK activities, as well as IL-6 and IL-10 levels were measured. Furthermore, IL-10 mRNA leukocyte expression was also measured by Real-time RT-PCR. Results The competition induced muscle damage, characterized by significant and similar increases in CK and AST activities in both placebo and caffeine groups. Caffeine supplementation induced higher increases in circulating total leukocyte count and neutrophils, with significant differences between groups after the short recovery period. However, caffeine ingestion did not influence lymphocyte response to the competition. Increases observed in IL-6 and IL-10 plasma levels after the competition were higher in the caffeine than in the placebo group. Total leukocyte IL-10 mRNA levels in response to the competition were similar in both groups, with significant increases two hours after finishing the competition. Discussion Changes observed in leukocyte counts were in agreement with previous results. It has been reported that caffeine supplementation induced higher increases in neutrophil number due to increased catecholamine levels in response to exercise and supplementation. IL-6 and IL-10 response to exercise was influenced by caffeine, with higher increases in the caffeine group. IL-6 has been proposed as the key factor in the response to exercise. In fact, IL-10 increases in response to IL-6. Because IL-6 and IL-10 have been classified as anti-inflammatory cytokines, caffeine supplementation seems to enhance the anti-inflammatory response to exercise. References Graham, T.E. Sports Med, 2001. 31(11): p. 785-807. Graham, T.E. and L.L. Spriet, J Appl Physiol, 1995. 78(3): p. 867-74. Pedersen, B.K., et al. Proc Nutr Soc, 2004. 63(2): p. 263-7.

### EFFECTS OF A COMBINED TREATMENT WITH CAFFEINE AND EXERCISE ON INSULIN RESISTANCE IN SKELETAL MUSCLES AND LIVER

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PURPOSE: Keijzers reported that caffeine decreased insulin sensitivity by ~15% in healthy humans. Caffeine is known to promote lipolysis and enhance energy expenditure. Therefore, chronic consumption of caffeinated beverages may improve insulin resistance (IR). Moreover, it would be interesting to elucidate whether a combination of caffeine and exercise improves IR through reduction in visceral fat mass (VFM) and triglyceride (TG) content and increases glycogen (Gly) accumulation in the liver and skeletal muscles. The present study aimed to clarify the effects of caffeine intake and exercise and their combined effects on VFM and the contents of TG and Gly, known as

indicators of insulin resistance, in obese diabetic OLETF rats. **METHODS:** Twenty-four OLETF rats were divided into the following groups: sedentary (-Sed), exercise (-Ex), caffeine (-Caf), and a combination of exercise and caffeine group (-Ex & Caf). Each treatment was conducted in rats from 25 to 29 weeks of age. Rats in the -Caf and -Ex & Caf groups were fed rat chow containing 0.25% caffeine. Rats in the -Ex and -Ex & Caf groups were allowed to voluntarily run every day. Body weight (BW) and blood pressure were measured once every week. After completion of the 5-week treatment, blood samples were collected. Fasting blood glucose (FBG), insulin, leptin, and lipid concentrations were measured. HOMA-IR was also calculated. The liver, skeletal muscles, and VFM were weighed. The TG and Gly contents in the liver and quadriceps femoris were measured. **RESULTS AND DISCUSSION:** FBG and HOMA-IR remarkably improved in the case of rats in the -Ex and -Ex & Caf groups after the treatment. In particular, VFM tended to be lower in the -Ex & Caf group than in the -Ex group and the -Caf group. The liver TG and Gly contents were considerably higher in the -Sed group than in the other 3 groups. The results of the present study indicate that chronic consumption of caffeine improves IR in the liver and skeletal muscles, decreases TG content in the skeletal muscle and the liver, and increases Gly content in the quadriceps femoris. Interestingly, a combined treatment with caffeine and exercise considerably decreased TG content in the liver and increased Gly content in the quadriceps femoris; however, the TG content in the quadriceps femoris and the Gly content in the liver did not differ between the -Ex, -Caf, and -Ex & Caf groups. **CONCLUSION:** The results suggest that a combined treatment with caffeine and exercise is more efficacious than is single treatment with either caffeine or exercise for improving IR in the skeletal muscles and for reducing VFM and serum lipid concentrations.

