

### Free communications and posters from Swiss participants

#### ACL RUPTURES IN CHILDREN WITH OPEN PHYSES - TREATMENT OPTION

Mayer, R.R. 1, Koenig, U. 2, Widmer, H. 1, Friederich, N.F. 1

1 Kantonsspital Bruderholz, CH-4101 Bruderholz, 2 Ortho-Klinik Rhein-Main, D-63067 Offenbach, Switzerland

##### Introduction:

ACL injuries in Children with open physes are rare but the number is lately increasing, especially due to the increase of risky trendsports. (Carving, Snowboarding, Inlineskating etc.) The strategy of treatment is still controversially discussed in the literature.

##### Material and Method:

Between 10/1997 and 5/2004 35 Children ( mean age 12, range 10-14, 22 boys, 13 girls) with acl tear and open physes were operatively treated in our hospital.

The rupture occurred during sport activity in all cases, the indication for reconstructive surgery was persisting ap instability.

Our operative technique needs a pit of 8mm in diameter on the femoral side just below the epiphyseal line. The bony block of the autologous quadriceps tendon graft with the same size is placed in this pit and fixed extraarticular to a screw on the lateral side of the femur proximal to the physis. The tibial fixation is performed in a similar way, the free end of the quad tendon is armed with #3 nonresorbable sutures in <<baseball stitch>> technique and fixed through an 8mm transtibial tunnel to a second extraarticular screw medial and inferior to the tibial tuberosity.

In the followup Lysholm and IKDC scores were taken, as well as KT 1000 Measurements and plain x-rays. In some cases MRI were obtained.

##### Results:

The average Lysholm Score was 95 (93-97), IKDC: 85% in group A and B. The average KT 1000 difference was 1,5mm (1-2mm) compared to the opposite side.

One patient showed a growth difference on the femoral side with an increase of femoral valgus. Tibial axis deviation did not occur. There were also no difference in leg length. 2 Patients showed enlargement of the tibial tunnel (bungee effect).

5 of 35 patients had a re-rupture in an adequate trauma in sport.

##### Conclusion:

We recommend children after acl rupture and persistant instability to undergo acl-reconstruction to avoid secondary intraarticular damage despite open physes.

Our technique with a quadriceps tendon autograft has an extraarticular fixation and shows no bungee effect on the femoral side. We found no growth disturbances, there was no tibial axis deformity despite of the (minimal) damage to the tibial physes. The rate of re-ruptures is higher than in adults.

#### THE ROLE OF EPFL AS SCIENTIFIC ADVISOR FOR ALINGHI

Vuilliamenet, P., Manson, J.-A.

Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

The Ecole Polytechnique Fédérale de Lausanne (EPFL) collaborated with Alinghi prior to its 2003 America's Cup victory, and this collaboration generated a strong relationship between the Alinghi Design Team and EPFL researchers. Based on this experience, the number of research topics has been increased for the 2007 campaign, leading to a massive effort in terms of scientific research and implementation strategy of new technologies.

The Scientific Advisor acts as an extension of Alinghi Design Team. Research is carried out in close collaboration with the designers of Alinghi, thus ensuring that the technological and scientific advances developed in the university can be adapted to and implemented in the very specific domain of an America's Cup boat.

The hull of Alinghi is made of a rigid, strong and incredibly light composite material referred to as a

#### CHANGES IN PUBLIC PERCEPTION OF DOPING IN SPORT IN SWITZERLAND 1995-2004

Kamber, M., Stamm, H.P., Mahler, N., Lamprecht, M., Marti, B.

Federal Office of Sports, Magglingen, Switzerland

##### Objective:

To assess the changes in the public awareness of doping in sport and its prevention issues over a period of 9 years in Switzerland and to compare some of the results with the answers from a survey with top level athletes.

##### Design:

The surveys were carried out with population-based representative telephone surveys in the years 1995, 1998, 2001 and 2004 as well as with a written questionnaire for top level athletes in 2006. The core questions in the telephone surveys remained the same throughout the observation period. The topics covered doping and ethics in sports. The time to conduct the telephone surveys was always late summer and fall and there was never any particular media attention to doping issues during these periods. The questionnaires had eight (1995), twenty-five (1998) twelve (2001) and nineteen (2004) items. The questions were pretested for each run on a smaller number of respondents. The questions concerning doping and ethics were embedded in the telephone surveys of 1998, 2001 and 2004 within broader surveys about the respondents' physical activity behavior. The survey with top level athletes was carried out at the end of 2005 and beginning of 2006.

##### Setting:

Population of Switzerland and top level athletes in the Swiss registered control-pool.

##### Participants:

1201 (1995), 800 (1998), 1535 (2001) and 2114 (2004) respondents between 18 to 74 years old, selected by stratified random sampling and top level athletes (2006).

##### Main Outcome Measures:

When asked about the main problems in sports (survey of 2004),

#### ACTUAL BLOOD TESTS TO DETECT BLOOD DOPING IN ATHLETES

Robinson, N., Sottas, P.-E., Bader, S., Kamber, M., Mangin, P., Saugy, M.

Laboratoire Suisse d'Analyse du Dopage, Switzerland

In the last 15 years, endurance sports have been taunted by EPO doping. The introduction of synthetic EPO in 1990 to fight patients with kidney damage was also the starting point of the misuse of EPO in endurance sports. To fight this development several international sport federations have introduced blood screening tests before competitions. These analyses are performed on a regularly basis for health purposes to avoid athletes competing with a haematocrit level well above normal and also to select and target athletes manipulating their blood formulae.

A 2-years longitudinal study

#### INTERNATIONAL STANDARDS FOR LABORATORIES

Saugy Martial

Swiss Laboratory for doping analyses, Switzerland

The purpose of the International Standard for Laboratories is to ensure production of valid test results and evidentiary data and to achieve uniform and harmonized results and reporting from all accredited laboratories.

All laboratories are certified under the ISO 17025 rules. The World Anti-doping Agency has the duty to control the efficiency of the Laboratory network. External round tests are organized in order to improve the overall system and to be sure that the detection methods are fitting for the purpose defined in the World Anti-doping

code. The chain of custody for any anti-doping sample must be strictly followed in order to prevent any formal discredit of a result. In some cases, a second opinion on an adverse analytical result can be requested to assure an optimal result management. Research and development in the doping analyses are now formally part of the accreditation scope of the accredited laboratories. These international standards have been created in order to guarantee to the athletes similar treatment of their biological sample from the analytical point of view all over the world.

### OPTIMAL SLOPE FOR MINIMIZING ENERGY COST OF LOCOMOTION: INDIRECT ASSESSMENT BY HIGH ACCURACY GPS

Terrier, P., Wearing, S., Hills, A., Schutz, Y.

University of Lausanne, Switzerland / Queensland University of Technology, Australia, Switzerland

The energy cost of human locomotion is significantly influenced by the slope of the terrain. The relationship of energy cost to slope may be expressed as a J-shaped curve with a minimum at about -10% slope. The underlying mechanics that explains such a relationship include: 1) the differential efficiency of the muscles used as force and brake generators 2) the residual positive mechanical work against gravity that occurs during downhill walking, as well as residual negative work during uphill walking.

Although uphill and downhill walking has been studied over decades in the gait laboratory, there is a lack of data concerning the effect of grade on the energetics of outdoor free walking. The objective of the present report, therefore, was to ascertain the slope at which the energy cost of locomotion was minimized under free walking conditions.

A high accuracy Global Positioning System (<1cm) was used to continuously monitor the vertical oscillation of the head in 25 young healthy non-obese women while walking along a 2.5km outdoor circuit, exhibiting a wide range of grades (-20% to +20%). The head oscillation was assumed to represent trunk oscillation. The step frequency, walking speed and vertical oscillation were subsequently used to estimate the energy cost of walking at various grades.

The observed vertical body oscillation (positive and negative, expressed per step) was +6.5/-6.5cm at 0% slope, +3.6cm/-10.6cm at -10% slope and +11cm/-4.0cm at +10% slope. The mechanical power induced by these oscillations was expressed as transport cost per unit body mass (i.e. the energy to transport 1kg mass over 1m). The physiological cost of walking was computed taking into account the theoretical well known difference in efficiency of eccentric/negative work (0.25) and concentric/positive work (1.25). By pooling the individual data sets (about 10hour walking) we found a J-shaped curve pattern with a theoretical minimal energy cost of locomotion at a decline of 10.4%.

Despite the use of a simplified model and the application of a new technology (GPS) which is still at its infancy, we confirm in our free-living conditions the literature results in the lab based on the analysis of treadmill walking over short duration. This highlights the utility of high accuracy GPS in monitoring outdoor walking under free living conditions.

### ROLE OF MECHANICAL EXTERNAL WORK AND PENDULAR ENERGY TRANSDUCTION IN GAIT ECONOMY IN HEALTHY 65- AND 80-YR-OLDS

Malatesta, D., Borrani, F., Simar, D., Candau, R., Préfaut, C., Caillaud, C.

Institut des Sciences du Sport et de l'Education Physique (ISSEP), Switzerland

#### INTRODUCTION

Several studies have reported higher energy cost of level walking (Cw) in elderly subjects at several walking speed (3, 4). The mechanisms involved in this age-related decline in economy of walking remain however unclear. Even though it has been suggested that

increased in energy expenditure associated with walking movements and related to mechanical external work (Wext) and to impaired pendular energy transfer may be a contributing factor (3). The purpose of this study was to determine whether higher Cw in healthy elderly subjects is due to greater Wext necessary to translate the centre of body mass during gait.

#### METHODS

Three groups of subjects participated in the study: G80 (n=10; 81.6±3.3 yr), G65 (n=10; 65.3±2.5) and G25 (n=10; 24.6±2.6). Groups were matched according to gender, height, lower limb length, body mass, lean body mass, percent body fat. The subjects performed five 6 min treadmill walking trials at five different speeds (0.56, 0.78, 1.01, 1.24, 1.46 m/s), separated by 5 min resting periods. During these trials, metabolic and mechanical data were collected. For each subject, VO<sub>2</sub> values from the last two minutes were averaged and normalized to body mass. These data were subsequently used to calculate the net energy cost of walking (NCw). Wext changes and the fraction of mechanical energy recovered (Rstep) (2), due to the pendular transduction of potential to kinetic energy and vice-versa, were determined with a kinematic arm (1).

#### RESULTS

NCw was higher for G80 and G65 than for G25 across the different walking speeds (38% and 23%, respectively; P < 0.05). Wext was respectively 42% and 34% higher in G80 and G65 compared with G25 at the three fastest experimental walking speeds (1.01, 1.24, 1.46 m/s; P<0.05). Rstep was significantly lower in G80 than in G25 for the same walking speeds (-25%; P<0.05) and for the two fastest speeds (1.24 and 1.46 m/s) in G65 compared with G25 (-18%; P<0.05). NCw was directly correlated with Wext at the five walking speeds (r=0.49; r=0.40; r=0.46; r=0.46; r=0.68, respectively; P < 0.05). NCw was inversely correlated with Rstep at the four fastest walking speeds (r=-0.43; r=-0.42; r=-0.41; r=-0.62, respectively; P<0.05).

#### DISCUSSION/CONCLUSION

These findings demonstrate that greater energy cost in healthy elderly while walking is associated with greater mechanical external work and lower fraction of mechanical energy recovered. Our results suggest that greater mechanical muscular work, due to impaired pendular energy transfer, is involved in energy cost of walking in elderly subjects especially at intermediate and higher speeds. Future research should examine the role of co-activation of lower limb muscles and lower limb stiffness in biomechanics and energetics of walking in elderly.

#### REFERENCES

1. Belli A et al. *Ergonomics* 35: 177-186, 1992.
2. Cavagna GA et al. *J Physiol* 262: 639-657, 1976.
3. Malatesta D et al. *J Appl Physiol* 95: 2248-2256, 2003.
4. Martin PE et al. *J Appl Physiol* 73: 200-206., 1992.

### BODY FIXED SENSORS AND THEIR APPLICATION IN SPORT SCIENCE

Aminian, K., Favre, J.

Ecole Polytechnique Fédérale de Lausanne, Switzerland

Camera based motion capture, force-plate and instrumented walkway are the most commonly used system for movement analysis. Systems using these technologies are available on the market, but they provide information for a limited period of time and could be used only in a closed environment. In order to overcome limitations of these technologies, some investigators attached sensors on body segments to measure kinetics or kinematics features. Body fixed sensors (BFS) have several advantages. First, they allow mobile and outdoor motion capture. Second, they can provide information over extended periods of time. Third, frequency sampling is higher and several hundred hertz can be reached with existing datalogger. Finally, BFS approach is very similar to sensory system used in human movement control.

Here we review the use and application of the main BFS such as goniometers, foot pressure sensors, accelerometers, earth magnetic sensors and gyroscopes in human ambulatory monitoring. We outline the advantage of new technologies based on BFS and particularly the possibility to perform field measurement and during

the actual condition of the subject. The relevance of intelligent computing and its potential to enhance those features hidden in biomechanical signals are reviewed. An emphasis is made to show the results produced by these sensors when used alone and new possibilities offered when the information from different type of BFS are fused. We provide some applications related to sport science where BFS are used to improve athlete performances, training or rehabilitation. The first application is the assessment of spontaneous physical activity in order to provides valuable information about posture allocations (sitting, standing, lying, walking, ...) and allowing a better evaluation of moving ability and energy cost of the subjects. The second application concerns the 3D evaluation of body segments and joints. 3D knee function obtained in this way gives many outcomes for ligament rupture evaluation before and after surgery. The third application is related to jump performance where our results demonstrate that a simple ambulatory system provide a precise analysis of the principal parameters of the vertical jumps such as velocity, force, power, height, takeoff. Finally, using BFS, we provide a new approach to estimate multi-segment joint coordination during cyclic movement such as walking.

Based on these results, we believe that new technologies using BFS are well adapted for field measurement in sport science and provide outcomes which can be used for training, rehabilitation and physical activity monitoring.

### FUNCTIONAL COMPOSITE MATERIALS FOR IMPROVED FEEL AND CONTROL

Fischer, C., Bourban, P.-E., Michaud, V., Månson, J.-A.

*Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland*

High-end alloys and polymer composites are extensively used in sporting goods. Recently, the development and integration of "smart"- and "active" materials into composite structures have been a major topic of interest. These novel materials could improve the human-material interaction and thus provide better feel and comfort when practicing sports involving an equipment.

To illustrate this concept, it is generally accepted that classical design changes that cause an increase in damping will cause corresponding reductions in stiffness and strength. Thus, the integration of adaptive materials into composite structures to better control vibration and stiffness represents an area of considerable interest. Structures based on well-established "smart" systems (e.g. containing pre-deformed shape memory alloy (SMA), electro-rheological (ER) and magneto-rheological (MR) fluids) provide means of modifying vibrational properties via external stimuli in a wide range of applications. To avoid the need for an external power source, a material that changes its properties according to the loading conditions would be ideal. Such behavior is characteristic of shear-thickening fluids (STFs), which show a marked increase in viscosity beyond a critical shear rate. In the framework of this project, we have shown that the incorporation of a tailored STF into sandwich structures simultaneously lead to stiffness and damping changes of the structure under certain dynamic loading conditions. Such properties are thought to be very interesting for highly deformed structures such as alpine skis, and a first attempt to integrate STFs into skis showed promising results.

Beyond the activities focusing on materials development, we have recently developed a methodology to determine the influence of several characteristics of a sports equipment on the athletes' perception, in the perspective to assess the influence of novel materials on the users' "feel and control". Using alpine skis as a case study, this method has shown to provide a tool that relates the subjective evaluation of the athlete to the intrinsic mechanical and dynamic properties of sports equipment.

This project is part of the Sports and Rehabilitation Engineering program (SRE) at EPFL, and is being carried out in collaboration with scientists from the Brain Mind Institute (BMI).

### MECHANICAL LOADING, RUNNING RELATED INJURIES AND FOOTWEAR CONSTRUCTION: WATH DID WE LEARN IN THE LAST THIRTY YEARS?

Segesser, B., Brüggemann, G.P., Kälin, X.

*Praxisklinik Rennbahn, Switzerland*

During the last decades biomechanics had a strong influence on the functional design of sport shoes. The decrease of impact forces was predominant for a long time in sport shoe research. The soft cushioning materials, however, increased the instability of the rear foot and was one of the reasons for overpronation causing typical overuse problems at the runner's lower leg and Achilles tendon. The control of overpronation by different materials and techniques was basically a compensation of the problems induced by overdimensioned cushioning systems. The medial support elements themselves lead to a lateral shift during take-off which needed to be compensated as well. Hence, the philosophy of "Cushioning – Control – Guidance" was born as a compensation strategy of different errors. It influenced sport shoe design in all brands for decades and was not able to reduce injuries effectively. Therefore, new strategies should allow natural foot movements by avoiding additional levers of the shoe in all directions. In addition to this such a new concept should support the neuromuscular informations and functions using technologies influencing muscular function optimisation (TIMO®).

### SPORT: A UNIQUE IMPLEMENTATION DYNAMIC FOR TECHNOLOGIES

Manson, J.-A., Bourban, P.-E.

*Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland*

Sport: a unique implementation dynamic for technologies

Jan-Anders E. Månson, Pierre-Etienne Bourban

*Ecole Polytechnique Fédérale de Lausanne (EPFL)  
Vice présidence pour l'innovation et la valorisation (VPIV)  
CH-1015 Lausanne, Switzerland*

Athlete seeks the ultimate performance out of his own body, his equipment and his outfit while taking a maximum benefit from his skills and physical ability.

For this an equipment and outfit does not just need to be made of materials with the most extreme physical properties but it must also allow to transmit the "right" feeling and touch between himself and his equipment. Thus, in most cases the material has to possess a unique combination of structural and functional capabilities. Today these unique structural performances and functions are widely integrated in many sport equipments. For examples the latest tennis rackets and skies integrates these novel materials to reach the otherwise impossible combination of high stiffness, low weight and tuned damping performance.

Furthermore, the improvement of performance, perception, skill acquisition, comfort, safety and injury prediction, requires synergy between life sciences and engineering sciences. For example, by a more efficient measurement and control of sensations, body motion and by studying the influence of equipment and environment on performance or potential injury it will possible to propose technology for an improved and optimal adequacy between body, environment and performance. This is the objective of the current research programmes such as the Sport and Rehabilitation Engineering programme at EPFL (<http://sre.epfl.ch>) grouping key competences in cognitive assessment, psychophysics, tissue engineering, smart materials/structures, bio-sensors, multi-task control, simulation and imaging.

Technologies developed for professional sport will also impact our life quality, indeed they are in many cases established on the same generic platform as research on support system for any valid or disabled persons.

There are no doubts that the sports industry plays an important role during the implementation of a new technology to the market. In

comparison to other industrial branches such as aerospace and automotive the speed of the market changes in sport equipments and outfits are very high. This puts enormous time constraints on technology adaptation and market implementation. It is well known you cannot win America's Cup or Formula 1 without the very latest advanced technology. Thus, it is not surprising that sport during last decade has increasingly positioned itself as one of the driver in research. However, it is vital to seek synergies in research and implementation strategies in order to gain maximum experience from each other's unique experience about design, material performance, durability and manufacturing concepts. Finally, it is clearly demonstrated in recent years that sport does not just take increased use of advanced technologies it also shows an increased importance for the public economy.

### **GESUND BEWEGT - MOVE FOR HEALTH AND THE ENVIRONMENT: PHYSICAL ACTIVITY PROMOTION IN GENERAL PRACTICES IN SWITZERLAND**

**Handschin, M., Joss, M.K., Nüscheler, M., Braun-Fahrländer, C.**

*Swiss Doctors for the Environment, ecos ag, Institute for Social and Preventive Medicine, Basel, Switzerland*

#### **Background**

Physical inactivity is increasing in the Swiss population. A Swiss pilot project in 5 private practices in Zurich showed that systematic screening of patients by the doctor and subsequent counselling increased physical activity in patients.

#### **Aim**

The project *Gesund bewegt* aimed at developing and testing a model for a systematic screening and counselling of patients in primary health care institutions suitable for a large number of general practitioners. A minimum of 25 general practitioners from the North-western region of Switzerland was planned to be recruited.

#### **Method**

Primary care physicians were invited to participate in the project through mailing, journal articles, presentations at meetings and personal contacting by physicians of the project team. Participating practices carried out a systematic screening about physical activity of patients aged 16-65 years by means of a short questionnaire distributed to the patients when they visited the practice. Distribution of questionnaires occurred during several two-week periods from January 2004 to July 2005. People identified as inactive were offered a brochure or a voucher for individual counselling with a trained physical activity adviser.

#### **Results**

44 primary care physicians participated in the project. 13 physiotherapists and 5 doctors were trained and certified as physical activity advisers. Recruitment of general practitioners for participation in the project was most successful when effected through personal contacts of a colleague of the project group. Physiotherapists were mostly recruited through information in their professional journal and after a presentation at a meeting of their professional association. Introduction of participating physicians into the practical and theoretical details of the project was mostly (68%) carried out face to face in the practice of the respective colleague because attendance of an introductory workshops was poor due to lack of time. Once recruited into the project effort was devoted to keep the general practitioners in the project and to adapt the screening schedule most flexibly to the needs of the individual practices. Eight screening cycles were run, most practices took part in 4 or less cycles because more time than scheduled was needed for their recruitment. During the eight screening cycles 7455 patients were eligible for recruitment to the project and 4987 (67%) filled in the questionnaire. Out of 4621 analysed questionnaires 1049 patients (22.7%) were identified as being physically inactive receiving further intervention.

#### **Conclusion**

Our experience shows that it is important to develop a concept that takes the reality of general practitioners into account, being flexible and minimizing the work load of doctors and assistants added by the project. It is essential that the project is supported by doctors to increase credibility and acceptance within the medical community. The project was well received by participating patients and doctors.

### **DETECTION OF SHORT WALKING EPISODES IN DAILY LIFE BY MEANS OF A NEW ACCELEROMETRIC APPROACH**

**Terrier, P., Chalokh, M., Schutz, Y.**

*University of Lausanne, Switzerland, Switzerland*

The energy expenditure induced by spontaneous non-structured activities called Non-Exercise Activity Thermogenesis (NEAT) has been shown to play a key role in the regulation of energy balance. NEAT comprises fidgeting, posture changes, short discontinuous walking bouts and static work. Among these activities, walking is an energy demanding exercise and it may constitute a major component of NEAT.

The aim of the present work was to objectively assess walking activities during daily life with a new method using a motion sensor optimized for walking recognition. The technical challenge was to offer increased specificity, sensitivity and accuracy as compared to classical pedometers/accelerometers.

The tri-axial accelerometer was a Leica Vectronix DMC-SX Digital Magnetic Compass. The unit contains 3 accelerometers and signal processing capabilities: the acceleration is measured in a -2 G to +2G range, and sampled at 60Hz with signed 16bits words, for an accuracy of 0.003G. This small sensor (31x33x13.5mm, 28g) was attached to the low back (L4-L5). A programmable logger (prototype) received the digital acceleration data through a serial interface, compressed them "on the fly", and stored the file onto a Compact Flash data card. This device (20x10x5cm, 100g) was worn on the side, attached with a belt.

In order to specifically track walking activities, the accelerometric signals were analyzed to detect the repetitive acceleration pattern of the gait. Hence, the duration and frequency of walking episodes were specifically assessed. The hypothesis was that a substantial part of the daily walking activities was due to short walking "bouts". The physical activity level of 29 healthy young subjects with variable Body Mass Index (18-41kg/m<sup>2</sup>) was assessed during their habitual occupation typically over 8 hours. The results showed that during daytime the subjects performed 151±77 (SD) very short walking episodes (<60s) of an average duration of 11second each (6-17s). The subjects spent 18.7% of their day-time in walking activities. Long duration walking (>60s) accounted for about two third of the walking duration, whereas short walking episodes (<60s) accounted for about one third (respectively 12.9 and 5.8% of the total time).

Although intermittent short walks are rarely considered in the analysis of daily walking pattern, we found that they were spontaneously performed by all the subjects. Because intermittent short walking bouts are relatively high energy demanding movement among sedentary activities, they should not be neglected, due to their repetitive pattern, for a more appropriate assessment of total daily physical activity and energy expenditure.

The use of new objective methods to assess physical activity level by taking into account movements performed during everyday activities (including short walking bouts) is probably a new opening area to a better understanding of energy balance dysfunction leading to obesity.

### **PREDICTABILITY OF CARDIOVASCULAR FITNESS AT AGE 35 YEARS FROM BMI IN EARLY VERSUS LATE MATURING CHILDREN: A LONGITUDINAL STUDY.**

**Taeymans, J., Hebbelink, M., Borms, J., Abidi, H., Duquet, W.**

*Internationale Akademie Physiotherapie, Switzerland*

#### **Introduction**

In adulthood, high VO<sub>2</sub>max is correlated with a decrease of cardiovascular disease and is important for success in many sports (1). It was the aim of this study to investigate the possible relationships between childhood BMI and some cardiovascular fitness (CVF) variables at age 35 yrs in former early and late maturers.

#### Methods

For this study, data of the Belgian longitudinal "LEGS", were used (2). Of the original 515 subjects who had been followed from 6 to 18 yrs of age, 119 (M=59; F=60) participated in this follow-up study at age 35 yrs. Informed consent was obtained. CVF can be expressed in terms of systolic (SBP) and diastolic (DBP) blood pressure and heart rate at rest (HR) and in terms of VO<sub>2</sub>max during exercise. At rest SBP and DBP, HR, height and weight were measured. VO<sub>2</sub>max was directly assessed during an incremental bike ergometer protocol until exhaustion. Age at peak height velocity (PHV) was calculated using the JPA method and software (3). Early (EM), moderate and late maturity (LM) groups were established using tertiles. For statistical analysis the SPSS 12.0 was used. Pearson correlations (r) were calculated. Significance was set at 5%.

#### Results

In EM girls BMI of all ages show moderate to very strong negative r (-0.4<r<-1.0) with VO<sub>2</sub>max at age 35 yrs (p<0.05). There are moderate and positive r (r>0.4; p<0.05) with HR, except at ages 13 and 14 yrs when r are weak (p<0.05). Correlations with SBP and DBP are positive low to moderate (0.2<r<0.5) until age 15 yrs but moderate to very high from age 16 yrs on (p>0.05). In former LM women, the r between childhood BMI and VO<sub>2</sub>max at age 35 yrs are very weak to moderate but negative (p>0.05), while r between childhood BMI and adult HR, SBP and DBP are very weak (until age 13 yrs) to moderate (from age 14 yrs on) but positive (p>0.05). In former EM men the r between childhood BMI and HR at age 35 yrs are positive weak to strong (r>0.6) and significant at the ages 7 and 11 to 18 yrs except at age 15 yrs. None of the other r are significant. This is also the case for all r between childhood BMI and CVF variables at age 35 yrs in former LM men.

#### Discussion

Our data suggest that former LM men and women have the more healthy cardiovascular outcome at age 35 yrs. In former EM women the predictability of adult CVF from childhood BMI values is very good. This is not the case in female LM. For each of the CVF variables prediction is not possible from BMI during childhood and adolescence in LM girls and in EM and LM boys. Our findings suggest that in the female subjects the childhood maturation status is discriminative for the predictability of selected adult variables of CVF (HR, SBP, DBP and VO<sub>2</sub>max) from childhood BMI.

#### Conclusion

Assessment of BMI in young EM girls may be a useful tool when screening them for adult CVF. In LM girls and in EM and LM boys, determinants other than BMI, will be needed to predict adult CVF.

#### References

1. Wilmore & Costill, 2003
2. Hebbelinck et al., 1995
3. Abidi et al., 1997

## AN ACCELEROMETRY METHOD TO TRACK THE EFFECTIVENESS OF A WALKING PROGRAM

Schutz, Y., Hills, A.P., Lecoultre, V., Terrier, P.

University of Lausanne, Switzerland / Queensland University of Technology, Australia, Switzerland

It is commonly suggested that daily moderate-intensity physical activity (PA) is an important factor in the prevention, treatment and management of obesity. Although a theoretical 0.3kg weight loss per week would be possible with 1h walking/day, many studies conclude that this value is rarely reached. Hypotheses used include 1) the added exercise induces higher food intake; 2) poor adherence to activity programs may occur; 3) compensation for extra-exercise by an increased placidity may be observed.

The objective of the present study was to assess the effectiveness of 3 different walking programs. We used a motion sensor (bi-axial accelerometer) able to record daily PA profile over several weeks. The device can measure: 1) number of steps per day; 2) estimated

total energy expenditure; 3) duration of walking activities per day from an analysis of activity profile.

Seventeen young women participated in the study (body mass 60±11kg, height 165±7cm, Body Mass Index (BMI) 22.3±4.6kg/m<sup>2</sup>). Participants wore the accelerometer during 8 consecutive weeks, from which 2x2 weeks (i.e. before and after the 4-week prescription) were the baseline activity, without exercise prescription. Three different PA programs were randomly assigned to the participants: 1) 30min walking; 2) 60min walking; 3) 90min walking. The prescription involved the completion of additional walking periods to one's habitual activity in "blocks" of a minimum of 30min walking, 5 days per week during 4 weeks. Adherence to the program was evaluated by comparing the duration of walking objectively assessed by the accelerometer with the prescribed duration. We tested whether the extra-walking imposed was partly offset by a lower spontaneous PA in pre/post exercise periods by comparing the average baseline activity level with the level during the program weeks.

The PA programs increased the average number of steps per day as compared to baseline level by 21% (30min, N=6), 36% (60min, N=5) and 60% (90min, N=6), respectively. In terms of total daily energy expenditure, increases were 3.6%, 5.8% and 10.2%, respectively. The adherence to exercise averaged 93±32% (N=17, range 22-141%), with no significant differences among groups. All participants compensated for the imposed extra exercise by diminishing their spontaneous walking activities, except one. On average, the basal activity level (i.e. excluding the exercise periods) decreased by 25±16%, with a higher effect seen with 90min exercise prescription (37±19%, p<0.05 vs 30min) than for 60min (19±12%) and 30min (18±8%).

Despite good adherence to the activity program, we found that a substantial part of the effect of exercise on total daily activity was lost due to a decrease in spontaneous activity in pre- and post-exercise periods. This may in part explain the mitigated effect of prescribed exercise encountered in the literature. However, the large inter-individual variability we observed requires the conduct of further investigations to better describe the compensation effect.

## WALKING AND CYCLING BEHAVIOUR OF CHILDREN AND YOUNG ADULTS IN SWITZERLAND: RESULTS FROM THE TRAVEL SURVEY 2000

Martin-Diener, E., Sauter, D.

Federal Office of Sports, Magglingen, Switzerland

At least one hour of physical activity a day is recommended for children and half an hour of moderate intensity activities for adults. Active transport can contribute substantially to meet these recommendations. As in many industrialized countries, there is public concern in Switzerland about an increasing number of children not walking or biking but being brought to their destinations by car. For this paper, travel survey data were analysed focussing specifically on children's travel behaviour.

The travel behaviour of 5030 individuals aged 6 to 20 years was assessed in a telephone interview in the context of a national representative travel survey. Basis for the results presented below are 1) the 6737 trips to school accumulated by those 2130 individuals reporting at least one trip to school on the day preceding the interview, and 2) the 7889 trips during leisure time accumulated by those 3204 individuals reporting at least one trip on the day of interest.

In the year 2000, 76.8% of the 6-9 year old children walked to school, 3.6% used their bicycle, 8.1% were brought by car, 6% walked and used public transport and 5.4% other forms of combined mobility. The respective numbers for the other age groups were: 10-12 years: 61.6%, 18.7%, 4.6%, 8.4%, 6.7%; 13-15 years: 30.9%, 27.6%, 6.3%, 24.5%, 10.8%; 16-17 years: 18.7%, 20.0%, 9.8%, 32.0%, 19.5%; 18-20 years: 19.6%, 12.0%, 21.5%, 33.8%, 12.9%. In a logistic regression model, determinants for the choice of different modes of transport were assessed. Distances up to 1km increased

the chance of walking compared to longer distances, while medium distances increased the use of a bicycle. Living in the German part of Switzerland was associated with a higher probability of walking or cycling to school than living in the French part of the country, where on the other hand the chance of being brought by car was higher. With an increasing number of cars in the household the chance of walking to school decreased.

During leisure time, 38.8% of 6-9 year olds walked to their destinations, 8.8% used their bicycle, 37.0% were brought by car, 3.7% walked and used public transport and 11.7% other forms of combined mobility. The respective numbers for the other age groups were: 10-12 years: 35.0%, 14.4%, 32.8%, 6.4%, 11.4%; 13-15 years: 33.7%, 21.7%, 23.8%, 9.2%, 11.6%; 16-17 years: 29.9%, 13.3%, 30.3%, 14.6%, 12.1%; 18-20 years: 21.1%, 7.6%, 44.2%, 11.1%, 15.9%. A comparison with the 1994 survey data revealed that for school trips as well as for trips during leisure time, for trips up to 3km and overall, the shares of walking did not change between 1994 and 2000, whereas the shares of cycling decreased and the shares of individual motorized transport increased.

For trips to school the share of active transport was high, whereas for trips during leisure time the potential was not used. The development from 1994 to 2000 suggests that the use of the bicycle for short distances should be encouraged and facilitated.

### CLASSIFICATION OF PHYSICAL ACTIVITY BY HEART RATE AND ACCELEROMETRY DATA, RECORDED SIMULTANEOUSLY

Mäder, U., Ruch, N., Rumo, M., Martin, B.W.

*Federal Office of Sports, Switzerland*

**INTRODUCTION:** The extraordinary importance of habitual physical activity and exercise for disease prevention and health promotion is widely recognized. However, physical activity remains difficult to be measured accurately and the available measurement techniques have inherent limitations. The simultaneous use of heart-rate monitoring and accelerometry may be useful to overcome some limitations of those two methods, commonly used separately. The purpose of this study was to elicit, whether physical activities might be classified by heart rate and accelerometry data.

**METHOD:** Heart rate and accelerometry (biaxial) data were collected simultaneously by a chest mounted device (ikcal, Teltronic AG, Biberist, Switzerland) every 10 sec during walking (flat, uphill, downhill at 3 different velocities), during biking and arm cranking with two intensities each, sitting and standing. 6 of the volunteers were women (30.5 ± 11.6 y, BMI = 22.8 ± 5.0, 10 were men (37.2 y, BMI = 26.6 ± 3.3). Data of walking at 3 velocities on the flat and sitting were used to normalise all measured values before scanning for activity specific data patterns and defining 8 activity classes (walking (W), uphill (UH), downhill (DH), leg activity (LA), arm activity (AA), inactivity (IA), and not assigned (NA)). The established data patterns were used to classify measured activities among 12 subjects (6 females, 41.5 ± 14 y, BMI = 21.4 ± 2.6; 6 males, 39.3 ± 16.3 y, BMI = 22.3 ± 1.0) during 30 min of walking (treadmill, flat), biking (ergometer), stepping, and playing (jogging, diabolos, hit a target). Before the measurement, volunteers performed the calibration procedure described above.

**RESULTS:** During 30 min of walking 42.3 ± 37.0 % were classified correctly. Other classes were significantly less often selected ( $p < 0.05$ ), except DH (16.7 ± 27.7 %) and NA (28.0 ± 28.6 %). 48.7 ± 29.7 % during 30 min biking were assigned to LA. The other classes were less represented ( $p < 0.05$ ), except AA (30.6 ± 20.7 %). During 30 min of stepping 30.7 ± 37.7 % and 25.1 ± 31.7 % were recognised as UH and DH, respectively. 30.3 ± 25.3 % were NA. Only IA was significantly less represented than DH (0.3 ± 0.7 %,  $p < 0.05$ ) during stepping. The 30 min of playing consisted of 39.7 ± 16.7 % min NA, 30.7 ± 17.0 % LA, 9.3 ± 11 % AA, 8.0 ± 8.7 % IA, 6.7 ± 22.3 % UH, and 6.3 ± 7.0 % W.

**DISCUSSION:** The results indicate, that values, averaged over 10 sec, for heart rate and accelerometry might be used to classify physical activity. The simple algorithms used for the classification

process in this study have been applied to minimise the required computing level for a wearable device that record physical activity. However, it would be desirable to improve the validity of the classification process so it can be used in advanced research on physical activity behaviour.

### PHYSICAL FITNESS OF DRAFTEES COMPARED WITH THEIR HABITUAL PHYSICAL ACTIVITY

Wyss, T., Marti, B., Mäder, U.

*Federal Institute of Sports, Magglingen, Switzerland*

Physical Fitness of draftees compared with their habitual physical activity

Thomas Wyss, Bernard Marti, Urs Mäder

*Swiss Federal Institute of Sports, Magglingen, Switzerland*

**INTRODUCTION:** The fitness test battery of the Swiss Army recruitment (TFR) is used to assign the conscripts appropriate tasks and allows monitoring of fitness development among Swiss males 19-20 years old. The TFR consists of four performance tests and a questionnaire aiming at physical activity behaviour and motivation of sport. The purpose of this study was to determine the relationship between physical fitness objectively measured by the TFR and the habitual physical activity registered by self-report questionnaire. **METHOD:** 1444 draftees (19.47 ± 0.99y, 177.94 ± 6.47cm, 72.69 ± 11.74kg) performed in summer 2005 the TFR and completed the questionnaire. The TFR consisted of a progressive endurance run, standing long jump, seated shot put, and a trunk muscle strength test. For further analysis the total score, scores for each test and a dichotomous categorisation ("high-performance" versus "lower fitness level") were built. The questionnaire included 6 questions on self-reported habitual physical activity and allowed to classify the respondents as "trained", "regularly active", "irregularly active", "partially active" and "inactive". Spearman correlation coefficients were calculated to establish the relation between physical activity behaviour and the results of each of the four TFR tests. The Kappa value was calculated to quantify the magnitude of agreement between the categorisation "high performance" and "trained".

**RESULTS:** Draftees classified as trained (n=694) achieved 63.1, regularly active (n=127) 56.9, irregularly active (n=305) 57.3, partially active (n=238) 52.0 and inactive (n=80) 48.9 TFR-scores on the average. The total score of the TFR and the scores for each test were positively related to the habitual physical activity level, respectively ( $r=0.40$ , progressive endurance run:  $r=0.39$ , trunk muscle strength test:  $r=0.29$ , standing long jump:  $r=0.23$  and seated shot put:  $r=0.20$ ,  $p < 0.0001$ ). 68% of the high-performance draftees (n=519) were classified as trained by the questionnaire. 37% of the draftees with lower fitness level (n=925) were classified inconsistently as trained (Kappa = 0.284,  $p < 0.0001$ ).

**DISCUSSION:** These results suggest that in young men habitual physical activity has some promoting effects on physical fitness. Kushima et al. (1) found similar coherences in middle-aged men. As expected, the aerobic endurance is stronger related to the habitual physical activity level than explosive muscle power. Fair agreement was observed between the classifications "high performance" and "trained"; however, there seems to be a need for both assessments.

#### REFERENCE:

1. Kushima K, Ohtaki M, Fukuba Y, Takamoto N, Une S, and Munka M. [Effect of habitual physical activity on physical fitness and serum cholesterol in middle-aged male workers]. *Nippon Koshu Eis*

### CAN INACTIVE YOUNG PEOPLE BE REACHED THROUGH AN INTERNET PROGRAMME TO PROMOTE PHYSICAL ACTIVITY?

Padlina, O., Jimmy, G., Martin, B.

*Swiss Federal Office of Sports, Switzerland*

Introduction

Feelok is an online health promotion programme for young people aged 12-18 ([www.feelok.ch](http://www.feelok.ch)). It has been available since 2002 and includes sections on the following topics: smoking, cannabis, stress, self-confidence, alcohol, nutrition, and sexuality.

An additional section to promote physical activity among inactive youth was added in 2005 with support of the Swiss Federal Office of Sports.

The aim of the current study was to determine whether inactive young people could be reached through the internet medium and if they showed an interest in engaging in the programme.

#### Method

Three different sources were used to answer the above question.

1) When the section on physical activity had not been added to feelok yet, all visitors of the general feelok programme were asked how many times per week they engaged in sports outside school hours.

2) Once the section on physical activity was launched, a programme running in the background of feelok recorded user numbers and duration of visits to this section.

3) feelok also offers a physical activity test based on a 7-day recall questionnaire. The number of test participants classified as inactive was determined being those who accumulated less than 1500 kcal through physical activities during a week.

#### Results

1) The question on sports outside school hours was answered by 545 youths aged 10 to 19 (54% female, response rate 14.2%) during a 2 week time period. Twenty-five percent reported engaging in sports less than once a week.

2) The feelok physical activity promotion programme was visited 208 times for at least 3 minutes during a time period of 8 weeks. An average visit lasted 14 minutes.

3) Out of 378 youths aged 10 to 19 (64% females) who completed the physical activity test, 12% were classified as inactive.

#### Conclusion

Seeing that a quarter of visitors of the general feelok programme were rarely active in sports, it can be concluded that this kind of programme is a good starting point to reach the group of inactive youths. The number of 104 visits per month for the physical activity promotion programme is comparable to the use of partial modules for other health dimensions of feelok and shows that this programme attracted the interest of the young people. Among those who completed the physical activity test, 12% were classified as inactive which indicates that this group can be reached. However, more active recruitment measures may lead to a higher participation rate of the inactive.

## EVALUATION OF SENIOR SPORT OFFERS IN SWITZERLAND: A PILOT STUDY

Wanner, M., Martin, B., Wyss, T., Schneider, A.

*Swiss Federal Office of Sports, Switzerland*

**Background:** In Switzerland several different organisations offer a wide range of physical activity and sport courses for seniors. These are well known in the Swiss population. However, the variety of sport offers for seniors has not yet been systematically evaluated.

**Objective:** In this pilot study the feasibility of evaluating senior sport offers was investigated and preliminary data were collected on the participant's profile.