### EFFECTS OF CAFFEINE SUPPLEMENTATION ON OXIDATIVE STRESS AND ENERGETIC METABOLISM IN A 15 KM-RUN COMPETITION

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**Introduction** Caffeine is an ergogenic aid commonly used by endurance athletes. It has been suggested that caffeine, as a consequence of ergogenic mechanisms, could increase oxidative stress induced by exercise. The aim of the study was to determine the effect of caffeine supplementation on energy metabolism parameters and on the oxidative stress induced by physical activity in a competition. **Methods** A double-blinded study of supplementation with caffeine was performed. Athletes participating in the study (n=33) completed a 15-Km run competition. Before competition, athletes took 6 mg/kg body weight of caffeine (caffeine group, n=17) or a placebo (placebo group, n=16). Blood samples were taken before competition, immediately after finishing the competition and, also, two hours after finishing the competition. Caffeine, glucose, free fatty acids and lactate levels were measured in plasma. Furthermore, oxidative stress markers (MDA and lipid hydroperoxides) as well as antioxidant (vitamin C and uric acid) levels were also determined in plasma. **Results** Plasma caffeine was detected only in the caffeine group after supplementation. Glucose and lactate plasma levels increased after the competition, with significant higher increases in the caffeine group than in the placebo one. However, no differences between groups were observed in plasma free fatty acids levels, which had been also increased after the competition. Oxidative stress markers increased after the competition. Lipid hydroperoxides increases were higher in the caffeine group than in the placebo one. MDA increases were non significantly higher in the caffeine group. Similar increases were observed in both groups after the competition in plasma vitamin C and uric acid levels. **Discussion** Results obtained in the present study confirm the paradoxical finding that caffeine supplementation induces higher increases in lactate levels in response to exercise. It has been suggested that this response could be induced by an effect of caffeine on lactate clearance. On the other hand, this study revealed a possible effect of caffeine increasing oxidative stress characterized by markers such as lipid hydroperoxides, with a significant difference between groups, and MDA, with a non significant difference between groups. **References** Graham, T.E. Sports Med, 2001. 31(11): p. 785-807. Olcina, G.J., et al. J Sports Sci Med, 2006. 5: p. 621-628. Azam, S., et al. Med Sci Monit, 2003. 9(9): p. BR325-30.

## Poster presentations

### PP-BN05 Biomechanics: Methodologies

#### MATHEMATICAL MODEL FOR THE EFFECTS OF ACCELERATIONS AND DECELERATIONS DURING VARIABLE POWER CYCLING TIME TRIAL PERFORMANCE

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**Mathematical model for the effects of accelerations and decelerations during variable power cycling time trial performance** M. Wells.1, G. Atkinson.2 and S. Marwood.1 1:Faculty of Science and Social Sciences (Liverpool Hope University, Liverpool) 2:R.I.S.E.S (Liverpool John Moores University, Liverpool) **Introduction** Previous researchers have modelled the impact of stochastic versus constant power output during a cycling time trial (TT) and demonstrated an increase in the time to complete a flat, windless course when power output fluctuates (Swain, 1997; Atkinson et al., 2007). These researchers modelled relatively long variation periods (5 km and greater) and considered the effects of acceleration and deceleration to be negligible. We aimed to examine the effects of more frequent variations in power output and include acceleration/deceleration components in our model of cycling. **Methods** We used a previously validated equation of motion (Martin et al., 2006) and forward integration (2 Hz) to account for the effects of acceleration and deceleration. Assuming a starting speed of 1m.s<sup>-1</sup>, the time to complete a flat, windless 40-km TT was calculated utilising a hypothetical rider with a mass of 70 kg, bicycle mass of 10 kg and a drag area of 0.2914 m<sup>2</sup>. A range of mean power outputs of 200 – 600 W (50 W increments) were considered and within-race power was systematically varied by  $\pm 0$ ,  $\pm 5$ ,  $\pm 10$  or  $\pm 15\%$  for periods of variation of 1.25, 2.5, 5, 10, 20 and 40 km; all possible combinations were modelled. **Results** Increasing the amplitude of variation and period of power variation caused independent increases in completion time. For a mean power output of 400 W, there was an increase in completion time of 0.02, 0.09 and 0.23% when the amplitude of variation during 5-km periods was increased from 0% (constant state) to 5, 10 and 15%, respectively. When the period of variation was decreased from 40 km (constant state) to 20, 10, 5, 2.5 and 1.25 km with 10% amplitude of variation, there was an increase in completion time of 0.10, 0.10, 0.09, 0.09 and 0.07% respectively. This negative impact of increasing amplitude and period of variation was attenuated as mean power output increased. **Discussion** The present data, which controlled for the influences of acceleration and deceleration, demonstrate that constant, versus variable, power output produces the shortest TT duration when external conditions are constant. However, the effects of varying power output decrease as the amplitude and period of variation are reduced. Though attenuated at higher power outputs these effects are reasonably consistent, suggesting that regardless of ability cyclists should attempt to maintain the

highest possible constant power output. References Atkinson G, Peacock O, Passfield L. (2007). *Journal of Sports Science*, 25, 1001-1009. Martin J, Gardner A, Barras M, Martin D. (2006). *Med Sci Sports Exerc*, 38, 592-597. Swain D. (1997). *Med Sci Sports Exerc*, 29, 1104-1108.