**Methods:** In structures volunteering for this study, seven open-end courses (gymnastic clubs, N=112, no refusals), two 10-week courses (aqua gymnastics, N=17, response rate 85%) and one 1-week course (different sports, N=71, response rate 92%) participated in the questionnaire survey. Data were obtained on course satisfaction, expectations, level of physical activity and characteristics of the participants. Different aspects of overall course satisfaction were assessed such as organisation, competence of the instructor, atmosphere among the participants, motivation to be physically active outside the course.

**Results:** The mean age was 67.2 years in the open-end courses, 57.0 years in the 10-week courses and 68.2 years in the 1-week

course. The proportion of women was 96.1%, 100% and 66.2% in the open-end courses, the 10-week courses and the 1-week course, respectively. 48.4% of participants in the open-end courses and 60.5% of participants in the 1-week course were sufficiently active according to the physical activity recommendations in Switzerland compared to 35.9% in the general Swiss population (1). None of the participants were classified as completely inactive, compared to 19.4% in the general Swiss population (1).

In the three types of courses, between 73.2% and 100% of the participants were very satisfied with the course, 99% were at least rather satisfied. The proportion of individuals at least rather satisfied ranged from 88% to 100% for organisation, competence, atmosphere and motivation. In both the 10-week courses and the 1-week course, the participant's expectations were met or exceeded (as assessed in the beginning and at the end of the course).

**Conclusions:** A questionnaire survey appears to be a feasible and well accepted method to obtain data from participants of senior sport offers in Switzerland. Preliminary data suggest that very active elderly people are currently reached by senior sport courses. The results have to be confirmed in larger samples. It remains a challenge to reach other segments of the senior population while maintaining the excellent satisfaction of participants.

1. Stamm H, Lamprecht M. Structural and cultural factors influencing physical activity in Switzerland. *Journal of Public Health* 2005;13(4):203-211.

## BONE MASS IS POSITIVELY ASSOCIATED WITH PHYSICAL ACTIVITY, MUSCLE STRENGTH, FITNESS AND LEAN BODY MASS IN SWISS SCHOOL CHILDREN [ISRCTN15360785]

Kriemler, S., Zahner, L., Puder, J.J., Roth, R., Schmid, M., Guldimann, R., Knöpfli, M., Rizzoli, R.

*Institute of Sports and Sport Sciences, Switzerland*

**Background:** More than every 3rd woman over 50 years suffers from osteoporosis. The impact of preventive measures on bone accretion is most pronounced during growth. We therefore looked for factors associated with higher bone mass in children and analysed the relationship between measures of physical activity (PA) and bone mineral density (BMD). **Methods:** Among 540 7-13 y old children (males and females) from randomly selected socio-ethnic diverse urban and rural public schools in Switzerland studied, 389 children had BMD and body composition measurements by dual energy x-ray absorptiometry (DXA). In 374 children physical activity was assessed by accelerometer. Vigorous PA was defined as the daily amount of time above 3000 counts/min. The independent association between BMD, PA, lower extremity strength (jump and reach), and aerobic fitness (20 m shuttle run) was assessed using partial correlation analyses. The association between low age- and gender adjusted BMD (Z-Score less than -1) with age, sex and pubertal stage, family history of osteoporosis, calcium intake, lean body mass (LBM), daily media use and all measures of PA was assessed using stepwise multiple logistic regression analyses. The amount of PA in children with low vs. high age- and gender adjusted BMD (Z-Score less than -1 and over +1, respectively) was compared by t-test. **Results:** The children were 9.2±2.2 yrs old (x±SD) with a LBM of 25.2 ± 6.7 kg and 23.5±6.0% body fat. BMD of the hip was 0.699±0.099 g\*cm<sup>-2</sup> and calcium intake 971±384 mg\*d<sup>-1</sup>. Their daily PA was 599'390±167'322 counts\*d<sup>-1</sup> with 44.7±21.9 min spent in vigorous PA, in the jump and reach test they achieved 24.1±6.9 cm and in the shuttle run test they performed 5.7±2.2 laps. Independently of age, weight, height, sex, pubertal stage, calcium intake and family history of osteoporosis, total hip BMD was positively associated with more time spent in total and in vigorous PA (r=0.19 and 0.2, both p<0.01), strength (r=0.26, p<0.0001) and aerobic fitness (r=0.29, p<0.0001). On multiple logistic regression analyses, a low BMD of the hip was associated

with male sex, older age and decreased LBM, strength and less vigorous PA ( $p < 0.0001$ ,  $n = 274$ ). Children with a high BMD spent 17% more time in daily PA compared to children with a low BMD ( $p < 0.01$ ). Conclusion: In Swiss children, higher BMD of the hip is independently associated with higher physical activity, muscle strength and fitness as well as LBM. Bone health improving interventions should therefore focus on increasing PA which also positively affects LBM, muscle strength and aerobic fitness.

This study was supported by the Federal council of Sports, Magglingen, Switzerland

### INFLUENCE OF SAMPLING RATE ON THE EVALUATION OF ACCELEROMETRY DATA OF CHILDREN

Ruch, N., Mäder, U., Rumo, M.

Swiss federal Institute of Sports Magglingen, Switzerland

#### Introduction

The objective measurement of physical activity (PA) in free-living individuals is essential for the estimation of the PA - health outcome relationship. Accelerometry is known as a valid and reliable system to measure PA in adults as well as in children. Although the issue of sampling rate has not been studied in adults, the use of cut-off points based on 1-min sampling mode may be inappropriate in children and may result in underestimation of PA. The aim of this study was to determine the effect of accelerometer sampling rate on PA measures in children.

#### Method

25 girls and 21 boys (age:  $11 \pm 1$  y, weight:  $39.1 \pm 8.1$  kg, height:  $1.49 \pm 0.09$  cm) were included in the study. They wore hip-placed accelerometers with a sampling rate of 1 s for seven consecutive days. Activity counts were subsequently reintegrated into 60-s intervals and classified as either low, moderate, vigorous as well as moderate and vigorous (MVPA) using a children MET prediction equation.

#### Results

Daily accumulated time classified as MVPA was significantly lower in 1-s than 1-min sampling mode (1-s:  $126 \pm 23$  min, 1-min:  $137 \pm 35$  min). Time spent in moderate activity was significantly lower in 1-s than in 1-min sampling mode (1-s:  $87 \pm 16$  min, 1-min:  $119 \pm 32$  min), while time spent in low (1-s:  $683 \pm 49$  min and 1-min:  $671 \pm 58$  min) and vigorous (1-s:  $39 \pm 12$  min and 1-min:  $18 \pm 12$  min) activities was significantly higher in 1-s than 1-min sampling mode.

#### Discussion

In comparison to the 1-s sampling mode, the integration over 60 s leads to a significant under-representation of high- and low-intensity activities and to a significant over-representation of moderate-intensity activities. Therefore, sampling mode should be chosen accordingly to the questions to be studied. Further studies should quantify the differences in the estimation of PA between sampling modes in adults.

### METABOLIC SYNDROME AND PHYSICAL ACTIVITY LEVEL IN PREPUBERTAL OBESE CHILDREN

Farpour-Lambert, N.J., Keller-Marchand, L., Martin, X., Trigona, B., Schwitzgebel, V., Aggoun, Y., Beghetti, M.

Pediatric Cardiology Unit, Switzerland

BACKGROUND: Obesity is a major public health problem that is associated with the Metabolic Syndrome, defined by body fatness, dyslipidemia, hyperinsulinemia, hypertension, and low aerobic

fitness. Foundation of cardiovascular diseases may appear early in life in this population. OBJECTIVE: To assess the main components of the metabolic syndrome and physical activity level in prepubertal obese children. METHODS: Cross-sectional study including 47 prepubertal obese children and 47 matched lean controls (mean age  $9.1 \pm 1.5$  years). We measured fasting blood lipids, glucose and insulin levels; body fatness by DXA; 24-hour systolic and diastolic systemic blood pressure; maximal aerobic capacity (peakVO<sub>2</sub>) by a treadmill test, 7-day physical activity count by uniaxial accelerometer (MTI Actigraph), and anthropometrics. RESULTS: Age, height and pubertal stage (Tanner 1) were similar among groups, however obese children had higher body weight ( $48.4 \pm 13.6$  vs  $31.8 \pm 7.0$  kg), BMI ( $25.1 \pm 4.7$  vs  $16.4 \pm 1.9$  U) and body fatness ( $41.4 \pm 9.2$  vs  $21.1 \pm 7.4$  %). Obese children had lower cholesterol-HDL ( $1.11 \pm 0.26$  vs  $1.42 \pm 0.32$  mmol/l,  $p = 0.001$ ), and higher cholesterol total/HDL ratio ( $4.12 \pm 1.31$  vs  $3.21 \pm 0.72$ ,  $p = 0.001$ ) and cholesterol-LDL/HDL ratio ( $2.83 \pm 1.17$  vs  $2.00 \pm 0.64$ ,  $p = 0.001$ ) compared to controls. Insulin levels ( $12.0 \pm 6.3$  mU/l vs  $4.6 \pm 3.2$ ,  $p = 0.001$ ), mean 24-hour systolic ( $124.7 \pm 14.0$  vs  $101.8 \pm 18.3$  mmHg,  $p = 0.001$ ) and diastolic blood pressure ( $72.9 \pm 7.1$  vs  $63.8 \pm 5.4$  mmHg,  $p = 0.001$ ) were augmented. Seven day physical activity count ( $317.6 \pm 57.2$  vs  $376.5 \pm 119.0$  cpm) and VO<sub>2</sub>peak ( $35.9 \pm 6.6$  vs  $44.2 \pm 7.8$  ml/kg/min,  $p = 0.001$ ) were reduced in obese children. CONCLUSIONS: Our study demonstrates that main components of the metabolic syndrome appear before puberty in obese children. Therefore, there is an urgent need to develop prevention strategies early in life. The treatment of obese children should include adapted physical activity, to prevent the development of cardiovascular diseases and type 2 diabetes risk factors.

### SELF-REPORTED WAKING AND SLEEPING PERIODS VERSUS VALUES ESTIMATED FROM ACCELEROMETRY DATA

Rumo, M., Ruch, N., Mäder, U.

Swiss Federal Institute of Sport, Switzerland

INTRO: Accelerometers are widely used in the objective measurement of physical activity. In order to adequately interpret behavioural pattern concerning physical activity, it is crucial to determine waking and sleeping periods. Globally fixed points of time for getting up and going to bed do not take individual differences into account, so one can rely on diaries or try to estimate sleeping and waking periods from the accelerometry data. Differences between estimated and self-reported time points for rising and sleeping were investigated.

METHOD: Accelerometry data was recorded from 50 individuals (26 males, 24 females; age:  $39 \pm 11$  years) wearing an Actigraph (Manufacturing Technology Inc. (MTI), Fort Walton Beach, FL, USA) for 4 to 7 consecutive days. All subjects had to indicate for each day the time of getting up and the time of going to bed in a diary. 332 valid days were used for the analysis. Counts were recorded minute-by-minute. For each day the longest time period, during which the mean counts over 10 minutes do not exceed 180 were considered to be the sleeping period. The time points estimated in this way were compared to the indications from the diary.

RESULTS: The mean of the time that was reported by the subjects for rising in the morning was  $7h58 \pm 1h38$  and for the time of going to bed  $23h07 \pm 3h19$ , the means of the algorithms estimation were  $8h14 \pm 1h57$  and  $23h52 \pm 12h07$  respectively. The differences between the two methods did reach statistical significance.

CONCLUSION: The automated estimation tends to assign later time points to the start and the end of the waking period. The gap between the estimated time of rising and the self-reported one can be explained by the fact that the subject put on the accelerometer short after he / she actually got up. The estimation of the times for going to bed seems to be a harder problem to automate.

## EFFECT OF AN INPATIENT INTERVENTION ON AEROBIC FITNESS IN PATIENTS WITH JUVENILE OBESITY

Knöpfli, B.H., Schätzle, B., Lehmann, M., Radtke, T.

*Alpine Children's Hospital Davos, Switzerland, Switzerland*

**Background:** In most patients with juvenile obesity limitations in aerobic fitness occur, especially if the overweight exceeds the age related 98th percentile. Such deconditioning leads to restrictions in the career prospect or even to physical disability. Specific therapeutic exercise is needed to treat those patients. The present study evaluates a 14-month follow-up of an inpatient intervention on aerobic fitness. **Methods:** 17 obese girls (n=9) and boys (n=8) were tested at the beginning (IN), at the end of an inpatient program lasting 8 weeks (8W), after 6 month post-hospitalization program (6MFU = 6-month follow-up) and again 8 month later (14MFU = 14-month follow-up). They were 13.4±1.8 years old with a body weight of 87.5±19.2 kg and a body mass index of 32.6±4.8 kg/m<sup>2</sup> (for all subjects age related percentile >98). The inpatient program was based on a multicomponent treatment and education focusing on nutritional changes, behavioral modifications and physical activity (at least 45 min/day; 50-75% of maximal heart rate; in swimming, walking, hiking, jogging, skiing, and ball games), in which the participants took part in daily organized activities. In addition, patients were encouraged to use active pursuits as part of their daily life in the hospital. A major effort was done in planning for, and monitoring each patient's post-hospitalization program including the identification of a team of health professionals located close to the patient's home. This was done in coordination with the referring health professional. Maximal aerobic power tests were performed on a cycle ergometer. The study was analyzed, using a one-way ANOVA with repeated measurements. **Results:** VO<sub>2</sub>max per body weight significantly increased throughout the inpatient program from 26.8±5.2 to 33.1±4.3 ml/min/kg (pIN-8W<0.001). This increase lasted for the whole outpatient period: at 6MFU 33.1±6.5 and at 14MFU 32.0±5.7 ml/min/kg; pIN-6MFU<0.001 and pIN-14MFU<0.001; p8W-6MFU=ns(1.00), p8W-14MFU=ns(0.61). A similar pattern occurred in VO<sub>2</sub>max percent predicted (IN 58.1±12.3, 8W 71.5±10.1, 6MFU 71.6±13.5, 14MFU 69.7±12.8 %predicted; pIN-8W<0.001, pIN-6MFU<0.001, pIN-14MFU<0.001; p8W-6MFU=ns(1.00), p8W-14MFU=ns(0.76)) as well as relative peak mechanical power (IN 2.03±0.39, 8W 2.72±0.43, 6MFU 2.82±0.54, 14MFU 2.74±0.56 Watt/kg; pIN-8W<0.001, pIN-6MFU<0.001, pIN-14MFU<0.001; p8W-6MFU=ns(0.64), p8W-14MFU=ns(1.00)). Absolute VO<sub>2</sub>max as well as absolute peak mechanical power significantly increased throughout the in- and outpatient periods (IN 2333±581, 8W 2470±461, 6MFU 2470±543, 14MFU 2631±440 l/min; pIN-8W=ns(0.34), pIN-6MFU=ns(0.34), pIN-14MFU=0.003; p8W-6MFU=ns(1.00), p8W-14MFU=ns(0.21). IN 173±35, 8W 203±41, 6MFU 213±39, 14MFU 225±45 Watt; pIN-8W<0.001, pIN-6MFU<0.001, pIN-14MFU<0.001; p8W-6MFU=ns(0.40), p8W-14MFU=0.002). **Conclusion:** A specific therapeutic exercise as a component of a multidisciplinary inpatient program and a comprehensive follow-up outpatient program is a successful method to improve a clinically relevant aerobic deconditioning to an almost normal fitness.

## IS PHYSICAL ACTIVITY LEVEL REDUCED IN CHILDREN WITH CHRONIC DISEASES ?

Farpour-Lambert, N.J., Martini, X., Keller-Marchand, L., Trigona, B., Oehli, M., Schwitzgebel, V., Aggoun, Y., Hofer, M., Beghetti, M.

*University Hospitals of Geneva and Lausanne, Switzerland*

**BACKGROUND:** Physical activity may be reduced in children with chronic diseases due to overprotection, social exclusion, low physical fitness, lack of information or pain. However, there is little information about physical activity in this population. **OBJECTIVE:** To compare the physical activity level of children with type 1 diabetes, obesity, or juvenile idiopathic arthritis with that of healthy children. **METHODS:** This was a cross-sectional study including 30 children with type 1 diabetes (DIAB, 10.5 +/- 2.3 yr), 32 obese children (OB, 9.5 +/- 1.1 yr), 26 children with juvenile idiopathic arthritis (JIA, 10.0

+/- 2.5 yr) and 122 healthy controls (CON, 9.9 +/- 2.8 yr). We measured the physical activity count and the time spent in light, moderate, hard and very hard activities using an uniaxial accelerometer (MTI Actigraph 7064) worn at the waist during 7 days (24 hours /day), except during aquatic activities. We also assessed past 12-month leisure-time physical activity by the Modifiable physical activity questionnaire for Adolescents, and anthropometrics. **RESULTS:** Groups were matched for age and height. Obese children had higher body weight (52.6 +/- 14.0 kg) and body mass index (25.2 +/- 5.4 U) compared to other groups. Physical activity count was decreased in DIAB (303.9 +/- 104.2 cpm, p=0.011), OB (308.2 +/- 53.5, p=0.016) and JIA children (316.4 +/- 82.2, p=0.048) compared to controls (361.3 +/- 125.2). There were no significant differences among the three groups with chronic diseases. Time spent in moderate physical activity was significantly decreased in DIAB and OB compared to JIA and CON groups, and time spent in hard activities was reduced in OB compared to CON. Past 12-month leisure-time physical activity was significantly reduced in OB (0.6 +/- 1.1, hours/week, p=0.001) compared to DIAB (4.0 +/- 4.1), JIA (4.3 +/- 3.2) and CON groups (4.2 +/- 4.6). **CONCLUSION:** Our study demonstrates that children with type 1 diabetes, obesity and juvenile idiopathic arthritis have reduced physical activity levels compared to healthy children. As physical activity is an important determinant of health and quality of life during growth, these children should be encouraged to be more active.

## LOOKING AT SPORTS: DEATH IN SPECTATORS FROM A PUBLIC HEALTH PERSPECTIVE

Katz, E.

*Centre Hospitalier Universitaire Vaudois, Switzerland*

Sudden cardiac death (SCD) is a natural death due to cardiac causes, heralded by abrupt loss of consciousness within one hour of the onset of symptoms. The incidence of SCD in Europe is of 1 per 1000 persons/year and the estimated number of SCD varies from 184'000 to 450'000/year in the USA. The causes of SCD differ before and after 35 years. In young athletes common SCD causes are hypertrophic cardiomyopathy, coronary artery anomalies and right ventricular dysplasia. After 35 years coronary artery disease (CAD) is the first cause of SCD. The mechanism of 80% of SCD is that of ventricular tachycardia or ventricular fibrillation, 20% are due to bradycardia or asystole. For 50% of victims SCD is the first manifestation of CAD; 15%-20% of SCD occurs in public places (airport, shopping mall, stadium), but most (70-80%) happen at home. Currently reported survival rates are poor (near 5%).

Risk factors for SCD are nearly the same as that for CAD. Anger, mental stress, cocaine and marijuana use, heavy exertion and, exceptionally, sexual activity were described as initiating events (triggers) of myocardial infarction and SCD. It was suggested that the emotional intensity of sporting events and behaviors associated with spectating such as smoking and binge drinking could trigger SCD. Soccer has often been the focus of such studies since the intensity of football games is arguably unmatched by few other sporting events. The significant increase in cardio-vascular mortality on the day of important matches have been shown in the Netherlands and Great Britain. Our group confirmed the increase of SCD in Switzerland during major soccer tournaments.

The survival in SCD is dependent of a series of critical interventions including early defibrillation. Recently automated external defibrillator (AED) for laymen use was developed and AED deployment encouraged in public places and private homes. Public Access Defibrillation (PAD) initiatives promote basic life support (BLS) and defibrillation by laymen. The survival doubled in the PAD trial and tripled in Piacenza, where public initiative was limited to defibrillation. Studies from Germany and Spain confirmed the interest of early defibrillation programs on soccer stadiums. Spectators suffering from SCD were immediately treated – this resulted in impressive survival rates (up to 62% in Germany)!

We also advise general practitioners to inform their patients and their families before major sporting events about the risks of medical non-compliance, decreased physical activity and increased alcohol and tobacco consumption. More information has to be provided by physicians and the media about practical measures to

adopt in case of chest pain or cardiac arrest. Information about how to reach Emergency Medical Service (EMS) and how to perform BLS has to be broadly advertised. The reinforcement of the EMS systems and PAD development should be proposed in order to reduce the burden of SCD during major sporting events.

### A QUALITATIVE APPROACH TO THE DEVELOPMENT OF PHYSICAL ACTIVITY PROMOTION IN PRIMARY CARE

**Bize, R., Cornuz, J., Martin, B.**

*Federal Office of Sports, Magglingen, Switzerland*

**Introduction:** A number of physical activity promotion models for primary care have been developed in Switzerland over the last few years. None of them has however been taken up by general practitioners on a wider scale.

**Objective:** To assess opinions, beliefs and behavior of a sample of Swiss physicians regarding physical activity (PA) promotion in a primary care setting, in order to develop, together with the results of focus groups interviews, a widely acceptable concept and the material for PA counseling in this particular setting (written booklets for patient, manual for physicians training, and a prescription form).

**Methods:** We conducted a qualitative study with semi-structured interviews among 16 physicians in the French speaking part of Switzerland. Nine were primary care physicians (GPs), four were mainly involved in preventive medicine, and three mainly involved in the field of physical activity.

**Results:** The main themes that were explored are presented below. Screening for sedentary lifestyle and counseling practices - History regarding physical activity is consequently taken with new cases, but not in a systematic manner. Counseling is more likely to be delivered if other cardiovascular risk factors are present.

**Counseling techniques** - According to some interviewees, more emphasis should be put on well-being as a motivational tool, rather than on disease prevention.

**Barriers to counseling** - Lack of time, lack of reimbursement, lack of clear guidelines

**Interventions advocated by GPs for PA promotion in a primary care setting** - Screening for sedentary lifestyle, booklets accompanying physician counseling, patient orientation to structured fitness programs or to specially trained counselors.

**Effectiveness of counseling** - Most physicians describe themselves as rather pessimistic in their perception of counseling effectiveness. **Management of the numerous prevention topics** - Practical continuing education directed to motivational interviewing skills and topic-specific tools are requested.

**Conclusions:** In order to find wider acceptance in primary care settings, the conception of physical promotion should take into account physicians' attitudes and expectations, address their perceived barriers (lack of time, reimbursement and clear guidelines) and try to improve their self-efficacy in physical activity counseling. Such an approach is currently being developed jointly with the Swiss College of Primary Care Medicine. Its feasibility, acceptance and use, will be further tested among a sample of family physicians.

### THE MECHANO-SENSOR FOCAL ADHESION KINASE (FAK) GOVERNS THE SLOW OXIDATIVE EXPRESSION PROGRAM IN ANTI-GRAVITATION RAT SOLEUS MUSCLE

**Durieux, A.C., Desplanches, D., Freyssenet, D., Flück, M.**

*University of Bern, Switzerland*

**Background & Significance:** Maintenance of skeletal muscle function critically depends on the mechanical stimuli. The basic mechanisms underlying mechanosensation and its integration into a

phenotypic muscle response are not understood. In this regard, the mechanically-induced expression and activation of the costameric protein tyrosine kinase FAK and its role in myogenesis suggest that FAK operates as a governor of the contraction-dependent myocellular program of muscle fibers [1, 2].

**Hypothesis:** We hypothesized that overexpression of FAK in the anti-gravitational soleus muscle induces the expression of transcripts related to the slow-oxidative program in a loading-dependent fashion.

**Methods:** The right soleus muscles of 3-month old female Wistar rats were transfected with L19-tagged FAK via gene electrotransfer [3]. Transfection of the left soleus muscle with the L19-tag alone served as internal control. Overexpression of FAK protein vs. the contralateral soleus was evaluated immunochemically as described [2]. Changes in muscle loading were induced in the hindlimb suspension-reloading model [4]. Transcript levels alterations were monitored with custom-available cDNA microarrays as described in [4].

**Results:** Seven days after gene transfer, overexpression of FAK was detected in 20% of soleus muscle fibers and on the level of total protein in cage control and suspended animals. Concomitantly, enhanced mRNA levels of numerous factors associated with the oxidative metabolism as well as voltage-gated membrane-depolarization were noted in the FAK-transfected muscles of cage controls. The effect on gene expression of oxidative factors was reduced after 7 days of unloading when overexpression of FAK was diminished vs. cage controls. With 1 day reloading, FAK-transfected muscles were 12% heavier than contralateral control and FAK protein levels were enhanced. Concomitantly, numerous factors involved in myogenic control and protein turn-over were up-regulated.

**Conclusions:** The combined application of transcript profiling technology and somatic gene transfer highlights that skeletal muscle is an excellent model to map signaling pathways in vivo. The data imply that FAK is part of a mechano-sensory cascade which conditionally integrates mechanical loading and contractile activity of soleus muscle into mitochondrial biogenesis and protein turnover.

**References:**

- 1) Gordon S.E., Flück M., Booth F.W. *J. Appl. Physiol.* 90(3):1174, 2001.
- 2) Fluck M, Ziemiecki A., Billeter R., Muntener M. *J. Exp. Biol.* 205(Pt 16):2337, 2002.
- 3) Durieux A.-C., Manissolle C., Bonnefoy R., Freyssenet D. *Biochem. Biophys. Res. Commun.* 296(2):443, 2002.
- 4) Fluck M. Schmutz S., Wittmer M., Hoppeler H. *Am. J. Physiol.* 289(1):R4, 2005.

### ENDURANCE TRAINING IN HYPOXIA HAS A SPECIFIC GENE EXPRESSIONAL TIME-COURSE AND SIGNATURE

**Schmutz, S., Däpp, C., Wittwer, M., Vogt, M., Hoppeler, H., Flück, M.**

*University of Bern, Switzerland*

**Hypothesis:** Ambient hypoxia makes up an additional stimulus to endurance exercise and activates a gene expressional program which supports mitochondrial biogenesis, myogenesis and capillary neo-formation. This would be reflected by differences in the acute adjustments of the muscle transcriptome in response to a single bout of endurance exercise in hypoxia compared to an analogous single bout in normoxia. Similarly, different steady state adaptations of the transcriptome are expected in response to six weeks of training.

**Methods:** 5 untrained subjects underwent six weeks of endurance training in normobaric hypoxia (4000m above sea-level) on a bicycle ergometer. A 30-minutes near-maximal bout of exercise in normobaric hypoxia was performed in the untrained as well as in the six weeks trained state. Biopsies from the vastus lateralis muscle were taken before and 1, 8 and 24 hours after both single bouts of exercise. The muscle biopsies were processed for morphometric and gene expressional analysis including 220 selected transcripts. Results were compared to the published alterations in

response to endurance training in normoxia (Schmutz et al, Pflugers Arch 451(5): 678-87, 2006).

Results: Endurance training in hypoxia increased the mitochondrial density (86%;  $p < 0.05$ ). Similar to six weeks of training in normoxia, the transcript levels of genes involved in the mitochondrial respiration and protein turnover were upregulated. Specificity of training in hypoxia was seen on the molecular level by and upregulation of the transcripts involved in angiogenesis and cell regulation inducing a myogenic response. The generalized gene response to a single bout of exercise in hypoxia in the untrained and in the trained state was different compared to the response in normoxia ( $p < 0.0001$ ).

Conclusions: The muscle gene expression response after endurance exercise in hypoxia is different from that in normoxia. Hypoxia provokes additional steady state level adaptations of the transcriptome. These observations are in line with earlier findings concerning specific muscular adaptations to endurance exercise in hypoxia compared to exercise in normoxia (Vogt et al, J Appl Physiol 91(1): 173-82, 2001).

### MOLECULAR SPECIFICITY OF THE LOCAL TRAINING RESPONSE IN HUMANS

Flück, M., Schmutz, S., Hoppeler, H.

University of Berne, Switzerland

Background: It is commonly accepted in Sports that the adaptive potential of skeletal muscle to a given type of training is preset by the specific training state. Aerobic capacity may constitute a main determinant of the degree of adjustment for muscle oxidative metabolism with endurance training as it largely defines the relative metabolic stress with repetitive muscle contractions.

Hypothesis: The muscle gene transcript response to acute endurance exercise relates to the aerobic training state and allows a grading of the local exercise responsiveness of individuals.

Methods: Meta analysis was carried out on published results from Schmutz et al (Pflugers Arch 451(5): 678-87, 2006). During this protocol, six not-specifically trained young male volunteers pursued 6 weeks of ergometer training, 5-times a week for 30 minutes at 65% of the maximal workload ( $P_{max}$ ). Before and after the training, body composition, cardiovascular and respiratory performance of the subjects was characterized. Local adaptations to training were determined by ultrastructural analysis of vastus lateralis muscle and by gene expression profiling of 220 muscle-relevant transcripts throughout the first 24 hours of recovery from a 30-minute bout of exercise which matched the intensity of the 6-week training. Expression data were related to pre-biopsy values and verified for major patterns in the transcript response by public available cluster algorithms.

Results: Training improved the initial maximal power output [ $298 \pm 22$  Watt] and maximal oxygen consumption [ $VO_{2max}$ ;  $42.3 \pm 6.0$  ml/min/kg] by 12% and 9%, respectively. This was reflected by a doubling of steady-state levels of transcripts for oxidative metabolic and related redox mechanism in vastus lateralis muscle in correspondence to a 40%-enhanced total mitochondrial volume density after training. The acute muscle response of gene transcripts to endurance exercise at the same relative intensity was blunted in the endurance-trained state. A virtually unchanged transcript expression pattern after the first exercise also discriminated the fittest individual with exceptional respiratory and cardiovascular values, i.e. a  $VO_{2max}$  of 56 ml/min/kg, from the other untrained subjects.

Conclusion: The data support the contention that the systemic oxidative capacity modifies the molecular training response in humans. Thereby training responders appear tentatively identifiable from the analysis of the time-course of the gene response during recovery from a single bout of exercise.

Discussion: A cohort study with a well-matched human population is indicated to validate the use of combined molecular-biological and respiratory diagnostics in the prediction of the efficiency of endurance training.

### EFFECT OF SMALL DOSES OF ALCOHOL ON THE ENDURANCE PERFORMANCE OF TRAINED CYCLISTS

Lecoultre, V., Schutz, Y.

University of Lausanne, Switzerland

Introduction: Alcohol (OH) is considered among athletes as deleterious to endurance performance. However, athletes' OH consumption in most western countries is similar to their non-athletes counterparts, and sometimes it occurs before training session/competition. The effect of OH may be detrimental to performance, as onset of early hypoglycemia, alteration of cardiac work, increase of diuresis or alteration of neuro-muscular excitability. Nevertheless, some effects of OH could be beneficial to performance, i.e. by an increase of self confidence and a decrease in pain perception and anxiety.

The aim of this study was to investigate the acute effect of a small alcohol dose (approximately one standard dose) on endurance performance and metabolic response of trained amateur cyclists.

Methods: 13 male well-trained cyclists took part to this study. After measurement of maximal aerobic power and  $VO_{2max}$ , they familiarized with a 60 minutes time-trial (TT). Subjects then came twice to the lab in standardized nutritional conditions and completed the TT in a randomized single blind condition. The TT was performed in a calorimetric chamber 30 minutes after drinking a cold fruit juice solution containing 0.5 ml OH per kg fat free mass (25 g OH) and 50 g of carbohydrates (CHO) or a control (C) solution of the same volume and containing the same amounts of CHO. Power, heart rate, pedaling cadence,  $VO_2$ ,  $VCO_2$ , energy expenditure (EE) were continuously recorded. Blood alcohol level, glycemia, blood lactate and ratings of perceived exertion (RPE) were measured at regular intervals.

Results: At the start of the TT, blood alcohol levels reached  $0.18 \pm 0.6$  ‰.

OH induced a significant ( $p < 0.01$ ) decrease of global performance vs. C, as assessed by average power (OH:  $233 \pm 23$  W vs. C:  $243 \pm 24$  W). Time course of mechanical power was influenced by OH, the latter inducing an early decrease of power during the TT compared to control ( $p < 0.01$ ). In OH condition,  $VO_2$ ,  $VCO_2$ , EE and glucose oxidation were significantly lower ( $p < 0.05$ ) compared to C. However, this is related to the lower power output observed during the OH trial. In contrast, OH did not influence gross efficiency, global heart rate, RPE, glycemia and blood lactate concentration.

Discussion: These results show that consecutive to acute low dose of OH ingestion, a decrease of high intensity endurance performance occurred. This decrease was not related to modifications of metabolic or physiologic parameters such heart rate, glycemia or blood lactate concentration. These results suggest a central effect of OH affecting either integrated peripheral feedback or central drive. A cephalic response after the ingestion of OH and/or a metabolic effect after intestinal absorption may affect performance.

Conclusion: Performance of well trained amateurs cyclists during a 1 hour TT was significantly decreased by low acute dosage of OH producing alcoolemia much below 0.5 ‰. The absence of OH induced metabolic alterations suggest that the decreased performance may be due to a modulation of central drive or peripheral feedback.

### THE GLYCEMIC INDEX AND PHYSICAL ACTIVITY

Mettler, S., Lamprecht-Rusca, F., Stoffel-Kurt, N., Wenk, C., Colombani, P.C.

ETH Zurich, Switzerland

Background: A food's GI is a percentage representing the area under the blood glucose response curve (over two hours and measured at defined intervals) relative to the blood glucose response curve of a reference food (glucose or white bread). One of the GI's characteristics is that it describes a specific food and does not seem to be related to subject specific factors such as age, gender, body mass index, ethnicity or absolute glycemic response. However, we recently have detected a substantial 25 GI unit difference in a commercially available breakfast cereal's GI when com-

paring endurance trained to sedentary subjects (Mettler et al, in press).

Objective: We therefore intended to validate the results and to further investigate the possible impact of the subjects' training status on the glycemic index.

Subjects and design: Young, adult males of normal body mass index and normal glucose tolerance were tested twice with a 50 g reference glucose solution and twice with a breakfast cereal containing 50 g of available carbohydrates in a randomized order. Ten subjects were sedentary (SE), 12 were moderately trained (MT) and 12 were endurance trained (ET). Blood glucose and insulin were measured.

Results: The GI ( $80 \pm 22$ ,  $63 \pm 18$ ,  $57 \pm 15$  for SE, MT and ET respectively, mean  $\pm$  SD) differed significantly between SE and ET subjects ( $p=0.02$ , mean difference: 23 GI units, 95 % CI = 3-42 GI units). The GI of the MT subjects was intermediary, but did not differ significantly from the SE or ET subjects. The insulin index did not differ significantly between the groups ( $p=0.65$ ).

Conclusion: In accordance with our previous results (Mettler et al, in press), we observed a GI dependence of the commercially available breakfast cereal on the training state of the healthy males. The training state is the first reported factor influencing the GI that is subject specific and not food specific.

References: Mettler S, Wenk C and Colombani PC (in press): Influence of the Training Status on the Glycemic Index. *Int.J.Vitam.Nutr.Res*

## FOOD BEHAVIOUR : NEW APPROACHES

**Golay, A.**

*Geneva University Hospital, Switzerland*

Prevention of weight regain must be integrated in the follow-up of an interdisciplinary programme of weight loss and maintenance.

Therapeutic patient education is a patient-centred approach, focused on obese patients' needs, resources, values and strategies. It allows obese patients to improve their knowledge and conceptions not only concerning their chronic illness and eating disorder, but also their weight loss programme. It brings a better quality of life, a greater therapeutic compliance and a reduction in weight regain. The most difficult part of therapeutic education occurs when patients must change their behaviour.

Motivational interviewing techniques contribute greatly and allow both the preparation and support of patients during progressive "step by step" change. The work on resistance to change is fundamental, and ambivalence must be discussed and negotiated. Patients become partners and we become "coaches". The negotiation of objectives must allow patients to choose their own strategies, which normally should cost them the least possible psychologically and bring them the maximum benefit.

Psycho-social obstacles coming from patients and their environment are very common and should be detected. Emotions, negative thoughts, cognitive restriction, cognitive distortions are approached by cognitive-behavioural therapy.

Finally, the motivational interviewing and the cognitive-behavioural approaches are perfect complements to therapeutic education for long term weight loss maintenance with more than 50 % success over 5 years. The patients become active and co-responsible for their own weight maintenance programme with the aim of improving their quality of life as well as reducing potential relapse.

## THE EFFECTS OF GRAVITY ACCELERATION ON THE CARDIOPULMONARY RESPONSE TO EXERCISE

**Bonjour, J., Tam, E., Grazzina, F., Antonutto, G., Capelli, C., Montmerle, S., Linnarsson, D., Ferretti, G.**

*CMU, Genève, CH; Uni Udine, IT; Uni Brescia, IT; Karolinska Institute, Stockholm, SE, Switzerland*

Models of internal work of cycling predict that the oxygen consumption ( $\dot{V}O_2$ ) at any given work rate should be higher the greater the gravity acceleration (ag). If so, assuming that the relationship between cardiac output ( $Q'$ ) and  $\dot{V}O_2$  be unchanged, then  $Q'$  also should be a function of ag. We tested these predictions by measuring, on 14 male subjects (age =  $26 \pm 5$  years, body mass  $76 \pm 8$  kg),  $\dot{V}O_2$ , carbon dioxide output ( $\dot{V}CO_2$ ), pulmonary ventilation ( $\dot{V}E$ ), heart rate (fH) and  $Q'$  at rest and at the steady state of sub-maximal exercise carried out at a pedalling frequency of 60 min<sup>-1</sup> in the human centrifuge at 1 (centrifuge still), 1.5, 2 and 2.5 G ( $1\text{ G} = 9.81\text{ m/s}^2$ ).  $\dot{V}O_2$ ,  $\dot{V}CO_2$  and  $\dot{V}E$  increased linearly with the mechanical power. As ag was increased, these lines were displaced upward. The linear relationship between  $\dot{V}E$  and  $\dot{V}O_2$  was unchanged, indicating that the ventilatory equivalent was the same at all ag. At any investigated power,  $\dot{V}O_2$  was linearly related to ag. These results are coherent with the first tested hypothesis. They allow predictions of the oxygen cost of exercise on planets with different masses than the Earth. fH increased linearly with both power and  $\dot{V}O_2$ . The relationship between fH and power was displaced upward when ag is increased, such that the relationship between fH and  $\dot{V}O_2$  was unaffected by ag. By contrast, because the increase in fH did not correct the decrease in stroke volume, the relationship between  $Q'$  and power was unaffected by ag, despite the increase in  $\dot{V}O_2$ . As a consequence, the relationship between  $Q'$  and  $\dot{V}O_2$  was displaced downward by increasing ag, contrary to the tested hypothesis. The increase in  $\dot{V}O_2$  with ag was supported by greater oxygen extraction by the tissues. These results imply that the maximal aerobic power should be lower, the higher the ag, in spite of a potentially unchanged maximal oxygen consumption.

## PRECLAMPسيا IS ASSOCIATED WITH EXAGGERATED OXIDATIVE STRESS AND PULMONARY HYPERTENSION AT HIGH ALTITUDE – A NOVEL RISK FACTOR FOR HAPE DURING THE PRACTICE OF SPORTS AT HIGH ALTITUDE?

**Schwab, M., Jayet, P.Y., Thalmann, S., Stuber, T., Hutler, D., Salinas, C., Cucchia, C., Spielvogel, H., Villena, M., Allemann, Y., Sartori, C., Scherrer, U.**

*Bohnar Center for Extreme Medicine, University Hospital, Lausanne, Switzerland*

High-altitude pulmonary edema is the most frequent life-threatening disease occurring during the practice of sports at high altitude. Exaggerated pulmonary HT and an individual predisposition are hallmarks of HAPE but the mechanism that underpins this individual susceptibility is unknown. There is increasing evidence that not only genetic, but also epigenetic mechanisms play an important role in the pathogenesis of human disease. The "Fetal Programming Theory" postulates that adverse events in predispose to disease in adulthood. In line with this theory, preliminary data from our group indicate that preeclampsia predisposes the offspring to exaggerated hypoxic pulmonary hypertension in later life, but the mechanism is unknown. Exaggerated pulmonary hypertension could be related to a structural (defective pulmonary angiogenesis, vascular remodeling) or functional defect. We, therefore, assessed carbon monoxide diffusion capacity (DLCO), and measured pulmonary-artery pressure (systolic right ventricular to right atrial [RV-RA] pressure gradient, echocardiography) before and during nitric oxide inhalation (40 ppb) in 27 young (age,  $12 \pm 2$  years,  $X \pm SE$ ) healthy Bolivian offspring of preeclampsia and 68 sex- and age-matched offspring of normal pregnancies in La Paz (3600 m). The systolic RV-RA gradient was, as expected, roughly 36 percent higher in offspring of preeclampsia than in controls ( $34 \pm 1$  vs.  $25 \pm 1$  mmHg,  $P < 0.001$ ). We found no evidence for defective pulmonary angiogenesis, since DLCO was comparable in the two groups. The exaggerated pulmonary hypertension was related, at least in part, to a functional defect, since nitric oxide inhalation caused an almost twice as large ( $P < 0.001$ ) decrease in pulmonary-artery pressure in offspring than in controls. In a second step, we tested for underlying mechanisms of this functional defect. Preeclampsia is associated with augmented oxidative stress in the mother as well

as in the offspring, and in experimental animals, oxidative stress facilitates hypoxic pulmonary vasoconstriction. We, therefore, examined the effects of the antioxidant vitamin C on pulmonary-artery pressure in the two groups. Vitamin C significantly decreased pulmonary-artery pressure (by  $6.5 \pm 1.3$  mm Hg,  $P=0.002$ ) in the offspring, but had no detectable effect in controls. In conclusion, these findings provide the very first evidence that preeclampsia leaves a persistent and potentially fatal epigenetic imprint in the pulmonary circulation of the offspring living at high-altitude, namely augmented oxidative stress, which predisposes to exaggerated hypoxic pulmonary hypertension in later life. We speculate that offspring of preeclampsia may be at risk to develop HAPE when practicing sports at high altitude. If so, prophylactic administration of antioxidants may prevent this life-threatening complication.