### **NORMALIZATION OF KNEE EXTENSOR SURFACE EMG TO JOINT ANGLE**

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**Introduction** Surface electromyography (sEMG) normalization is the process of comparing a referenced contraction to those collected within or between testing sessions increasing reliability when comparing measurements between different trials or days. sEMG signals are often normalized to a given force or velocity, however, joint angle is rarely taken into account. Maximal muscle activity changes with joint angle due to a range of factors and it is important to perform normalization when sEMG is measured over a large (range of motion) ROM. **Methods** Sixteen healthy physically active men (n=8) and women (n=8) performed large ROM (110°-0°) isokinetic knee extensions at 30°·s<sup>-1</sup>, during which joint position and sEMG of the vastus lateralis (VL), medialis (VM) and rectus femoris (RF) were recorded and analyzed using a custom LabView program. sEMG signals (2000 Hz) were full-wave rectified, filtered using a Butterworth 6th-order 10-500Hz bandpass filter, and smoothed using a 2nd-order 6-Hz linear envelope. Treated signals were then fitted to one of four joint angle-sEMG models: linear (Lin) or 2nd (2P), 3rd (3P) or 4th (4P) order polynomials. The mean-squared error (MSE), sEMG activation range and sEMG values at 0°, 45°, 90° and 110° knee flexion were compared between normalization models. Ten subjects performed an additional five isotonic knee extensions using a range of loads. sEMG was then normalized using the four joint angle-sEMG models as well as to the peak RMS (2.5s window). Repeated measures ANOVAs with Bonferroni post hoc tests were used to determine differences between the four normalization methods ( $p < 0.05$ ). Results Maximal muscle activation varied significantly between joint angles for the RF (25%), VM (16%) and VL (12%). The average MSE decreased for all recorded knee flexors as the complexity of the fitted curve increased (Lin<2P<3P<4P), but increases were not always statistically significant. However, differences in signal variance and MSE were observed between Lin and 2P for VL and 2P and 3P for VM and RF. Differences between normalization models were greatest at 0° and 110° for the RF and VM muscles. sEMG signals corrected for knee angle during isotonic trials had significantly greater peak and average values than when normalized using the peak RMS. **Conclusions** Maximal sEMG values were influenced by joint angle. Also, signals normalized to knee angle were significantly different to those normalized using peak RMS, supporting the efficacy of a knee angle-dependent normalization model. All normalization models appeared to provide valid corrections, but using 2P when correcting for VL and 3P when correcting for RF and VM better match the true signals than less complex processing methods.

### **3D ACCELEROMETER AS A TOOL FOR SPEED DEVELOPMENT IN SPRINT**

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**Introduction** Sprint running is a very dynamic sporting activity where intensive events and impact forces occur in very short time intervals. Inefficient and uneconomical running results in lower maximal speeds and increase of musculoskeletal injuries. However it is generally accepted that sprint performance can improve considerably with training. Because of the limitation and subjectivity of our senses different tracking systems are used. **Methods** There are currently several fundamental tracking technologies, such as mechanical, optical, acoustic and inertial tracking. Among these, inertial tracking technology has attracted considerable interest since accelerometer technology has advanced significantly, making these devices small, light and portable enough to be placed on the athlete body. We used a triaxial accelerometer LIS331HH (ST Microelectronics, USA), that returns a real valued estimate of acceleration along the x, y and z axes. The accelerometer is capable of sensing accelerations up to 24 g. The sensor unit (HSS1, TMG-BMC, Ltd., Slovenia) included a triaxial accelerometer, triaxial gyroscope, microcontroller and a wireless module. Whole unit weighted 25 grams. Data were sampled at 1 kHz, stored in internal memory or transmitted wirelessly to a computer, allowing for measurements to be taken on a track in real competitive or workout situation. A group of sprinters (six females and two males) running 40 m flying were monitored with the sensor unit attached to the lumbar spine (L4-L5 position). Running speed was approximately 10 m/s for males and 9.4 m/s for females. During this near to constant velocity phase athletes made 17-18 steps. Since human running is a periodic system in dynamic equilibrium (Hamill & al. 1995) a special algorithm was designed to detect individual steps in accelerometer signal. Several identification strategies are possible but we obtained the most robust results with localizing maxima and minima within a fixed interval. Because the individual steps are not equidistant, dynamic time warping was used. Thus aligned signals are suitable for further statistical analysis or for mapping characteristics of the reference step to others. **Results** Different kind of asymmetrical movement was found at nearly all sprinters. The asymmetry could be as large as 20 %. **Discussion** Described method allows us to easily detect the errors in the running technique. The obtained results also demonstrate that fatigue influences the signal pattern. We demonstrate that the use of 3D accelerometer and data analysis software can help us optimize the training, increase running efficiency and reduce the risk of injuries. References Hamill J, Derrick TR, Holt KG. (1994) *Hum. Mov. Scie.*, 14: 45-60.