### THE INFLUENCE OF FUNCTIONAL CLOTHING ON THE THERMOREGULATION OF AN ATHLETE.

Jack, A., Thoma, S., Rossi, R., Niess, A., Schmidt, W.

*Empa St. Gallen (CH)/ Universität Bayreuth Sportwissenschaft (D), Switzerland*

Human beings are homeothermic, which means that they have to maintain their core temperature within close limits around  $37^{\circ}\text{C}$ . During every activity, the body produces a certain amount of heat lying between 80 W while sleeping and over 1000 W during most strenuous activities. The surplus energy can be transferred to the environment via three channels: respiration and release of dry (radiation, convection and conduction) and evaporative heat through the skin. Evaporative cooling is a very efficient means of heat dissipation, as one litre evaporated sweat removes about 670 W/h from the body. The body evaporates from at least about 22 g/h so-called perspiration insensibilis, up to 4 l/h during short periods of time. In order to avoid heat stress, the heat loss to the environment should be as high as the heat production. In many sports activities, the heat production of the muscles is higher than the heat release and therefore the body will overheat. Marathon runners, for instance, show core temperature of  $40^{\circ}\text{C}$  or even higher at the end of the run. If the ambient temperature is high, the heat and moisture transport through the garment should be as high as possible to avoid heat stress. In order to develop sports clothing with optimal thermo physiological properties, all thermo physiological parameters have to be considered. In summertime, the thermal insulation should usually be low and the clothing should allow efficient water vapour transfer. During very strenuous activities, it is also very important that the liquid sweat produced can evaporate near the body. If the liquid sweat produced drops down, it will not contribute to cooling the body. Any liquid sweat that does not evaporate near the body will, on the contrary, correspond to an additional physiological load, as the body has to produce more sweat to compensate the run-off. For this reason we aim to develop new textiles, which help to improve human thermoregulation in order to achieve an enhancement of the physical performance. For this purpose we carried out a series of human subject tests on a treadmill. We chose environmental conditions similar to those we will find at the summer Olympic Games in Peking 08. The goal of our study was to look at the influence of running suits on the evaporation cooling process and the thermo physiological parameters of the human body, compared to a nude athlete. This investigation shows that the thermoregulation of the human body works best without clothes, as could be expected. Even if the garments can store additional sweat, they could not increase the evaporative cooling process in comparison to the nude body. However, the lower core temperature reached with one garment shows that a garment with fast wicking properties can efficiently help the thermoregulation of the body.

### DOES LOW INTENSITY ISOCAPNIC HYPERPNEA ENHANCE BLOOD LACTATE ELIMINATION AFTER EXHAUSTIVE ARM EXERCISE?

Perret, C., Mueller, G.

*Swiss Paraplegic Research, Switzerland*

Introduction: Increased lactate concentrations compromise exercise performance. Therefore to regain maximal exercise capacity a fast elimination of accumulated lactic acid is important, particularly if several high intensity exercise bouts have to be performed within a short period of time. In general, blood lactate elimination is enhanced by active recovery at moderate intensities using the previously loaded muscle groups. In doing so glycogen resynthesis in these muscles is compromised and might impair subsequent exercise performance. Respiratory muscles have the ability to metabolize lactate and may therefore be used for recovery purposes without affecting glycogen resynthesis in previously stressed limb muscles. The aim of this study was to investigate the impact of moderate isocapnic hyperpnea (IH) on blood lactate elimination after exhaustive arm exercise in comparison to passive and active recovery using the previously loaded muscles.

Methods: 18 healthy male subjects (age:  $30 \pm 5$ yr; height:  $178 \pm 7$ cm; weight:  $72 \pm 9$ kg;  $\text{VO}_2$ peak:  $42 \pm 7 \text{ml} \cdot \text{min}^{-1} \cdot \text{kg}^{-1}$ ) performed three arm cranking tests to volitional exhaustion on 3 different days at least 48h apart. Arm exercise was randomly followed by 30min of passive re-recovery (PR), ventilatory recovery (VR) by means of IH at 30% of 12s maximal voluntary ventilation, or active arm cranking (AC) at a moderate intensity. Blood lactate concentrations were measured at rest, immediately after the exercise test and every 2min until the end of the re-recovery period. Furthermore peak power, peak oxygen uptake and rate of perceived exertion were determined at the end of the arm cranking test. Heart rate was measured continuously throughout the test.

Results: No significant differences for blood lactate concentrations were found between interventions PR, VR and AC during the whole measurement period (peak lactate concentrations:  $11.09 \pm 1.98 \text{mmol} \cdot \text{l}^{-1}$  (PR),  $11.25 \pm 1.93 \text{mmol} \cdot \text{l}^{-1}$  (VR),  $11.13 \pm 1.44 \text{mmol} \cdot \text{l}^{-1}$  (AC); lactate concentrations at the end of the recovery period:  $4.35 \pm 1.56 \text{mmol} \cdot \text{l}^{-1}$  (PR),  $4.09 \pm 1.35 \text{mmol} \cdot \text{l}^{-1}$  (VR),  $3.77 \pm 1.60 \text{mmol} \cdot \text{l}^{-1}$  (AC). All other parameters measured were not significantly different between interventions, with the exception of higher mean recovery heart rates during VR ( $111 \pm 7$ bpm) and AC ( $116 \pm 9$ bpm) compared to PR ( $93 \pm 11$ bpm).

Conclusion: Low intensity IH seems not to enhance blood lactate elimination after exhaustive arm exercise compared to passive or active recovery using the previously loaded muscle groups.

### MENARCHEAL AGE, MENSTRUAL DISORDERS AND SOMATOTYPES OF SWISS ELITE JUNIOR AND SENIOR SYNCHRONIZED SWIMMERS.

Taeymans, J., Clijisen, R., Kersting, M., Clarys, P., Duquet, W.

*Internationale Akademie Physiotherapie, Switzerland*

Introduction

The aim of this study was to investigate menarcheal age (MA), menstrual disorders (MD) and the somatotypes (S) of the junior (JR) and senior (SR) athletes from the Swiss National Synchronized Swimming Team.

Methods

Six JR ( $16.4 \pm 1.6$  yrs) and 9 SR ( $20.2 \pm 2.6$  yrs) participated in this study. MA and MD were assessed using questionnaires. Anthropometric measurements were carried out following the ISAK guidelines. S was calculated (Heath & Carter method). SPSS 12.0 was used for statistical analysis ( $p < 0.05$ ).

Results

In JR mean MA was  $12.8 \pm 1.0$  yrs while in SR mean MA was  $13.6 \pm 1.2$  yrs. Oral contraceptives (OC) were used by 5 out of 9 SR, and not by JR. MD were found in 66.7% of the JR and SR not using OC. Mean height of JR was  $164.1 \pm 4.9$  cm and mean weight was  $51.0 \pm 5.4$  kg ( $\text{BMI} = 18.9 \pm 1.1 \text{kg/m}^2$ ). Mean S were  $2.9 - 3.3 - 3.9$ . Mean

height of SR was 164.0±6.1cm and mean weight was 54.7±4.6kg (BMI=20.1±1.0kg/m<sup>2</sup>). Mean S of SR were 3.1–3.5–3.3. Mean S of the whole sample were 3.0–3.4–3.5. The differences in age and in BMI between JR and SR were significant. The relatively low SD of the anthropometric data indicate small variance (distribution) in these athletes. No differences between the mean values of several anthropometric variables and of the S compounds in JR and SR were found ( $p>0.05$ ). Mean %fat in JR and SR was 21.5±2.5% and 22.8±3.1% resp.

#### Discussion

Mean MA (13.4±1.1yrs) is on the P50 of the "Leuven Growth Study" (1) and comparable with MA (13.0±1.3 yrs) found in the "LEGS-Study" (2). In our sample sexual maturation was normal. The absence of differences for the mean epicondylar femur and humerus widths between JR and SR indicate that skeletal maturation is completed by the age of 16 yrs. The prevalence of MD is high, with 22.2% of the athletes that are amenorrhoeic probably due to severe training regimens and unconventional nutritional habits. Mean BMI (19.6±2.1kg/m<sup>2</sup>) is borderline with the lower cut-off for a healthy BMI. Mean age (18.7±2.9 yrs) is above this of Olympic female stroke swimmers (17.0 yrs) (3). Although there are no differences ( $p<0.05$ ) between the mean S of JR and SR, JR are more ectomorphic and less endomorphic than SR. The same has been found in different selections of female Olympic stroke swimmers (3). S of synchronized swimmers tend to be central, with the 3 S compounds differing from one another by no more than 0.5 units. Such athletes have well balanced bodies, which is an advantage in esthetic based sports.

#### Conclusion

Synchronized swimmers show normal sexual maturation but also important MD. Seen the central S and the relatively low BMI, further analyses of the administered food questionnaires will be needed for a better understanding of these relationships.

#### Reference

- (1) Growth, Maturation and Physical Activity (Malina&Bouchard&Bar-Or,2004)
- (2) The Longitudinal Experimental Growth Study (Hebbelink et al.,1990)
- (3) Somatotyping, development and applications (Carter&Heath,1990)

## BLOOD LACTATE CHANGES DURING INDOOR CYCLING

Clijse, R., Taeymans, J., Pfister, R., Wüthrich, M., Duquet, W.

*Internationale Akademie Physiotherapie, Switzerland*

#### Introduction

Indoor Cycling (IC) booms in European fitness centres. It is said to be an aerobic training method. Cycling frequency is determined by heavy beat music. Mostly resistance is set subjectively by the athlete while heart rate controlled training is not that common yet. The aim of this study was to investigate changes of blood lactate concentration (Lact) during an IC session with resistance set subjectively and set at a percentage of maximal heart rate (HR) estimated by the common formula 220 minus age.

#### Methods

Subjects (M=4;F=3) aged between 31 and 43 yrs were recruited in a Swiss fitness centre. They were familiar with IC. Informed consent was given. On 3 consecutive Saturdays following tests were conducted: a bike ergometer-test to assess lactate threshold (day1), a first IC session with resistance set subjectively (day2) and a second IC session that was HR controlled (day3). IC sessions took place in a group and were guided by an instructor (60min.). Per subject and per session 8 fingertip blood samples were analysed:1 at rest and 7 after different blocks of higher and lower intensity bouts. The Lactate Pro<sup>TM</sup>LT1710 was used for lactate analyses. HR was monitored using Polar devices. Exhaustion was assessed using the Borg scale (6-20). SPSS 12.0 was used for statistics (ANOVA for repeated measurements). Significance was set at 5%.

#### Results

Mean HR at lactate threshold (4.0 mmol/l) was 157.0±16.8 bpm. Baseline Lact was 2.5±0.8 mmol/l at the 1st and 2.9±2.0 mmol/l at

the 2nd IC session. Under conditions of subjectively set resistance mean Lact was 4.9±3.0 mmol/l after warming-up and peaked at 8.6±4.4 mmol/l ( $p<0.05$ ). At each measurement moments mean Lact was above 4 mmol/l ( $p=0.008$ ). Under conditions of HR controlled set resistance mean Lact was 7.0±7.3 mmol/l after warming-up and peaked at 8.0±4.3 mmol/l. However, ANOVA showed no significant changes of Lact during the IC session under HR controlled conditions ( $p=0.243$ ). Under both conditions Borg and HR increased ( $p<0.05$ ).

#### Discussion

Lact increases above 4 mmol/l directly after warming-up and remains high during the entire session period, indicating that intensity levels are too high for adequate aerobic training. Subjectively set resistance may lead to a significant increase in Lact with individual values above 14 mmol/l. It may be argued that this is an appropriate training method for not highly trained persons. Our data suggest that the use of individual HR monitoring devices may lead to a better management of the individual set resistances.

#### Conclusions

During an IC session the anaerobic component is dominant. Following the Indoor Cycling concept warming-up already leads to Lact concentration above the threshold. The use of individual heart rate monitoring devices may lead to a better management of the individual set resistances which may avoid significant changes in blood lactate concentration. Further research with larger numbers of participants is needed to increase statistical power.

## USE OF ISOTOPE RATIO MASS SPECTROMETRY TO DETECT DOPING WITH ORAL TESTOSTERONE UNDECANOATE: INTER-INDIVIDUAL VARIABILITY OF 13C/12C RATIO

Saudan, C., Baume, N., Desmarchelier, A., Strahm, E., Sottas, P.-E., Bagutti, C., Caudey, M., Schumacher, Y.O., Mangin, P., Saugy, M.

*Institut Universitaire de Médecine Légale, Switzerland*

The metabolic effect of multiple oral testosterone undecanoate (TU) doses over 4 weeks was assessed in 7 voluntary men. The protocol was designed to detect accumulation of the substance by choosing the appropriate spot urines collections time and to study the urinary clearance of the substance after weeks of treatment. Urines were analysed by a new GC/C/IRMS method to establish the d13C-values of testosterone metabolites (androsterone and etiocholanolone) together with an endogenous reference compound (16(5a)-androst-3a-ol). The significant differences in inter-individual metabolism following TU intake was illustrated by large variations in d13C-values of both T metabolites (max D d13C-values = 5.5 ‰), as well as by very stable longitudinal T/E profiles and carbon isotopic ratios in the first hours following administration. According to T/E ratios and d13C-values, the washout period after 80 mg TU intake was less than 48 hours for all subjects and no accumulation phenomenon was observed upon chronic oral administration.

## LONGITUDINAL PROFILING OF URINARY STEROIDS BY GAS CHROMATOGRAPHY/COMBUSTION/ISOTOPE RATIO MASS SPECTROMETRY: DIET CHANGE MAY RESULT IN CARBON ISOTOPIC VARIATIONS

Saudan, C., Kamber, M., Barbat, G., Robinson, N., Desmarchelier, A., Mangin, P., Saugy, P.

*Institut Universitaire de Médecine Légale, Switzerland*

Longitudinal profiling of urinary steroids was investigated by using a gas chromatography/combustion/isotope ratio mass spectrometry (GC/C/IRMS) method. The carbon isotope ratio of three urinary testosterone (T) metabolites: androsterone, etiocholanolone, 5b-androstane-3a,17b-diol (5b-androstanediol) together with 16(5a)-androst-3a-ol (androst-3a-ol) and 5b-pregnane-3a,20a-diol (5b-pregnanediol) was measured in urine samples collected from three

top-level athletes over two years. Throughout the study, the subjects were living in Switzerland and were residing every year for a month or two in an African country.  $^{13}\text{C}$ -enrichment larger than 2.5 ‰ was observed for one subject after a two-month stay in Africa. Our findings reveal that  $^{13}\text{C}$ -enrichment caused by a diet change might be reduced if the stay in Africa was shorter or if the urine sample was not collected within the days after return to Switzerland. The steroids of interest in each sample did not show significant isotopic fractionation that could lead to false positive results in anti-doping testing. In contrast to the results obtained with the carbon isotopic ratio, profiling of urinary testosterone/epitestosterone (T/E) ratios was found to be unaffected by a diet change.

### SLIMMER AND STRONGER - THE EFFECT OF ECCENTRIC EXERCISE IN THE ELDERLY

Däpp, C., Vogt, M., Klossner, S., Popp, A., Lippuner, K., Hoppeler, H.

University of Bern, Switzerland

#### Introduction

Loss of muscle strength and coordination is a consequence of aging and increases the risk for falling. Conventional heavy resistance training improves muscle strength but represents a safety risk for people with limited cardiovascular exercise tolerance. By contrast, eccentric muscle work (lengthening contractions) allows high-load muscular exercise training with low cardiovascular stress as compared to shortening contractions. We hypothesized that eccentric ergometer training is superior to conventional strength training for gain in leg strength, muscle mass and muscular coordination in elderly subjects >75 years.

#### Methods

Forty-six elderly subjects (age  $81.3 \pm 3.2$  years, 30 females, 16 males) were randomized to an eccentric (ECT), a resistance (RET) training and a control (CTL) group. Each group followed two guided trainings per week for 12 weeks; each session lasting 45 min. ECT trained on an electronically braked eccentric ergometer where appropriate dosage of the eccentric target load had to be self-monitored on a screen by the subject. RET performed a high-intensity heavy resistance training (4 exercises with 2 sets of 8-10 repetitions each) on weight machines. CTL did not train physically but followed guided cognitive training sessions of the same duration. Pre- and post-intervention testing assigned the risk for falling (Timed Up&Go (TUG), Berg Balance Scale (BBS)), maximal voluntary contraction (MVC) of the legs and eccentric muscle coordination (dosage of the target load), while dual X-ray absorptiometry (DXA) determined the subjects' body composition.

#### Results

The training intervention caused a significant improvement for TUG in ECT ( $-0.5 \pm 0.1$ s) and RET ( $-0.7 \pm 0.1$ s), but not in CTL. BBS score was not changed in any group. Significant increases were recorded for MVC ( $+7.1 \pm 2.0\%$ ) and for eccentric muscle coordination ( $+66 \pm 11\%$ ) exclusively in ECT. Thigh muscle mass was not changed in any group, but interestingly, body and thigh fat were decreased exclusively in ECT by  $5.3 \pm 1.7\%$  and  $8.0 \pm 2.0\%$ , respectively.

#### Discussion / Conclusion

Eccentric ergometer training in elderly outperformed conventional resistance training concerning gain in leg strength and muscle coordination which resulted in comparable improvements in functional tests assessing the risk for falling. Unexpectedly, eccentric ergometer training positively influenced the subjects' body composition lowering their fat proportion. However, the cellular or molecular mechanisms behind this metabolic phenomenon remain speculative. Our results suggest that eccentric ergometer training may be a well-suited type of exercise for elderly to become slimmer and stronger, and to reduce the risk for falling.

### KINETICS OF CARDIAC OUTPUT, SYSTEMIC O<sub>2</sub> DELIVERY AND LUNG O<sub>2</sub> UPTAKE IN NORMOXIA AND NORMOBARIC HYPOXIA IN MEN.

Lador, F. 1, Azabji Kenfack, M. 1, Moia, C. 1, Caufero, M. 2, Morel, D.R. 3, Capelli, C. 2, Ferretti, G. 1-4

1 Centre Médical Universitaire, Geneva, Switzerland, 2 Hôpital Cantonal Universitaire, Geneva, Switzerland, 3 Università di Udine, Italy 4 Università di Brescia, Italy, Switzerland

At the onset of light square wave exercise in normoxia, cardiac output (Q) and systemic O<sub>2</sub> delivery (QaO<sub>2</sub>) is characterized by a first rapid phase (phase I) followed by a slower phase (phase II) up to steady state. The appearance of phase I was related, amongst others, to withdrawal of vagal tone upon exercise onset. Exposure to acute hypoxia implies reduced vagal activity and increased sympathetic activity. If this is so, the kinetics of Q and QaO<sub>2</sub> ought to be slower in hypoxia than in normoxia, possibly for lack of phase I, this being a possible consequence of a lack of vagal activation in resting humans in hypoxia. In this study we tested the hypothesis that the kinetics of Q and QaO<sub>2</sub> is slower in hypoxia than in normoxia, as would the associated kinetics of VO<sub>2</sub>. To test this hypothesis, simultaneous determinations of beat-by-beat (BBB) Q and QaO<sub>2</sub>, and breath-by-breath VO<sub>2</sub> at the onset of constant load exercises at 50 and 100 W were obtained in normoxia and hypoxia on six men (age  $24.3 \pm 3.1$  years, maximal aerobic power  $333 \pm 61$  W in normoxia). VO<sub>2</sub> was determined using Gronlund's algorithm. Q was computed from BBB stroke volume (Qst, from arterial pulse pressure profiles) and heart rate (fH, electrocardiography) and calibrated against a steady-state method. This, along with the time course of hemoglobin concentration and arterial O<sub>2</sub> saturation (infrared oximetry) allowed computation of BBB QaO<sub>2</sub>. Lactataemia remained below the so-called lactate threshold during the experiments. The Q, QaO<sub>2</sub> and VO<sub>2</sub> kinetics were analysed with single and double exponential models. Q and VO<sub>2</sub> increased upon exercise onset to reach a new steady state. The steady level of Q was significantly higher in hypoxia (Qrest  $6.75 \pm 0.33$  l/min, Q50W  $12.18 \pm 0.25$  l/min, Q100W  $17.81 \pm 0.64$  l/min) than in normoxia (Qrest  $6.58 \pm 0.22$  l/min, Q50W  $11.89 \pm 0.25$  l/min, Q100W  $14.44 \pm 0.33$  l/min) for each work load. The steady level of VO<sub>2</sub> in hypoxia (VO2rest  $0.57 \pm 0.08$  l/min, VO250W  $1.41 \pm 0.12$  l/min, VO2100W  $1.91 \pm 0.07$  l/min) was not significantly different from that obtained in normoxia (VO2rest  $0.61 \pm 0.08$  l/min, VO250W  $1.44 \pm 0.07$  l/min, VO2100W  $1.77 \pm 0.05$  l/min) for each work load. The kinetics of Q and QaO<sub>2</sub> at the whole body level was found slower in hypoxia than in normoxia (Time constants for phase I (T1) and II (T2): Qn50W T1  $3.02 \pm 1.50$  s, T2  $2.10 \pm 1.04$  s, QaO2n50W T1  $2.69 \pm 1.31$  s, T2  $2.54 \pm 1.48$  s; Qn100W T1  $3.10 \pm 1.42$  s, T2  $8.53 \pm 3.28$  s, QaO2n100W T1  $2.47 \pm 1.64$  s, T2  $9.29 \pm 4.60$  s; Qh50W T1  $2.20 \pm 1.65$  s, T2  $20.59 \pm 8.63$  s, QaO2h50W T1  $2.38 \pm 1.08$  s, T2  $16.98 \pm 7.61$  s; Qh100W T1  $5.13 \pm 3.97$  s, T2  $37.23 \pm 7.41$  s, QaO2h100W T1  $5.54 \pm 5.59$  s, T2  $30.49 \pm 7.91$  s). Moreover, the kinetics of QaO<sub>2</sub> was not significantly different from that of VO<sub>2</sub> (VO2h50W T1  $1.36 \pm 0.73$  s, T2  $29.77 \pm 5.89$  s, VO2h100W T1  $2.67 \pm 0.63$  s, T2  $30.54 \pm 5.68$  s). These results are compatible with the tested hypothesis, as well as with the notion of a lack of vagal activation in resting humans in hypoxia.