### **CHOOSING THE RIGHT BODY POSITION FOR ASSESSING TRUNK FLEXORS AND EXTENSORS TORQUE OUTPUT**

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**Introduction** Sitting position is generally adopted when measuring torques produced by flexors and extensors of the trunk (Wit A., 1992). Results of such measurements are influenced by the strength of both abdominal muscles and flexors of the hip joint. In order to assess the effect of exercises used to strengthen the abdominal muscles it was necessary to find such a measuring position which engaged mainly the abdominal muscles. The objective of the study was an assessment of EMG activity of abdominal and spinal muscles during the measurements of muscle torques in the sitting position, as well as in the lying position. **Methods** Thirteen female students of the University School of Physical Education in Wrocław participated in the study. The methods of measuring muscle torques and surface electromyography (sEMG) were used under static conditions. The torques were measured on a multifunctional chair in the lying and sitting position (Szpala et al., 2010). The surface EMG electrodes were placed on the right and left hand side of m. rectus abdominis (RA) and m. erector spinae (ES) (Clark et al., 2003). Signals from both muscles were sampled at 1000 Hz. **Results** The maximal torques of trunk flexors in the sitting position and in the lying position were similar: 130.6±31.7 Nm and 129.8±37.9 Nm, respectively. By contrast, the torque of trunk extensors was significantly larger when the measurement was carried out in the sitting position (228.1±76.4 Nm) as compared with the lying position (148.8±25.3 Nm). The ratio of the maximal torques of flexors and extensors of the trunk in the examined

women was 0.572 in the sitting position and 0.872 in the lying position. Both RA and ES showed higher EMG activity in the lying position than in the sitting position. Discussion The higher EMG activity of the RA muscle in the lying position at the same values of the trunk flexors torque in both positions may suggest that in the sitting position flexors of the hip joint are more engaged than abdominal muscles. That is why, in order to assess the effects of abdominal muscles training, measurements of the trunk flexors torque should be performed in the lying position (Szpala et al., 2011) References Wit A. (ed.) (1992) Biomechanical assessment of the athlete's system of movement. Institute of Sport, Warszawa, 21–52 [in Polish]. Szpala A, Rutkowska-Kucharska A, Drapala J, Brzostowski K, Zawadzki J, (2010) Acta Bioeng Biomech, 12(4), 11-18. Clark KM, Holt L, Sinyard J, (2003) J Strength Cond Res, 17 (3), 475-483. Szpala A, Rutkowska-Kucharska A, Drapala J, Brzostowski K, (2011) Hum Mov, 12(1), 58-65. Acknowledgments This work is supported by the research grant N N404 155834 from the Polish Ministry of Science and Higher Education

### **"DGPSANA": ADVANCED RTK-GNSS DATA ANALYSIS IN ALPINE SKIING DAILY TRAINING**

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"DGPSana": ADVANCED RTK-GNSS DATA ANALYSIS IN ALPINE SKIING DAILY TRAINING Supej, M. Dept. of Biomechanics, Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia Introduction It has been shown that among the fastest alpine skiers time differences in shorter sections along the course can vary by 10% (Supej & Cernigoj, 2006). Despite that, the technique and/or tactical differences are often too minute to observe with the naked eye. Furthermore, established photocells provide only limited time information. The aim of the present study was to demonstrate the usefulness of a high-end Global Navigation Satellite System (GNSS) in daily alpine ski training, by using custom-built analysing routines. Methods Two elite skiers participated in the study, each performing four runs through a 29-gate long slalom course. The runs were simultaneously recorded with a camcorder and an RTK GNSS Leica GX1230 GG (Leica Geosystems AG, Heerbrugg, Switzerland). The GNSS surveys positions with 1–2 cm accuracy at a 20 Hz sampling rate. Skis and centre-of-mass trajectories were calculated using the methodology described by Supej et al. (2008). A "DGPSana" custom-built analysis system was designed in Matlab R2007a (Mathworks Inc., Natick, MA) in order to calculate and analyse the mechanical parameters simultaneously with recorded video clips. Results DGPSana enabled detailed analysis of the recorded data after the training session. The gate-to-gate lag times showed differences between the runs ranging up to 0.1 s (10%). For each run, sections of different performance levels were identified using cumulative gate-to-gate lag times. In addition, the *diffle\_mech* (Supej 2008) values showed the exact location where the skier's energy behaviour was good or poor. The centre-of-mass velocities were used to examine the consequences of energy behaviour. Finally, the comparison of trajectories demonstrated the differences in skied lines. Discussion The results demonstrated the high usability of the RTK GNSS data for daily training purposes, when they were analysed using DGPSana. The methodology enables 1) quantifying skiers' mistakes and 2) identifying differences that cannot be observed by a computer-aided video analysis. Finally, RTK GNSS with DGPSana provides coaches a daily training tool to judge technique and tactics differences more precisely. References Supej, M., Cernigoj, M. (2006). Relations between different technical and tactical approaches and overall time at men's world cup giant slalom races. Kinesiol. Slov, 12(2) 59–68. Supej, M. (2008). Differential specific mechanical energy as a quality parameter in racing alpine skiing. J App Biomech, 24(2), 121–129. Supej, M., Kugovnik, O., Nemec, B. DGPS measurement system in alpine skiing track and center of mass estimation. In: Proceedings of First Joint International Pre-Olympic Conference of Sports Sciences and Sports Engineering: Nanjing, China, 2008. Liverpool: World Academic Union, pp. 120–125.

### **FLEXO-ROTATION TRUNK TEST VALIDITY FOR MEASURING ABDOMINAL MUSCLE FATIGUE**

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Introduction The assessment of trunk muscle fatigue is a fundamental component of a physical fitness appraisal. Sagittal trunk extension and flexion tests (Coorevits et al., 2008; Knudson and Johnston, 1995) are generally used for measuring the back and abdominal muscle endurance. However, trunk endurance tests involving rotation or side bending are lacking. A flexo-rotation trunk (FRT) field test was developed to assess abdominal endurance simultaneously on a large number of people. The aim of this study was to evaluate the validity of the FRT test using surface electromyography (EMG). Methods Twenty-seven healthy subjects executed the FRT test. In this test participants performed the maximum number of cross-crunches in 90 s. Each repetition started in supine position with knee flexion at 90°, straight arms and hands overlapped over the pubis. Then, subjects curled up and twisted the trunk in order to touch their partner's fist placed on the lateral of his/her left knee. Subjects alternated left and right trunk twist. EMG was bilaterally recorded from rectus abdominis (RA), internal oblique (IO) and rectus femoris (RF), and the hip motion was measured using an electrogoniometer. The mean power frequency of the raw EMG (MPF) was calculated to evaluate muscle fatigue. In addition, in order to explore the role of the muscles in the FRT test, the raw EMG was rectified, averaged, and normalized to maximal voluntary isometric contraction (% MVC). Results At the beginning of the FRT test, the mean levels of RA activation (about 30% MVC) were higher ( $p < 0.05$ ) than those of IO (about 20% MVC) and RF (5-10% MVC), and the mean levels of IO activation were higher than those of RF ( $p < 0.05$ ). During the FRT test a significant reduction of the MPF was observed for the abdominal muscles. The percentage of MPF reduction was higher ( $p < 0.001$ ) for RA (about 45%) than for IO (about 25%) and RF (about 10%). In addition, the MPF reduction was higher for IO than for RF ( $p < 0.01$ ). The goniometric results showed a small mean hip flexion of 7.9° at the beginning of the test, which increased up to 14.3° at the end ( $p < 0.001$ ). Discussion Despite the hip motion observed during the test, the EMG analysis in the amplitude domain showed that the abdominal muscles were the prime movers, especially RA. The higher muscle activation of RA and IO resulted in greater MPF reduction, and consequently in higher muscle fatigue (Coorevits et al., 2008). These findings support the validity of the FRT test for measuring abdominal muscle fatigue in flexo-rotation trunk motions. References Coorevits P, Danneels L, Cambier D, Ramon H, Vanderstraeten G. (2008). J Electromyogr Kinesiol, 18(6), 997-1005. Knudson D, Johnston D. (1995). J Strength Cond Res, 9(3), 165-169.

### **FACTORS ASSOCIATED WITH JOINT RANGE OF MOTION CHANGES FOLLOWING A STATIC STRETCH SESSION**

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Introduction Static stretching is commonly performed on the assumption that it increases joint ROM. Observations from our laboratory indicate that there is a large inter-individual variance in the response to static stretching with some individuals showing a reduction in

ROM. The aim of this study was to investigate the factors that are associated with a change in ROM in response to a static stretch session. Methods Participants were 163 apparently healthy, physically active, non-obese and between 18-50 years. Consenting participants were requested not to participate in any unaccustomed physical activity, stretch or use medication, shown to affect ROM, in the 24 hours prior to testing. Questionnaires and a single straight leg raise (SLR) test on both legs was completed by all participants. One leg, randomly chosen as the intervention leg, was subjected to an acute static stretch session (SSS) (3 repetitions of 30 second stretching) with the other leg acting as an internal control. This was followed by a repeat SLR test on the intervention and control legs. End ROM was determined using EMG techniques. Flexibility and sport training, stretching, anthropometric variables, age and pre-SLR measurements were included as variables in various statistical analyses to determine independent factors associated with change in ROM measurements in response to a static stretch session. Results There were no significant differences between the pre-SLR measurements of the intervention and control legs. The post- and change in SLR measurements of the intervention leg were significantly greater than the control leg ( $P < 0.001$ ). The average change in SLR measurements of the intervention leg was  $7.2 \pm 7.0^\circ$ , (range:  $-16.5^\circ$  -  $30.0^\circ$ ). Of the investigated independent factors, only pre-SLR ( $P = 0.005$ ) and post-exercise stretching ( $P = 0.031$ ) were associated with the change in SLR measurements in response to a SSS and together, accounted for 10% of the variance in the change. Larger pre-SLR measurements were associated with a smaller decrease in the change of SLR ( $r = 0.016$ ) following a SSS. Conclusion There is a variable response of joint ROM to a SSS, with a significant portion of the participants showing a reduction in ROM. Pre-SLR measurements were the most important factor that determined changes in ROM following a SSS.