### HOW DO INSPIRATORY AND EXPIRATORY MUSCLES FATIGUE DURING HEAVY BREATHING?

Verges, S., Renggli, A.S., Notter, D.A., Spengler, C.M.

Institute for Human Movement Sciences, ETH Zurich, and Institute of Physiology and Center of Integrative Human Physiology, University of Zurich, Switzerland

Respiratory muscles are fatigued after intensive hyperpnoea or whole-body exercise (Mador et al. 1996, Johnson et al. 1993). The time course of fatigue development of the different respiratory muscle is, however, unknown. We therefore studied fourteen healthy, young men performing intermittent normocapnic hyperpnoea (HYP), i.e. 8 min HYP (~70% of maximal voluntary ventilation), 6 min pause, etc., until task failure. Twitch transdiaphragmatic

(P<sub>di,tw</sub>) and gastric (P<sub>ga,tw</sub>) pressures were measured during cervical and thoracic magnetic stimulation after full potentiation to assess diaphragm and abdominal muscle fatigue before HYP, after each HYP-interval, at task failure, as well as after 30 and 60 min of recovery. Ventilation, oesophageal (P<sub>es</sub>) and gastric pressures (measured by balloon catheters) were recorded continuously during HYP. Inspiratory and expiratory pressure-time products (PTP, an index of respiratory muscle work) were calculated breath by breath. Breathlessness, respiratory effort and blood lactate concentration were assessed before HYP, at the end of each HYP-interval and at task failure. Subjects breathed for 25.3±4.7 min. After 8 min of HYP, P<sub>di,tw</sub> and P<sub>ga,tw</sub> decreased significantly (-18±12% and -20±7%); after 16 min, P<sub>di,tw</sub> decreased further (-28±7%) while P<sub>ga,tw</sub> remained unchanged (-21±8%, significantly different vs. P<sub>di,tw</sub>). Both P<sub>di,tw</sub> and P<sub>ga,tw</sub> did not further decrease until task failure and were still significantly reduced after 60 min of recovery (-9±9% and -9±7%). PTP<sub>es,insp</sub> / PTP<sub>di,insp</sub> (a surrogate for extra-diaphragmatic inspiratory muscle work) increased significantly during the first 16 min of HYP (+11±21%). Similarly, PTP<sub>es,exp</sub> / PTP<sub>ga,exp</sub> (a surrogate for rib cage expiratory muscle work) increased significantly during the first 8 min (+10±16%). No further change in PTP was observed until task failure. Breathlessness (+1.6±1.8 points), respiratory effort (+5.9±2.2 points) and blood lactate concentration (+1.1±0.4 mmol·l<sup>-1</sup>) increased significantly during the first 16 min of HYP with no further increase thereafter. We conclude that, during hyperpnoea, contractile fatigue of the diaphragm and abdominal muscles develops long before task failure and is likely compensated by increased recruitment of rib cage inspiratory and expiratory muscles to maintain target ventilation.

Supported by the Swiss National Science Foundation (31.61941.00), S. Vergès by a fellowship of AGIRadom, Grenoble, France.

Johnson BD, Babcock MA, Suman OE and Dempsey JA. Exercise-induced diaphragmatic fatigue in healthy humans. *J Physiol (Lond)*; 1993; 460:385-405.

Mador JM, Rodis A and Diaz J. Diaphragmatic fatigue following voluntary hyperpnea. *Am J Respir Crit Care Med*; 1996; 154:63-67.

### DIFFERENCES IN INTRAMYOCYLLULAR LIPIDS UTILIZATION IN THIGH AND CALF MUSCLES DURING ENDURANCE EXERCISE DETERMINED BY 1H-MR SPECTROSCOPIC IMAGING

Zehnder, M., Saillen, P., Kreis, R., Boesch, C., Vermathen, P.

*University and Inselspital Berne, Switzerland*

**Introduction** Intramyocellular lipids (IMCL) are important fuels during prolonged moderate-intensity exercise. However, little is known about specific IMCL usage in different muscles. Based on a previous feasibility study [1] we performed muscle specific analyses of metabolite changes in thigh and calf muscles using a standardized exercise protocol.

**Methods** 8 trained cyclists (6 males, 2 females, 31y, 8 training h/week) and 8 trained male runners (29y, 8 training h/week) exercised 3h on a cycle ergometer (at 49% of max workload = 69% of max heart rate) or on a treadmill (at 52% of max speed = 75% of max heart rate), respectively. The subjects added supplementary 0.75 g fat/kg bw to their diet during 2 days prior to exercise to ensure full IMCL stores. In 2 cyclists right and left thigh as well as in 4 runners right and left calf were examined. IMCL concentration was determined before and after endurance exercise in m. rectus femoris (RF), vastus intermedius (VI), medialis (VM), lateralis (VL1, VL2) and adductor magnus (AM) for the cyclists and in m. soleus (S), gastrocnemius (G), fibialis anterior (TA) and extensor digitorum (ED) for the runners.

MR-spectroscopic-imaging (MRSI) measurements were performed at 1.5T using a 2D-MRSI sequence in transverse orientation. Parameters: TR=1200ms, TE=35ms, Matrix=36x36, FOV=20cm. Processing included spatial zero-filling, lipid-extrapolation, receive profile correction and spectral fitting using TDFDFIT.

MRSI voxels were assigned to specific muscles using image segmentation and their metabolite content subsequently averaged to yield one value for each muscle and subject. Bone-marrow lipid served as reference for quantification.

Results a) a good correlation of IMCL before and after exercise in thigh and calf muscles (R<sup>2</sup>=0.75, p<0.0001), b) higher resting IMCL concentration in S than in G and TA for calf and higher resting IMCL in vastus muscles than in RF for thigh, c) strongly reduced IMCL after exercise by ~50%, d) stronger absolute IMCL depletion in muscles with high IMCL resting concentration. Beside absolute also relative IMCL depletion differences between muscles (relative to resting IMCL) were detected with higher reductions in "slow" than in "fast" muscles, e.g. between S (slow) and G (fast) for calf, and between vastus muscles (slow) and RF (fast) for thigh. An additional finding was that trimethyl-ammonium (TMA) increased significantly with exercise.

**Discussion** The results showed muscle specific reductions of IMCL after exercise. In general, resting IMCL and absolute as well as relative IMCL depletion after exercise was higher in slow compared to fast muscles. The TMA increase may be related to acetyl-carnitine increase with exercise and differing MR-visibility between carnitine and acetyl-carnitine [2].

References 1. Vermathen et al. *Proc. ISMRM* 11: 786, 2003; 2. Kreis et al. *NMR Biomed.* 12:471, 1999

Acknowledgement Supported by Swiss National Foundation (3100-065315.01)

### EFFECTS OF PROLONGED BED REST ON THE CARDIOPULMONARY RESPONSE TO POSTURAL CHANGES IN HUMANS.

Tam, E. 1+2, Fagoni, N. 3, Azabji-Kenfack, M. 1, Cautero, M. 2, Lador, F. 1, Moia, C. 1, Capelli, C. 2, Ferretti, G. 1+3

*1 CMU, Genève, CH, 2 Uni Udine, IT, 3 Uni Brescia, IT, Switzerland*

In order to gain a better understanding of the cardio-pulmonary impairment induced by prolonged bed rest, we measured steady-state oxygen uptake (V<sub>O2</sub>) and carbon dioxide output (V<sub>CO2</sub>), by Grønlund's algorithm on a breath-by-breath basis, cardiac output (Q<sub>l</sub>), by open circuit acetylene washout, heart rate (HR), by electrocardiography, and mean arterial pressure (MAP), by fingertip plethysmography, on 18 male subjects (33.1 years ± 0.9; 71.1 kg ± 1.1; 1.75 m ± 0.01) before (BB) and after (AB) 90 days of head down tilt bed rest, in the following conditions: upright and supine posture, both at rest and at the 50 W exercise. The stroke volume (SV) was calculated as the ratio of Q<sub>l</sub> to HR. The total peripheral resistance (TPR) was calculated as the ratio of MAP to Q<sub>l</sub>. V<sub>O2</sub> was lower (p<0.01) supine than upright (0.43 l/min vs 0.52 l/min at rest; 1.06 l/min vs 1.27 l/min at 50W) in BB. In AB, V<sub>O2</sub> was 0.81 l/min at rest and 1.61 l/min at 50W upright, whereas supine it was 0.74 l/min at rest and 1.54 l/min at 50W. All the values in AB were significantly higher than the corresponding values in BB. V<sub>CO2</sub> followed the same patterns as V<sub>O2</sub>, so that the gas exchange ratio was the same in all conditions. In BB, Q<sub>l</sub> was the same supine and upright. In AB, Q<sub>l</sub> was significantly higher supine than upright at rest (6.11 l/min vs 5.40 l/min). All Q<sub>l</sub> values observed in AB were significantly higher than the corresponding values in BB (rest: 5.40 vs 4.50 upright; 6.11 vs 5.05 supine. 50 W exercise 8.26 vs 6.99 upright and 9.18 vs 7.38 supine). SV was higher supine than upright (71.2 ml vs 51.2 ml BB, 78.6 vs 55.4 ml AB at rest; 76.9 ml vs 67.2 ml BB, 87.5 ml 70.8 ml AB at 50W). HR was lower supine (70.3 bpm at rest, 95.2 at 50W) than upright (87.8 bpm at rest, 104.7 at 50 W) in BB, and was (77.3 bpm at rest, 103.9 at 50W) and (97.7 bpm at rest, 116.8 at 50 W) in AB. SV was the same in AB as in BB, whereas HR was higher in AB than in BB. MAP was lower supine than upright in AB (94.3 mmHg vs 105.4 mmHg at rest; 101.6 mmHg vs 115.4 mmHg at 50W). In supine posture, MAP was lower in AB than in BB, both at rest and at exercise. TPR was lower supine than upright in AB (17.8 mmHg\*min/l vs 21.6 mmHg\*min/l at rest; 12.8 mmHg\*min/l vs 16 mmHg\*min/l at 50W). In supine posture, TPR was lower in AB than in BB, both at rest and at exercise. These

results suggest that the cardio-pulmonary system adjusts to reduced blood volume and increased venous compliance essentially by increasing HR, perhaps modulated by increase in sympathetic output tone. The HR increase is larger than the drop in SV, so that  $Q'$  is increased in AB. This is coherent with the higher  $\dot{V}O_2$  levels in AB than in BB at the same power. The  $\dot{V}O_2$  increase could be mainly due to an impairment of the motor control system after 90 days of bed rest.

## EFFECTS OF LUNG VOLUMES ON BREATH-HOLD DIVING DEPTH

Ferretti, G.

CMU, Université de Genève, Switzerland, and Università de Brescia, Italy, Switzerland

The speed that a human can attain is the ratio of the metabolic power to the energy cost of the movement (C), so that the distance covered is the ratio of the available metabolic energy (E) to C. In breath-hold diving, this means that the maximal diving depth (d) is directly proportional to the E stored by the diver and inversely proportional to the C of diving. In water, C is the ratio of the drag of water (D) to the mechanical efficiency of diving (h), so that  $d = h E/D$ . A reduction of C was pursued either by reducing D or by increasing h. The former was achieved by improving the hydrodynamics of diving, the latter by improving the diving technique. Concerning E, it is the sum of the energy provided by aerobic (EO<sub>2</sub>), anaerobic lactic (E<sub>La</sub>) and anaerobic alactic (E<sub>PC</sub>) metabolisms. E<sub>La</sub> and E<sub>PC</sub> can be set invariant, as they are imposed by maximal blood lactate concentration (Lab, say 15 mM) and by muscle phosphocreatine concentration (PC, 20 mM). In turn, EO<sub>2</sub> = ELO<sub>2</sub> + EBO<sub>2</sub> + EtO<sub>2</sub>, where suffixes L, B and t designate the O<sub>2</sub> stores in lungs, blood and tissues, respectively. EBO<sub>2</sub> depends on haemoglobin concentration ([Hb]), EtO<sub>2</sub> on myoglobin concentration, that are practically invariant. So EO<sub>2</sub> = ELO<sub>2</sub> + K, where K is the energy provided by other sources than lung O<sub>2</sub> stores. Since the energy equivalent of O<sub>2</sub> is a constant depending on the respiratory quotient, the last equation implies that EO<sub>2</sub>, and thus d, are linear functions of lung O<sub>2</sub> volume at the dive's start. We thus expect extreme divers to have very large total lung capacity (TLC) values. This is so for Korean diving women, whose TLC is low (< 5 L). The TLC of Enzo Maiorca, who first dived to 100 m under controlled conditions, was 7.8 L, at the uppermost limit of normal population. Bob Croft, however, who set a world record to 73 m in 1968, had a TLC of 9.1 L. TLC values above 9 L in elite breath-hold divers are a common finding nowadays. At least 15 values above 9 L, and a couple above 10 L, can be reckoned in the literature. Several divers also practise oropharyngeal breathing before diving, which increases the TLC by further 1.5 – 2.0 L. This data support the hypothesis put forward above. In a man with a body mass of 70 kg, a muscle mass of 20 kg, a TLC of 7 L, a blood volume of 5 L, a [Hb] of 150 g/L, a Lab of 15 mM and a PC of 20 mM, who dives close to TLC, the E at the dive's start, in O<sub>2</sub> equivalents, would be 6.76 L, of which 1.20 L provided by ELO<sub>2</sub>. In an extreme diver with the same characteristics as that man, except that his TLC is 10 L instead of 7 L, E would be 7.27 L, of which 1.71 L provided by ELO<sub>2</sub>. This difference may appear small, yet calculation of the energy balance of deep free dives shows that the C of diving is very low, so that the rate of energy expenditure is similar to that of a 50 W exercise on a bike. If this is so, a 0.5 L increase in ELO<sub>2</sub> would imply a 43 m increase in depth. Having large lung volumes is indeed an advantage in deep breath-hold diving.

## LONGITUDINAL STUDY 'DOPING FREE SPORT': STEROID PROFILES IN URINE

Schweizer, C., Sottas, P.E., Saugy, M., Kamber, M.

Laboratoire Suisse d'Analyse du Dopage, Switzerland

### Introduction

The measurement and interpretation of an athlete's urinary steroid profile is important in the fight against doping in sport. Changes of this profile may be due to biological variations but also due to the use of doping. The aim of this study was to illustrate that top level

performance could be reached without doping and to evaluate the biological variation of the steroid profile over time. In a joint project, the Federal Office of Sports, the Swiss Anti-Doping Commission and the Swiss Laboratory for Doping Analysis performed a longitudinal study with 20 top-level athletes (19-32 years) from five different endurance sports (athletics, triathlon, cycling, cross-country skiing and orienteering).

### Study design and methods

During the study, all athletes had to submit to two kinds of urine samples: one at pre-announced dates during medical check-ups within and off season (5 to 8 times) and one at unannounced out of competition doping controls (7 to 12 times). All urines were analysed for prohibited substances according to the doping list of the World Anti-Doping Agency. In addition, the steroid profiles were evaluated as well: among others the concentrations of testosterone (T), epitestosterone (E), androsterone (A), etiocholanolone (Etio) as well as different ratios (T/E, A/T, A/Etio) were measured. An elevated T/E ratio may be an indicator for the use of a prohibited substance. In these cases, some complementary investigations are required to find if the elevated ratio is due to doping.

### Results

There was no difference in the steroid profiles between announced and unannounced controls. In men, the inter-individual variation of the T/E ratio was between 14 and 38%. The lower were the concentrations of T and E, the higher the variations. In women, the variations were generally higher (up to 66%) due to the lower steroid concentrations. There was no indication for doping use in any of the samples analysed.

### Discussion

To our knowledge this is the first time that such a homogenous group of athletes (top level endurance athletes) was followed up so closely over a period of two competition and two training seasons. The data will serve as a basis to evaluate steroid profiles of other athletes for possible doping use. However, due to inter-individual variations of steroid profiles it is advisable to collect individual reference values from longitudinal studies for top level athletes.

## CHILDREN HAVE A HIGHER HYPOXIC VENTILATORY RESPONSE THAN THEIR FATHERS

Kriemler, S., Zehnder, M., Kohler, M., Bloch, K.E., Brunner, H.P., Boutellier, U.

ETH-University of Zurich, Switzerland

Introduction: Chemoreceptor sensitivity plays an important role in the short-term adaptation to high altitude (HA). Decreased ventilatory response to hypoxia (HVR) is a risk factor for the development of high altitude pulmonary edema and possibly of acute mountain sickness (AMS). It is not clear, however, whether HVR is different in prepubertal children and adults nor whether there is a hereditary influence. Isocapnic HVR was therefore measured in 20 fathers (mean age 44.0±4.2y) and their prepubertal children (mean age 10.7±1.1y) at low altitude (LA, 450m) and on day 1 and 2 of HA (3450m) using the partial rebreathing technique. After 15 min of resting ventilation, three levels of hypoxia (PE<sub>T</sub>O<sub>2</sub> 60, 55, 50 Torr) were randomly induced and kept stable (±2 Torr) for 2 min with 5 min of recovery in between. PCO<sub>2</sub> was kept constant at ±2 Torr of values while breathing room air. HVR is expressed as increase in minute ventilation per decrease in saturation corrected for body weight. AMS was measured by Lake Louise Questionnaire. Clustering of HVR within families was tested by correlation analysis of slope differences (deltaHVR) from LA to HA. Results: AMS occurred in 8 children and 7 adults. HVR (corrected for body weight) was significantly higher in children than in adults irrespective of altitude (0.020±0.010, 0.020±0.011, 0.024±0.012 vs. 0.012±0.007, 0.014±0.011, 0.018±0.012 ml\*kg<sup>-1</sup>\*min<sup>-1</sup>\*%<sup>-1</sup> at 450m, day 1 and 2 of 3450m, respectively, all p<0.0005). Only adults significantly increased their HVR on day 2 of HA (p<0.05). There was a significant correlation of deltaHVR from LA to day 2 of HA within families (r=0.59, p<0.01). Individuals with AMS did not show a lower HVR

than those without AMS. Conclusion: Children generally have a higher HVR than their fathers which does not protect them from AMS. HVR seems to be genetically influenced.

This study was supported by the Federal Council of Sports, Magglingen, Switzerland

### EFFECTS OF BED REST AND POSTURE ON THE KINETICS OF O<sub>2</sub> UPTAKE AND CARDIAC OUTPUT

Azabji Kenfack, M. 1, Fagoni, N. 2, Tam, E. 1+3, Cautero, M. 3, Lador, F. 1, Moia, C. 1, Capelli, C. 3, Linnarsson, D. 4, Ferretti, G. 1+2

1 CMU, Genève, CH, 2 Uni Brescia, IT, 3 Uni Udine, IT, 4 Karolinska Institute, Stockholm, SE, Switzerland

The aim of this study was to evaluate the effects of prolonged bed rest on the kinetics of O<sub>2</sub> uptake and cardiac output at the onset of square-wave exercise in upright and supine posture. To this aim, O<sub>2</sub> uptake (V'O<sub>2</sub>) was determined breath-by-breath by Gronlund's algorithm and cardiac output (Q') was determined beat-by-beat by the Modelflow method on 18 male subjects (33.1 years ± 0.9; 71.1 kg ± 1.1; 1.75 m ± 0.01) at rest and during the rest-to-work transient of 50 W exercise in upright and supine posture, before (BB) and after (AB) 90 days of head-down tilt bed rest. In BB, the amplitude of the V'O<sub>2</sub> change was lower supine (0.65±0.08 L/min) than upright (0.74±0.09 L/min) (p<0.05). In AB, the amplitude was the same supine (0.86±0.43 L/min) as upright (0.76±0.18 L/min). No effects of bed rest were observed. The time constant of the V'O<sub>2</sub> increase was longer supine than upright, both in BB (52,49±10,77 s vs 28,42±6,19 s) and in AB (56,78±10,36 s vs 36,26±10,08 s). A significant effect of bed rest was found only in the upright posture. In BB, the amplitude of the Q' change supine (2,36±0,86 L/min) was not significantly different from upright (2,91±0,54 L/min). The same was the case in AB (3,72±1,55 L/min supine vs 2,92±0,59 L/min upright). A significant effect of bed rest was found supine. The time constant of the Q' increase was longer supine than upright, both in BB (24,95±15,10 s vs 4,12±2,32 s) and in AB (34,28±18,57 s vs 7,02±4,13 s). No significant effects of bed rest were found. The time constants of the Q' response were always faster than those of the V'O<sub>2</sub> response. We conclude that the rapid Q' kinetics upright with respect to supine may be a consequence of reduced central blood volume in the former as compared to the latter posture. These results thus suggest a role for cardiopulmonary baroreceptors in determining the Q' response to exercise. The similar time constants before as after bed rest imply the regulation of circulation at exercise onset operates according to the same principles before as after bed rest, despite the development of cardiovascular deconditioning with bed rest.