## EFFECT OF UPPER LEG CONTACT TO DYNAMOMETERS' BAR WHILE PULLING ON BACK AND LIFT TEST RESULTS

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Introduction Testing and measurement is one of the important component of performance assessment but some details that underestimated may directly affect test result. The purpose of this study is determined effect of non suitable gripping technical in back and lift dynamometer, like bar may contact with legs, on test results. Methods Back & Lift Dynamometer Test procedure can be defined as follows according to literature (Tamer, 2000); subjects stand upright on the base of the dynamometer with their feet shoulder width apart. Arms hang straight down to hold the center of the bar with both hands; adjust the chain so that the knees are bent at approximately 110 degrees. In this position, the back should be bent slightly forward at the hips, head should be held upright, and should look straight ahead. Then without bending back, pull as hard as possible on the chain and try to straighten legs, keeping arms straight. In this study; 9 female and 23 male ( $n = 32$ ) athlete voluntarily participate for this research. Participants' leg strength was measured by Takei (Japan) back and lifts dynamometer. Strength dynamometers have been known as valid and reliable devices in order to estimate strength for years (Bookwalter, 1950, Ozer, 2001, Muratlı et al 2007). Participant performed 4 pulling trials, 2 of them without legs contact (WLG) and other 2 trials legs contact with bar (LC). Best performances are recorded for two types of trials. Obtained data were analyzed by SPSS (ver. 16). Wilcoxon Two-Related-Samples test was used to compare groups and  $\alpha$  was set as 0, 05. Results Mean age of female athletes were found  $21.44 \pm 1.24$  years, weight as found  $57.56 \pm 8.09$  kg, height was found  $166.89 \pm 4.01$  cm, LG  $106.44 \pm 20.86$  kg and WLG  $69.44 \pm 15.26$  kg. Male groups average values was found respectively; for age  $22.22 \pm 1.31$  years, body weight  $71.96 \pm 6.62$  kg, height  $176.83 \pm 4.95$  cm, LG  $207.24 \pm 55.40$  kilogram and leg strength without bar contact legs  $139.14 \pm 119.67$  kilogram. Both of groups has statistically significant differences between with and without legs contact to bar (For female  $p = 0.008$ , for male  $p = 0.000$ ;  $p < 0.05$ ). Discussion During the pulling phase, if the legs contact with bar, this case causes a sharply increase of leg strength values for female in the rate of 53,62 % and 49,92 % for male athletes compared with non-contact pulling. So while dynamometers test realized, "leg contact case" should be considered by researcher for objective measurement. References Tamer, K. (2000) Sporda Fiziksel-Fizyolojik Performansın Ölçülmesi ve Değerlendirilmesi. Ankara: Bağırçan Yay. Bookwalter, K.W. (1950) Grip Strength Norms For Male. The Research Quarterly, 21 (3), 1950. Muratlı, S., Kalyoncu, O., Şahin, G. (2007). Antrenman ve Müsabaka. İstanbul: Ladin Matbaası. Özer, K. (2001) Fiziksel Uygunluk. Ankara: Nobel Yay.

## ESTIMATION OF RELATIVE LOAD FROM MEAN VELOCITY IN THE FULL SQUAT EXERCISE

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ESTIMATION OF RELATIVE LOAD FROM MEAN VELOCITY IN THE FULL SQUAT EXERCISE. Sánchez-Medina, L.I, García-Pallarés J.2, Pérez CE.2, Fernandes J.3, González-Badillo JJ.1 1: UPO (Seville, Spain), 2: UMO (Murcia, Spain), 3: FADEUP (Porto, Portugal) Introduction Despite being generally considered a fundamental multi-joint exercise in strength and conditioning programs for sports that require high levels of strength and power, limited published research has analyzed the kinematics of the full squat (Escamilla, 2001). Since it has recently been shown that movement velocity can be used to adequately estimate loading intensity (%RM) in the bench press (González-Badillo and Sánchez-Medina, 2010), this study examined the possibility of using mean velocity (Sánchez-Medina et al., 2010) to estimate relative load in the full squat (SQ). Methods Ninety strength-trained male athletes [mean(SD): age 23.5(5.1) yr, height 177.4(7.7) cm, body weight 74.6(10.1) kg, body fat 12.0(4.7)%, capable of at least full squatting with an external load equivalent to their own body weight, performed a strength test with increasing loads up to the 1RM for the individual determination of the load-velocity profile. Subjects were required to descend until the top of the thighs got below the horizontal plane, the posterior thighs and shanks making contact with each other. The concentric phase was always performed at maximal velocity. A linear velocity transducer sampling at 1,000 Hz (T-Force System, Ergotech, Spain) was attached to a Smith machine and used for all mechanical measurements. Velocity-load relationships were studied by fitting 2nd order polynomials to data. Results A very close relationship between mean propulsive velocity (MPV) and load (%RM) was observed ( $R^2 = 0.96$ ). Mean velocity attained with 1RM (V1RM) was  $0.34 \pm 0.05$  m/s. Prediction equations to estimate load from MPV and mean velocity (MV) were obtained:  $\%RM = -2.185 MPV^2 - 61.53 MPV + 122.5$ ,  $R^2 = 0.96$ ,  $SEE = 5.5\%RM$  for MPV; and  $\%RM = -8.89 MV^2 - 58.55 MV + 122.4$ ,  $R^2 = 0.94$ ,  $SEE = 6.2\%RM$  for MV. Discussion The results of this study confirm an inextricable relationship between relative load and mean velocity in the SQ; i.e. each %RM has its own MV or MPV value. This finding makes it possible to: 1) evaluate strength without the need to perform a 1RM test, or test of maximum number of repetitions to failure (XRM); 2) determine the %RM that is being used as soon as the first repetition with any given load is performed; and 3) prescribe and monitor training load according to velocity, instead of percentages of 1RM or XRM. It is recommended that the provided prediction equations are not used with velocities higher than 1.20 m/s since there exists considerable velocity variability when the SQ is performed with light loads ( $< 50\%RM$ ) due to the inherent characteristics of this exercise. References Escamilla RF (2001). Med Sci Sports Exerc, 33(1), 127-141. González-Badillo JJ, Sánchez-Medina L (2010). Int J Sports Med, 31(5), 347-352. Sánchez-Medina L, Perez CE, González-Badillo JJ (2010). Int J Sports Med, 31(2), 123-129.

**VALIDATION OF E-TEXTILE STRAIN SENSOR TECHNOLOGY FOR MEASURING KNEE FLEXION DURING KICKING**

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**Introduction** Accurate and reliable measurement of skills and skill development is typically limited to a laboratory setting or simplified performance environment. Electronic textiles with sensors, such as strain sensors, are enabling measurement in a way that allows motion capture and real-time or rapid-time feedback stimuli in diverse training and competition environments. The 'e-textile' technology affords numerous opportunities for monitoring and training in the performance environment if such devices can be proven to be suitably accurate and reliable (Helmer et al., 2010). The purpose of this study was to compare electronic textile 'e-leggings' and 3D motion capture measurement systems to determine knee angle during kicking. **Methods** A pair of e-leggings was prepared by mounting textile strain sensors across the left and right knees on a pair of leggings commonly worn in sports training. A custom wireless electronic unit (40x40x12mm, located on the waist), sampling at 250Hz, streamed kinematic information from the e-leggings to a computer in real-time. The ability of the e-leggings to reliably monitor leg motion was assessed for a set of exercises involving running and kicking (soccer, rugby and Australian football kicks) in a motion capture laboratory. Three dimensional kinematic data was collected using a Optotrak Certus system (Northern Digital Inc., Waterloo, Canada, root mean square error of 0.1mm in 2D and 0.15mm 3D) operating at 100Hz. Marker clusters were placed on the thigh and shank with the knee joint axis located using a digital probe and functional tasks. Knee angle data from participants were calculated using each system to ascertain whether significant differences exist in knee angle data between the two measurement systems. **Results** Preliminary results during a range of lower limb tasks including kicking suggested the e-leggings were shown to perform very well when compared to the Optotrak Certus system, ( $R^2$  range 0.91 - 0.98), and was consistent with previous studies with similar garments on other limbs (Helmer et al. 2008). **Discussion** The e-leggings were found to be a valid tool for the real-time measurement and interpretation of key lower limb angles when running and kicking footballs. The freedom of movement allowed by the garment based system will allow running and kicking performance to be measured and biofeedback provided within the natural performance environment. **References** Helmer R, Farrow D, Lucas S, Higgerson G, Blanchonette I. (2010) Proc Eng 2, 2 2985-2990. Helmer R, Mestrovic M, Farrow D, Lucas S, Spratford W. (2008) Adv Sci Tech, 60 144-153.