### NO, THE KEY TO UNDERSTANDING THE PATHOPHYSIOLOGY OF HIGH ALTITUDE PULMONARY EDEMA

Scherrer, U., Sartori, C.

Botnar Center for Extreme Medicine, Switzerland

High-altitude pulmonary edema (HAPE) is a life-threatening condition occurring in predisposed, but otherwise healthy subjects, and, therefore, allows to study underlying mechanisms of pulmonary edema in humans, in the absence of confounding factors. Over the past decade, evidence has accumulated indicating that HAPE results from the conjunction of two major defects, augmented alveolar fluid flooding resulting from exaggerated hypoxic pulmonary hypertension on the one hand, and impaired alveolar fluid clearance related to defective respiratory transepithelial sodium transport on the other hand. Here, we will focus on the mechanisms underlying the exaggerated hypoxic pulmonary hypertension. We will provide experimental evidence for the hypothesis that an acquired and/or genetic defect of pulmonary vascular endothelial and respiratory epithelial nitric oxide synthesis and/or bioavailability may represent the central underlying defect predisposing HAPE-prone subjects to exaggerated hypoxic pulmonary vasoconstriction and alveolar fluid flooding. We will also review data based

on this concept suggesting that pharmacological interventions designed to augment pulmonary nitric oxide bioavailability may be useful for the prevention of exaggerated hypoxic pulmonary hypertension and HAPE during high-altitude exposure in susceptible subjects.

### PHYSIOLOGICAL EQUIVALENCE OF HORIZONTAL VS. UPHILL RUNNING: FINDINGS FROM JUNIOR AND ADULT WORLD CLASS ORIENTEERS.

Zürcher, S., Tschopp, M., Clénin, C., Marti, B.

Swiss Federal Institute of Sport, Magglingen, Switzerland

When sport activities are taken outdoors, natural obstacles such as hill climbing becomes an issue. Yet, the question persists, to what extent does a horizontal detour to avoid climb still present the same effort in terms of physiological exertion or perceived fatigue? The additional horizontal distance required to achieve equivalent uphill work can be calculated by multiplying incline, uphill speed and an equivalence factor (EF). The literature has published a range of EF from 1.8, which from practical experience is too little, to the frequently used standard of 10, which in our opinion is inflated (1). Research question: To which additional horizontal distance does uphill running correspond to in endurance athletes with balanced abilities in both horizontal and uphill running? METHODS: Elite orienteers (18 Men, 14 Women, 21.8yrs+/-4.1) from the Swiss National team took part in this study. Two treadmill stage tests, with 3-4 hours rest between, were completed. The first a horizontal lactate threshold test and the second an uphill running test at a 22% incline. In pilot testing, a "physiological equivalence" of horizontal to uphill running was approximated using a EF 6.5; this thereafter determined the speed for each stage in the uphill running test. The initial speed in the horizontal test and uphill test were typically 9.0km/h and 10.8km/h, with a 1.8km/h increase and 3.6km/h and 4.3km/h with a 0.7km/h increase per 3 minute stage for women and men, respectively. Both tests were run to voluntary exhaustion. In data analysis, uphill speed was compared to horizontal speed at test termination (maximal speed, (MS)), at 90% of maximal heart rate (subHR), at 90% of maximal lactate (subLa), and at a rating of perceived exertion of 17 (RPE17). Different EF's based on MS, subHR, subLa, or RPE17, and an EFALL (mean of the four criteria) were calculated. RESULTS: The different EF's based only on one single criterion varied slightly. EFMS was 6.2+/-0.54, (range 5.4-7.6); EFsubHR 7.0+/-0.88 (5.8-8.6); EFsubLa 6.3+/-0.76 (5.4-8.0); EFRPE17 6.7+/-0.76 (5.6-8.8). The aggregate EFALL was 6.5+/-0.62, with a 95% confidence interval of 6.32-6.76. CONCLUSION: Within this sample of well trained male and female elite orienteers, we found a surprisingly consistent EF of about 6.5 at an incline of 22%, regardless of whether it was calculated from maximal speed or additional sub-maximal parameters. Individual variation in EF was broader, with values between 5.5 and 8.5, the former suggesting above average ability and the latter below average ability in uphill running for orienteers. This information provided individual feedback for the coach and athletes. The validity of the presently found EF of 6.5 should be checked with additional runners, specifically trained for horizontal or uphill running under conditions without preliminary maximal running test in the same day.

(1)Zürcher S, Clénin G, Marti B. Uphill running capacity in Swiss elite orienteers. SciJO; 17 (1), 2005

### SPORTS PHYSIOTHERAPY INTERVENTIONS OF ANKLE SPRAINS. WHERE IS THE EVIDENCE

Clijisen, R., Taeymans, J., Clarys, P.

Akademie Physiotherapie Thim van der Laan Landquart, Switzerland

Epidemiological data show a high injury incidence of the lateral capsular ankle ligaments. About half of the ankle injuries occur during sporting activities, due to an inversion trauma. Although inversion injuries of the ankle are a common problem in physical therapy, there is a converse variety of treatment strategies and differences in therapy outcome. There still seem to be a lack of

evidence-based physical therapy strategies for this problem. The aim of this study was to scrutinize reported literature for the effectiveness of the physical therapy in patients with ankle sprain. Relevant studies were collected by conducting a literature search using the online databases; MEDLINE, PubMed, Pedro, and the Cochrane Database of Systematic Reviews. The following keywords were used: ankle, ankle injuries, acute ankle sprain, exercise therapy, physical therapy and ankle sprain, review, guidelines for physical therapy, cryotherapy, ultrasound and laser therapy. The selection criteria were randomised trials, clinical trials, review articles, and meta-analyses.

A total of 36 studies met these criteria; among them were 18 articles, 3 reviews and 15 CCTs.

For the diagnosis there seems to be no correlation between the medical classification of injury severity and the prognosis of recovery or between the severity of the ankle ligament injury and clinical findings. This may be partially caused due to the lack of a proper diagnosis definition of ankle sprain. Especially the use of a functional score, as often used in physical therapy, within the first five days after the initial injury is a valid and reliable diagnostic method to distinguish between mild and severe injury.

In general, there is no or only marginal evidence for the effectiveness of different physical therapies such as cryotherapy, electrotherapy and ultrasound. There is body of evidence that functional treatment is much more effective than immobilisation. Because there is a wide variety of treatment modalities and because in most studies multiple treatment regimens are used, no conclusions can be drawn concerning the effectiveness of specific treatment.

For chronic ankle problems, literature indicates that a conservative treatment is superior compared to surgery. There is intermediate evidence about therapy effectiveness of chronic ankle problems. The therapy should involve an exercise program, training proprioception, muscle strength, ADL activities and normalizing mobility. Most studies conclude that there is a lack of valid instruments for a standardized assessment of the different therapy interventions in physical therapy. Inconsistent definition of both treatment aims and therapy outcome impede an estimation of the effectiveness of different forms of conservative therapy.

Reference

Kerkhoffs et al. Different functional treatment strategies for acute lateral ankle ligament injuries in adults:

A systematic review. *Acta Orthop Scand*. 2003 Feb.

## THE EMOTIONAL SIDE OF COACH-ATHLETE RELATIONSHIP AS PERCEIVED BY SWISS MALES SWIMMERS

Antonini Philippe, R., Seiler, R.

*Swiss Federal Office of Sports Magglingen, Switzerland; University of Bern, Institute of Sport, Switzerland*

The relation between coach and athlete is often considered to be a decisive factor for performance in competitive sport. The mutual dependence is manifested in athletes' need to profit from the knowledge, competence and experience of the coach, and in coaches' need to transfer their competences and skills into performance and success. Research employing different methodologies and theoretical frameworks has shown that the quality of the professional and personal relationship between coaches and athletes has an impact on athletes' development and growth. The aim of this study was to investigate the quality of the coach-athlete relationship as perceived by the athletes. Participants were five male swimmers from the Swiss national swimming team who held international titles. A semi-structured interview schedule was employed to obtain qualitative data. The responses of the athletes were content analysed, utilising the three interpersonal constructs of closeness, co-orientation, and complementarity (Jowett & Meek, 2000) as a framework. The results show that the relationship comprised essential coach-athlete requirements and social relationship (closeness), communication and setting of objectives/goals (co-orientation), as well as acceptance and respect of roles (complementarity). It revealed that swimmers placed great importance in

maintaining good relations with their coach. Notably, the results highlighted the existence of extremely profound and intimate feelings. The swimmers have come to know their coaches well, appreciate their efforts and respect their opinions, and in the course of time the feelings were deepened into what some of them described as "more than a friendship". Thus, establishing a relationship based on strong feelings of respect, esteem and admiration seemed to be important to the swimmers. Overall, an "emotional relationship" developed between the coach and the athlete which included strong affective bonds and which can be compared to what Bloom, Durand-Bush, Schinke, and Salmela (1998) called the "human relationship". This part of the coach-athlete relationship may reflect the more personal and humanistic side of coaching in which coaches are perceived by the athletes to care about their welfare, interests, preferences, and needs. The results suggest that the emotional relationship or human relationship is an important facet because it promotes the professional relationship concerned with performance enhancement.

References

Bloom, G.A., Durand-Bush, N., Schinke, R.J., & Salmela, J.H. (1998). The importance of the mentoring in the development of coaches and athletes. *International Journal of Sport Psychology*, 29, 267-281.

Jowett, S., & Meek, G.A. (2000). The coach-athlete relationship in married couples: an exploratory content analysis. *The Sport Psychologist*, 14, 157-175.

## PERCEPTUAL DIFFERENCES IN TENNIS PLAYERS AND TRIATHLETES: A BATTERY OF TESTS THAT MAKES THE DIFFERENCE

Overney, L.S., Blanke, O., Herzog, M.H.

*Brain-Mind Institute EPFL, Switzerland*

The link between sport performance and various perceptual and cognitive abilities has been investigated by several authors in different sports such as basketball (Starkes et al., 1994), volleyball (Borgeaud & Abernethy, 1987) or tennis (Goulet et al., 1989). Until now, different types of abilities have been tested in order to identify differences between athletes and non-athletes but only few studies have tried to identify, at a larger scale, the complex network of perceptual and cognitive abilities underlying sport performance, especially in tennis. For instance, rapid target detection, tracking in three-dimensional space and visuo-motor coordination are part of the abilities of a tennis player. Thus, tennis skill requires high-speed visual processing and fine spatio-temporal resolution to reach optimal performance. Whereas many studies have investigated the involvement of higher information processing in sports, much less is known about the basic visual information processes with limited timing.

Here we present a battery of tests that allows to further narrow down which information is used during visual information processing and how this information is extracted. The battery includes low level discrimination tasks in different fields such as motion (coherent motion, speed discrimination), attention (attentional blink, visual detection tasks) or time-related tasks (B-type backward masking, flash-lag), as well as a higher level anticipation task (representational momentum). Tennis players were compared to age-matched triathletes and non-athletes. Triathletes were chosen as a control group because they share the same level of fitness but do not need such fine spatio-temporal resolution as tennis players. Preliminary results show that tennis players seem to perform better on motion- and time-related tasks than triathletes and non-athletes, whereas the other tasks do not seem to significantly discriminate the three groups of subjects. Future steps of this study will investigate how these abilities can be improved.

References:

Borgeaud, P., Abernethy, B. (1987). Skilled performance in volleyball defense. *Journal of Sport Psychology*, 9, 400-406.

Goulet, C., Bard, C., Fleury, M. (1989). Expertise differences in preparing to return a tennis serve: A visual information processing approach. *Journal of Sport & Exercise Psychology*, 11, 382-398.

Starkes, J. L., Allard, F., Lindley, S., O'Reilly, K. (1994). Abilities and skill in basketball. *International Journal of Sport Psychology*, 25, 249-265.

## THE IMPACT OF ECCENTRIC EXERCISE ON SELECTED COGNITIVE MEASURES IN THE ELDERLY

**Buschkuhl, M., Hutchison, S., Daepf, C., Hoppeler, H., Perrig, W.J.**

*Institute of Psychology, Switzerland*

There is a whole body of research showing that cardiovascular exercise has positive effects on cognitive performance measures in the elderly. However, little is known about the impact of eccentric exercise on cognition. In order to investigate this issue, we conducted an eccentric training study with 15 healthy elderly participants (Age: M = 81.2 years; SD = 3.5 years). Training took place twice a week for a period of 12 weeks; each session lasted 45 minutes. Before and after the training, several cognitive measures were administered, including tasks on memory, speed, executive functions and semantic knowledge. Furthermore, quality of life, daily activities, and locus of control were assessed with questionnaires. Besides a subjectively experienced improvement in quality of life, which was especially pronounced in the physiological domain, we also found enhancements in cognitive tasks that required abilities that were comparable to the ones used while performing the eccentric exercise, such as monitoring. These results show that eccentric training, like cardiovascular training, has a positive impact that goes beyond the improvement of physiological performance measures in the elderly.

## A FIRST STEP IN EXPLORING REASONS OF DROP-OUT FROM MAINSTREAM FITNESS CLUB MEMBERSHIP: ASSESSING NEW CLIENTS' CHARACTERISTICS

**Piffaretti, M., Lenzen, B., Kayser, B.**

*University of Geneva, Switzerland*

In view of the epidemics of the sedentary lifestyle and its related burden of chronic disease, factors influencing adherence to an active lifestyle are of great interest. Fitness club membership has become increasingly popular and may help individuals integrating physical activity into their lives. However, attrition rates are high while the factors predicting pursuit or dropout from using fitness clubs have not been much investigated. In the absence of sound data it is difficult to take efficient and scientifically coherent measures to prevent attrition. Ideally, a full investigation of predictors of perseverance and dropout concerning fitness clubs should encompass: a) a description of the characteristics of new fitness club clients at the time of their initial subscription; b) a descriptive analysis of dropout rates at different times (e.g. 3 and 6 months) after initial subscription; and c) an exploration of potential relations between clients' characteristics and their decision to continue or drop out of the program.

This exploratory study focused on step (a) of this prospective approach. We made an inventory of the psychological, demographical, environmental and physical factors that characterise a group of adults at the moment of entering a program in a fitness-club. Five mainstream clubs belonging to the same fitness-concept located in the two main linguistic regions of Switzerland agreed to participate, allowing us to contact 156 individuals (mean age=36.6 +/- 13.9; 67 male and 89 female), to participate on a voluntary basis and fill in a self-report questionnaire at the moment of their subscription to a fitness program within the club.

Prior to their subscription, 42% of the new clients had already practiced other physical or sport activities for more than 6 months, 23% had practiced irregularly, and 24% had either recently ceased or totally abandoned any form of physical exercise before applying for membership to the fitness club. 48% declared they like physical exercise, whereas the others are either mildly interested (44%) or totally dislike exercising (8%). The most frequently cited fitness goals are improving or maintaining health, improving physical appearance and finding better ways to cope with a stressful life. Attrition rate and factors predicting dropout in this cohort will be assessed in a planned follow-up study.

In conclusion, a large fraction of new clients applying for membership to mainstream fitness-clubs are non- or ex-exercisers who do not particularly like or even dislike physical exercise. Better knowledge of factors that can increase fidelity of members and/or continuation of physical exercise outside membership is necessary in order to increase the chances that these individuals continue exercising, within or without a fitness club.

## MOOD CHANGES AS A RELIABLE INDICATOR OF PHYSICAL STRESS AND OVERTRAINING

**Birrer, D., Seiler, R., Baume, N.**

*Swiss Federal Institute of Sports Magglingen, Switzerland*

Introduction: Disturbed mood states have been consistently described as sensitive markers of overtraining. Nevertheless, sport scientists have not clearly established a model to identify the early stages of overtraining. The majority of studies have used a global mood score. However, various mood factors differ substantially in their function and in their reactivity to the training load. This presentation will highlight the reaction of different mood factors to training load and different stages in the development of overtraining syndrome (OTS). Data will be presented from 3 different studies. Method and results of study 1: 6 elite male road cyclists using SRM power cranks 2 weeks prior and during a six day stage race were daily monitored with a mood measurement (BFS; Abele-Brehm & Brehm, 1986). Data was analysed on a single case basis using the cross correlation function. All 6 athletes showed a significant cross correlation between the training load and the mood states fatigue and positive activation at a lag of 1 day. No strong correlations were found for the other mood factors. Method and results of study 2: 30 male volunteers participated in a double blind study with the controlled administration of oral doses of placebo (n=10), 19-norandrostenedione (n=10) and testosterone undecanoate (n=10). During one month the volunteers underwent a rigorous endurance training program. The POMS was administered 3 times during this period. Repeated ANOVA measurements and discriminant analysis were calculated to identify mood development over time and predict group membership from mood states. Significant differences between the 3 groups were found in the mood factors vigour and fatigue. A direct discriminant function analysis matched 88% of the participants to the respective group (64% in the cross validation condition). Method and results of study 3: 35 athletes suspected of overtraining were administered the BFS. From performance analyses 13 of the athletes were diagnosed as overtrained and 22 as overreached. 26 athletes in a normal training condition administered the BFS as a control group. Data was analysed using discriminant function analysis in order to establish an instrument for future diagnosis of overtraining and to explore the role of the different mood factors in the development of OTS. The direct discriminant function ensured that all cases were correctly assigned to one of the 3 groups (1 mismatch in the cross validation condition). The mood factor depressed mood had the highest weight in the standardized canonical discriminant function followed by positive activation, fatigue and agitation. Discussion: Changes in the mood factors positive activation (vigour in POMS) and fatigue appear to be inextricably linked to the training load. Changes in these factors show an inability to cope with physical stress. In certain situations more psychologically related mood states (e.g., depressed mood, agitation, calmness) may be related to overtraining.

## SPORT, WELLBEING AND DEVIANT BEHAVIOR: A CROSS-SECTIONAL STUDY WITH SWISS ADOLESCENTS

Moesch, K., Birrer, D., Seiler, R.

*Federal Institute of Sports Magglingen & University of Berne, Switzerland*

**Introduction:** Sport is considered an effective means in reducing deviant behaviour in adolescents. Nevertheless, no empirical evidence has found a direct correlation between sport involvement and deviant behaviour (e.g. Brettschneider et al. 2005). This study examines the impact of wellbeing as a mediating variable between sport and deviance. We hypothesised that sport involvement has a positive effect on wellbeing, and high wellbeing reduces deviant behaviour. Gender differences were also predicted.

**Method:** 250 male and 292 female adolescents from the German speaking part of Switzerland aged 12 to 18 consented to participate in the study and completed a batch of questionnaires. Sport involvement was measured with the Sport and Physical activity INdex (SPHINX) developed by Brettschneider et al. (2005). The SPHINX integrated five variables including both attitudes toward sport and overt sport behaviour. Wellbeing was assessed with the questionnaire for adolescents (BFW, Grob et al., 1991). Deviance was measured through five different scales (Heitmeyer, 1998; Tillmann et al., 2000): attitudes towards and justification of deviance, delinquent behaviour, psychological and physical violence. These five variables were summarised to one single factor through a rank order procedure. For descriptive statistics, the five scales were examined separately. The proposed SEM was calculated for both genders, using generalised least square (GLS) estimation.

**Results:** As hypothesised, girls showed significantly lower values than boys in all deviance scales with gender explaining variances between 2.9% and 12%. For both genders, the SEM revealed a positive effect of sport involvement on wellbeing. The regression coefficients were .37 and .33, respectively, with marginally higher values for girls. Further, regression coefficients -.45 (girls) and -.48 (boys), respectively, revealed a negative relationship of wellbeing on deviance.

**Discussion:** In agreement with the hypothesis, results revealed that wellbeing might be a mediating variable in the relationship between sport involvement and deviance. However, it should not be overlooked that the Fit Indices were only moderate. More research is needed to elucidate the role of sport as well as other possible mediators on deviant behaviour.

Brettschneider, W.-D., Brandl-Bredenbeck, H. P., & Hofmann, J. (2005). Sportpartizipation und Gewaltbereitschaft bei Jugendlichen: Ein deutsch-israelischer Vergleich. Aachen: Meyer & Meyer.