**A PROTOCOL FOR MONITORING SOFT TISSUE MOTION UNDER COMPRESSION GARMENTS.**

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**Introduction** Establishing a valid and reliable protocol for monitoring soft tissue motion under compression garments is important before the effects of these garments on performance can be assessed. A protocol should aim to discriminate soft tissue motion between varying levels of compression, accurately assess motion under the garment and demonstrate acceptable reliability. **Methods** Within this study, the participant performed six 40 cm drop landings in no, medium and high compression garments onto a force platform. Two cameras (1000 Hz) collected video footage of the dynamic trials. Using a purpose built template ten markers were placed in pairs on the thigh. All markers were taped on the skin during no compression conditions and five markers (one from each pair) were taped on the skin (under the garment) and five on the surface of the garment during compression conditions. Maximum change in resultant separation distance for each marker pair was calculated. Typical errors (TEs) were calculated to assess variance in the displacement of markers placed under and over the garment. During static trials thirty five markers were applied, removed and re-applied to the participant's thigh. Six additional markers were placed on landmarks to identify the pelvis and thigh centre of gravity (CoG). Eight cameras tracked the markers as the participant stood in the anatomical position for 3 s. Distances from outer markers to thigh CoG and relative marker separations were calculated. **Results** Force data showed similar landings were performed during each trial. T-tests identified no difference in maximum marker separation between none and medium compression. However, reductions in marker separation from none to high and medium to high compression ( $p=0.00$ ) were detected. TEs in the displacement of markers placed under and over the garment were 0.1mm in compression conditions. No differences ( $p=0.87$ ) in marker positions or in marker separation ( $p=0.93$ ) after marker re-application were found. **Discussion** Significant reductions in marker separation distances between none and high; and medium and high compression suggest that the protocol was sufficiently sensitive to detect reductions in soft tissue motion. With typical thigh soft tissue displacements during drop landings of ~32 mm (Pain & Challis, 2006), the variability in the displacement of markers placed under and over the garment equates to <0.5% in the compression conditions. Static trials showed marker re-application was repeatable to within 3 mm. With a participant thigh length (ASIS to patella) of 430 mm the marker array was placed within 1 % after re-application. In conclusion, this protocol is a valid and reliable method for monitoring thigh soft tissue motion under compression garments during drop landings. **References** Pain, M. & Challis, J. (2006). Jn of Bio, 39, 119-124.

**STUDY REGARDING TORQUE MEASUREMENTS-ARE THE DIFFERENCES IN MUSCLE MEASUREMENTS CAUSED BY SEX DIFFERENCE QUALITATIVE OR QUANTITATIVE?-**

KITA, T.1, YAMAMOTO, T.2, YOSHIHARA, S.3, MIURA, M.4, MIURA, K.4, AKITA, K.4, KATOH, Z.5, TAMURA, M.6, REE KYOUG, O.K.7, CHUN JI, H.8

1:TEIKYO UNIVERSITY OF SCIENCE(JAPAN), 2:MUSASHINO ART UNIV., 3:ST.MARIANNA UNIV., 4:TOYO UNIV., 5:AICHI MIZUHO COLLEGE, 6:MEIJI UNIV., 7:EWHA WOMEN'S UNIV.(KOREA), 8:KAWASAKI UNIV. OF MEDICAL WELFARE

**Introduction:** In this study, we conducted new body-trunk measurements adding to hip-joint muscle strength, which was measured in our preceding study, to review the relevance among the data. **Method:** The following 10 items were measured: 1. height, 2. body weight, 3. adductor muscle torque in the hip joint, 4. abductor muscle torque in the hip joint, 5. right upper thigh, 6. right lower thigh, 7. left upper thigh, 8. left lower thigh, 9. abdominal muscle in the sitting position, and 10. back muscle in the sitting position. **Subjects:** 24 female and 13 male. **Time of measurement:** December 2010 **Results:** Analyses of correlation by sex showed that the relevance among the measured values that have statistically significant correlations was different between men and women. We conducted correlation analyses using all the acquired data through which statistically significant correlations were extracted among all the items. Then the extracted correlations were plotted on scatter diagrams by coding colors by sex. Individual differences in the trunk muscles were minimal, and the men's and women's data each showed scattered distributions according to the individual's muscle differences. The hip-joint muscle data, however, showed no distinctive gap between men and women, and some data among the two even clearly overlapped in many areas. The analyses of variation on the data of men's hip-joint muscles showed that for the hip flexor, the left-side muscles are significantly stronger than the right side; and for the extensor, the right side is significantly stronger than the left. The same results were shown in our previous study.

Regarding the body trunk muscles, a statistically significant correlation was seen between the abdominal muscles and the back muscles, and this result was common between men and women ( $r = 0.94$ ,  $p < 0.01$  in men;  $r = 0.60$ ,  $p < 0.05$  in women). Also according to variance analyses, the back muscles were stronger than the abdominal muscles in both men and women; however, the differences were significantly greater in men than women. Discussion/Conclusion: In this study, the plotted diagrams on correlations among the data regarding the hip-joint muscles, which were coded with different colors by sex, showed stronger correlations among data, with some parts specifically overlapping. This means that some of the male and female subjects showed extremely similar trends in physical traits and relevance among each of the measured items of the hip-joint muscles. It is an interesting question as to whether this similarity can be regarded as a mere accidental coincidence among stochastic variations in the (qualitatively) different populations, or whether the similarity can be regarded as evidence of the existence of individuals in the intermediate zone that link the higher layer (mainly males) and the lower layer (mainly females) in an (uninterrupted) population. It is at the same time a subject for future investigation.



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