Grob, A., Lüthi, R., Kaiser, F., Flammer, A., Mackinnon, A., & Wearing, A. (1991). Berner Fragebogen zum Wohlbefinden Jugendlicher (BFW). *Diagnostica*, 37, 66-75.

Heitmeyer, W. (1998). *Gewalt*. Weinheim: Juventa.

Tillmann, K.-J., Holler-Nowitzki, B., Holtappels, H.-G., Meier, U., & Popp, U. (2000). *Schülergewalt als Schulproblem*. Weinheim: Juventa.

## FOOTBALL PLAYERS' MENTAL REPRESENTATIONS OF GAME SCENARIOS: DOES EXPERTISE COUNT? A PSYCHOLINGUISTIC INVESTIGATION

Gyax, P.

*University of Fribourg, Switzerland*

In order to progress through a competitive sporting event, athletes need to build a mental representation of the event. The information included in such a representation will determine an athlete's behavioural and mental responses. In this paper, we present two studies exploring the mental representations of Swiss football players at different levels of expertise, when presented with textual information. In Study 1 (off-line), 1st Division and 5th Division players

were asked to write about performing in competitive scenarios after being provided an introductory sentence constraining the scenario. The results were analysed using a recurrent category coding system. Most importantly, the results showed that players of less expertise were more self-oriented and included more emotional content in their mental representations. In Study 2a and 2b (on-line), we presented players of three different levels of expertise with different scripts (National League, 1st Division and 5th division), constructed with the information provided in Study 1, and measured the participants' reading times focussing on the orientation of focus (self-orientated vs other-oriented) and sentences with an emotional valence. Although we found differences between 1st Division players and 5th Division players, suggesting that 1st Division players' mental representation more easily includes others and less readily includes emotions, we found that National League players were very similar to 5th Division players in their mental representations of game scenarios. It is suggested that although the results from the 5th Division and the National League were similar, different cognitive processes underlie the construction of the players' mental representation.

## IMPROVED MENTAL HEALTH AND QUALITY OF LIFE IN PHYSICALLY ACTIVE ELDERLY?

Conzelmann, A.

*University of Berne, Switzerland*

The paper deals with the effects of physical activity on mental health and quality of life in elderly people. "Mental health" will not primarily be considered under a medical perspective (being free of "mental illness") but rather be regarded as an equivalent to subjective (physical, psychic and social) well-being. "Quality of life" refers to the satisfaction with personally relevant spheres and therefore focuses on a cognitive aspect of subjective well-being.

During the last decades numerous studies have explored the effects of physical activity on health and subjective well-being. The results show that effects on health-relevant parameter such as lower risk for heart attacks or better function of vital organs can be established much easier than positive effects on subjective well-being (e.g. Fuchs, 2003). Whereas physical activity influences health parameter in a direct way, the interrelations with subjective well-being are more complex for various reasons. (1) Besides physical activity other factors (e.g. sociodemographic variables) influence subjective well-being, thereby implying that the isolated consideration of physical activity as an influence is insufficient to explain the variance of subjective well-being. (2) Biographical life experiences form the basis of an individual understanding of the effects of physical activity on subjective well-being. Thus, great heterogeneity in aging courses does exist, becoming manifest in different forms and fates of getting older (Thomae, 1987). (3) Subjective well-being is rather dependent on subjective domain evaluations than on objective life conditions. Thus, subjective health is a useful (direct) predictor for subjective well-being, again being influenced, however, by the number of contracted illnesses (Smith et al., 1999). In this context, physical activity can be seen as an indirect influence. Evaluations and estimations are cognitive processes dependent on cognitive traits such as competence and control beliefs or attribution style.

Consequently, the influence of physical activity has to be considered under a differential perspective, including the whole lifespan and taking cognitive processes into account. Complex models, for example up-to-date theories on successful aging (e.g. the SOC-model; Baltes & Baltes, 1989) are promising approaches.

## RESPIRATORY MUSCLE TRAINING IN INDIVIDUALS WITH SPINAL CORD INJURY

Perret, C.

*Swiss Paraplegic Research, Switzerland*

Among spinal cord injured (SCI) subjects respiratory complications are still one of the most common causes of death (approximately

25%) and occur three to four times more frequently than in the able-bodied population. Thereby, a higher neurological level and completeness of SCI is associated with a higher mortality risk. Due to respiratory complications, duration of hospitalisation during first rehabilitation is prolonged and quality of life in SCI patients is markedly decreased. As a consequence, health care costs increase.

Lesion dependent paralysed respiratory muscles lead to a diminished pulmonary function and respiratory insufficiency. Weakness or failure of the inspiratory muscles may cause alveolar hypoventilation and respiratory failure; the missing expiratory muscles impede a satisfying cough flow. As a consequence pulmonary complications, e.g. pneumonia and atelectasis frequently occur in this population. Thus, interventions to improve respiratory muscle performance and physical fitness of SCI patients are urgently needed.

In this context respiratory muscle training appears to be a promising approach. At present no generally accepted guidelines about respiratory training in SCI exist. Published data is insufficient to make conclusions concerning the effects of respiratory training on respiratory muscle endurance and strength, exercise performance, respiratory complications and quality of life in SCI subjects. Moreover, different types of respiratory muscle training have been used (e.g. respiratory strength vs. endurance training) and it has still to be determined, which form of training (i.e. type, frequency, duration and intensity) will best meet the needs of the clinic and patients. However, our clinical experiences and feedback of patients treated with respiratory muscle training were positive and indicate the potential of such training in SCI subjects. Thus, in the future, well directed studies have to be performed to fill the above mentioned gaps.

### THE COVERAGE OF MALE AND FEMALE ATHLETES AT THE 2004 OLYMPIC GAMES - FRENCH RESULTS

Ohl, F., Quin, G., Wipf, E.

*Université de Lausanne, Switzerland*

This paper presents the French results of an international research collaboration that assesses media coverage of sportswomen during the 2004 Olympic Games. In France, we analysed two newspapers L'Équipe and Le Monde. The first one, L'Équipe, is a specialized newspaper that plays an important role in sport. The second one, Le Monde, is the most important national paper considering his role in the media field. In both papers, we can observe that during the Olympic Games the media coverage of women is higher than outside this period. Nevertheless, coverage of men (around 55% of the paper) is still higher than sportswomen coverage (from 10% before the games to 20%). Differences are also qualitative. For example, women media coverage is more on emotional aspects of sport; women are less often presented during action and more outside sport. Even when French women are very successful, like in swimming, the media coverage is lower than for men. Thus, considering data we can observe some changes in the media coverage but the Olympic coverage still underrepresented women and present gender in very traditional way.

### CHILDREN PARTICIPATING IN COMPETITIVE SPORT DO NOT GET INJURED MORE THAN THE AVERAGE CHILD

Mahler, P.B., Guinand, S., Schopfer, C., Duperrex, O.

*Service de Santé de la Jeunesse, Switzerland*

Sports Injuries is a preoccupation for young sportsmen, their families, coaches and for health professionals. Injuries are often brought up as a danger linked to sports participation, and little is known as to what extent participation in competitive sport leads to more injuries than the average. Furthermore some studies seem to show that parents avoid inscribing their children in sports because of the potential danger of injury.

We used a prospective successive cohort (3 year follow-up) injury database, drawn from 180 children (approximately half boys, half girls) per year, aged 12-16, participating in competitive sports (average 9.93 h of training/wk SD 1.05) and that followed an adapted school curriculum. The data was collected systematically, using an individually reported injury slip and verified during an annual medical evaluation. This has been done since 1990 which permits to establish a baseline injury rate.

The injury prevalence is expressed as injuries/child/year allowing comparison with two other studies carried out in the same geographical area and during the same time period. The injury rate among the competitive sports children was found to be 0.27 (SD 0.07) injuries/child/year and was relatively constant from 1990-2003. It was compared to two other studies; one hospital based study from 1990 that showed an injury rate of 0.22 injuries/child/year (RR:1.24, p=.16) the other was a school based survey from 2001 that showed an injury rate of 0.24 injuries/child/year (RR: 1.17, P= .15).

Conclusion: Taking the limitations of the different study designs in to consideration, it can be suggested that children practising competitive sports in this particular school setting do not get more injured than the average child. This could be due to the setting, but the relative stability of injuries prevalence over the 15 yr period among sportsmen and the similarity in injury prevalence in the two comparative studies leads to believe that independently of study design, there seems to be little difference between the groups.

### GENDER DIFFERENCES IN SENSORY AND MOTOR THRESHOLDS DURING ELECTRICAL STIMULATION OF THE QUADRICEPS FEMORIS MUSCLE

Maffioletti, N.A., Herrero, A., Jubeau, M., Bizzini, M., Dvorak, J.

*Schulthess Clinic, Switzerland*

Electrical stimulation (ES) therapy is largely used in rehabilitation-orthopaedic medicine (Snyder-Mackler et al. 1995) and in sports medicine (Lake 1992), with the general objectives to (1) minimize the effects of prolonged disuse on skeletal muscle structure and function, and (2) improve neuromuscular function parameters (e.g., as a resistance training and/or as a recovery modality). One hypothesis for the well known gender differences in body composition is that males and females respond to ES differently, and would therefore require different current intensities to optimize treatment effectiveness. Aim of the present study was to examine gender differences in sensory and motor thresholds during ES of the quadriceps femoris muscle at both high (75 Hz) and low (10 Hz) frequency modulation.

Forty healthy subjects (20 males and 20 females) were stimulated via surface electrodes placed over the vastus lateralis muscle and a portable ES unit. The two experimental frequencies (10 and 75 Hz) were randomly presented. Stimulation intensity (in mA) was increased progressively and the following thresholds were determined: sensory (ST), i.e., initial perception of stimulus sensation; motor (MT), i.e., minimal visible muscle contraction; maximal motor (MMT), i.e., full knee extension. Then, maximal voluntary contraction (MVC) torque of the quadriceps muscle was measured, and the

subject was stimulated to evoke 10% of the MVC torque (10%T). Skinfold thickness was measured under the stimulating electrode and quadriceps cross-sectional area was estimated according to Housh et al. (1995). A two-way ANOVA (gender, frequency) was performed.

A significant frequency effect was consistently found; ES thresholds were significantly lower at 75 Hz compared with 10 Hz ( $p < 0.001$ ). ST and 10%T were significantly lower in females than in males (ST: 3.1 vs. 5.4 mA,  $p < 0.001$ ; 10%T: 46.8 vs. 57.0 mA,  $p = 0.01$ ), while MT was significantly higher in females as compared to males (13.5 vs. 11.3 mA,  $p = 0.042$ ). Interestingly, ST was significantly correlated to both skinfold thickness ( $r = -0.71$ ,  $p < 0.001$ ), and cross-sectional area ( $r = 0.65$ ,  $p < 0.001$ ). Significantly higher pain scores (VAS) were found in the female group and at low frequency (data not presented).

It is concluded that, during surface ES of the quadriceps femoris muscle, females need different doses of current to activate both sensory and motor nerve fibers as compared to their male counterparts. Gender differences in skin nerve fiber density (Goransson et al. 2004, Mowlavi et al. 2005), subcutaneous fat layer and quadriceps muscle mass mainly account for these results. Our findings are valuable in terms of the gender-specific response to acute and chronic application of ES.

Goransson LG et al., *Neurology* 62:774-7, 2004  
Housh DJ et al., *Med Sci Sports Exerc* 27:784-91, 1995  
Lake DA, *Sports Med* 13:320-36, 1992  
Mowlavi A et al., *Plast Reconstr Surg* 116:1407-10, 2005  
Snyder-Mackler L et al., *J Bone Joint Surg Am* 77:1166-73, 1995

## OPTIMISATION OF EXERCISE PERFORMANCE IN WHEELCHAIR RACING ATHLETES

Mueller, G.

*Swiss Paraplegic Research, 6207 Nottwil, Switzerland*

Wheelchair racing is a paralympic discipline where exercise performance is at the highest level in many categories. To win a medal at the paralympic games, athletes have to exercise and prepare for such competitions as able-bodied olympic athletes do. However, spinal cord injured (SCI) athletes have additional problems to consider due to their impairment. Such problems may cause special or additional exercise training, supplementation, or other arrangements to be used in order to reach the highest possible exercise performance level.

Some of these additional problems are the absence of the sympathetic nervous system regulation in tetraplegic and high lesion paraplegic athletes, the absence of thermoregulation below the lesion level, the lower amount of active muscle mass which also affects respiratory muscles e.g. abdominals and in tetraplegic athletes even most expiratory muscles. This leads to an altered coenaesthesia which needs special attention throughout the whole training process.

In order to consider all these special needs and to concurrently improve individual exercise performance, we conducted several studies with junior and elite wheelchair racing athletes. Thus we developed and validated a new exercise test in order to improve training quality in junior wheelchair racing athletes. Furthermore, the effects of respiratory muscle endurance training on 10km time-trial performance in elite wheelchair racing athletes was investigated, as well as the influence of creatine supplementation on 800m all-out exercise performance. Results of the study about respiratory muscle endurance training showed significant improvements in respiratory muscle endurance in the training group, but failed to show significance in 10km time-trial performance, even if the training group showed a mean improvement of 3 min. Our current investigations focus on different tests to determine the individual maximal lactate steady state in wheelchair racing ath-

letes in order to improve guidance of exercise training in this special group of athletes.

Outcomes of all these studies revealed that there are big inter-individual differences between athletes due to their varying types and levels of impairment. Lesion level for example plays a major role in exercise performance and due to only small numbers of athletes, large standard deviations occur in the results of scientific studies performed with SCI athletes. In general, due to the limited number and heterogeneity of wheelchair racing athletes, highly scientific studies are difficult to perform. Nevertheless, SCI individuals could benefit from such studies, and based on individual results each athlete would be able to decide which additional intervention may help to further improve personal exercise performance.

## FOOTBALL INJURIES – APPLICATION OF LAW 12 IN TOP-CLASS TOURNAMENTS

Tscholl, P., O'Riordan, D., Dvorak, J., Gutzwiller, F., Junge, A.

*FIFA Medical Assessment and Research Centre (F-MARC), Switzerland*

### INTRODUCTION:

FIFA's official Laws of the Game state that a free kick will be awarded if "a player tackles an opponent to gain possession of the ball, making contact with the opponent before touching the ball..." unless the tackling player "...plays in a dangerous manner" (Law 12).

This leaves a high degree of liberty on the decision-making of the referees. The objective of this study was to analyse their interpretation of the law in respect of the consequences on the player's health.

### METHOD:

Video recordings of 24 representative matches and all injury incidences reported by the team physicians from 6 FIFA tournaments of female players were analyzed for tackle parameters (direction, mode) and referee's decision during the match. For the present analysis, the tackling situations were divided into two groups:

- the ball was touched before the striking player made contact to the ball-leading player (ball-first-tackles)
- first touch occurred to the player, with or without touching the ball after (player-first-tackles)

The injury incidents were only included in the analysis if the ball-leading player was injured by the striking player. Statistical values were obtained by Chi2-test (95% CI).

### RESULTS:

3236 tackles (average: 135 tackles per match) and 103 injury incidences (average: 0.6 injuries per match) were analysed. Player-first-tackles occurred 6-times more frequent than ball-first-tackles, however the injury risk was 2.5-times higher for ball-first-tackles (9.3 vs. 3.7 injuries per 1000 tackles,  $p < 0.001$ ). The referees sanctioned only 11% of the ball-first and 17% of the player-first-tackles ( $p < 0.01$ ). Comparing the non-sanctioned injury incidences, 2.3-times more injuries resulted from ball-first than from player-first-tackles (5.7 vs. 2.4 injuries per 1000 tackles,  $p < 0.01$ ). With regard to tackling mechanism, non-sanctioned sliding-in tackles from the front showed a significant higher injury-risk if the ball was played first (4 respectively 34 injuries/1000 tackles;  $p < 0.05$ ).

### DISCUSSION:

The results show more injuries are caused by contact with the player first. While fewer injuries appear to be caused by the striking player touching the ball first, its injury risk was found to be 2.5-fold higher. The same propensity of injuries was found for non-sanctioned challenges, therefore referees have to penalise more rigorously dangerous tackles, and above all from the front. Making referees aware of these high-risk tackles could improve the player's safety.

On the other hand players have to be taught techniques as well to evade the impact of ball-first-tackles.

## LOW PHYSICAL ACTIVITY LEVEL AND INCREASED BODY FATNESS IN CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES

Trigona, B., Farpour-Lambert, N., Keller-Marchand, L., Oehrli, M., Martin, X., Beghetti, M., Schwitzgebel, V.

University Hospital of Geneva, Switzerland

**BACKGROUND:** Physical activity is recognized as an important component of the treatment of type 1 diabetes patients. However, little is known about their physical activity level. **OBJECTIVE:** To measure physical activity and fitness level in children and adolescents with type 1 diabetes, and to evaluate their relationships with body fatness. **METHODS:** Cross sectional study including 41 children and adolescents with type 1 diabetes and 61 matched healthy controls (mean age 10.5 +/- 2.6 yrs). Subjects were matched for gender, age, height, and pubertal stage. We measured 7-day physical activity count using an accelerometer Actigraph MTI; past 12-month physical activity by a questionnaire and maximal aerobic capacity (VO<sub>2</sub>peak) by a maximal treadmill test. In addition, we calculated body mass index (BMI) and assessed the percentage of body fat by DXA. **RESULTS:** Children with diabetes had higher BMI (18.6 +/- 2.7 vs 17.2 +/- 2.4 U, p=0.009), body fatness (22.1 +/- 7.9 vs 21.2 +/- 7.2 %, p=0.008) and lower 7-day physical activity count (305.0 +/- 91.1 vs 354.1 +/- 104.2 cpm, p=0.03) compared to controls. In the diabetic group, 34.9% were overweight and 16.3% were obese. Body fatness was negatively correlated with physical activity (r=-0.35, p=0.031) or VO<sub>2</sub>peak (r=-0.62, p=0.001). **CONCLUSIONS:** Children and adolescents with type 1 diabetes have reduced physical activity level and increased body fatness. As physical activity is known to reduce cardiovascular diseases risk factors, these patients should be encouraged to participate in sports.

## IS QUALITY OF LIFE REDUCED IN OBESE CHILDREN?

Keller-Marchand, L., Farpour-Lambert, N., Martin, X., Trigona, B., Schwitzgebel, V., Aggoun, Y., Beghetti, M.

University Hospital of Geneva, Switzerland

Is quality of life reduced in obese children ?

Keller-Marchand L1, Farpour-Lambert NJ1, Martin X1, Trigona B1, Schwitzgebel V2, Aggoun Y1, Beghetti M1.

1Pediatric Cardiology Unit; 2Pediatric Endocrinology and Diabetology Unit; Dept of Pediatrics, University Hospital of Geneva, Switzerland.

**BACKGROUND:** Childhood obesity is associated with poor quality of life, due to reduced psychosocial health, self-esteem and physical functioning. Physical activity is a major determinant of cardiovascular health and may also improve components of quality of life in this population. **OBJECTIVE:** To assess quality of life and physical activity in obese children. **METHODS:** Cross-sectional case control study including 41 obese prepubertal children and 41 lean controls aged 6 to 11 years (mean 9.0 ± 1.5 years). Both groups were matched for age, height and pubertal stage. Health-related quality of life was assessed by the Child Health Questionnaire. Other measures included: 7-day physical activity count by accelerometer; past 12-month physical activity level by questionnaire; body composition by DXA and anthropometrics. **RESULTS:** Quality of life total score (73.0 ± 10.9 vs 82.4 ± 7.3, p=0.001) was significantly lower in obese children compared to controls, especially psychosocial health, self-esteem, physical functioning, and impact on parental emotional well-being. Obese children had lower physical activity count (309.3 ± 42.4 vs 394.4 ± 99.5 cpm, p=0.04) and past 12-month physical activity (0.8 ± 1.3 vs 3.9 ± 3.2 hours/week, p=0.001) than controls, whereas body mass index (p=0.001) and percentage of body fat (p=0.001) were significantly increased. **CONCLUSIONS:** Our study demonstrates that quality of life is reduced in prepubertal obese children compared to lean controls, particularly psychosocial health and physical functioning. In addition, obese children are less physically active, suggesting decreased sports participation and physical conditioning. We conclude that obese children may benefit from

adapted physical activity interventions to improve their quality of life and social integration.

## RECONSTRUCTION OF TALAR OSTEOCHONDRAL LESIONS WITH MOSAICPLASTY FROM THE KNEE JOINT

Leumann, A., Valderrabano, V., Pagenstert, G., Hintermann, B.

Lower Extremity Orthopaedics, Switzerland

Introduction

Osteochondral talar lesions are frequent injuries in ankle sprains and may lead to persistent pain, constriction of range of motion, sports stop, or even degenerative joint disease. Many surgical therapies have been described for talar osteochondral lesions treatment: chondrocyte transplantation, mosaicplasty, retrograde drilling, microfacturing, and others. However, despite this variety of methods, no mid- and long-term results in the modern treatment of talar osteochondral lesions are available.

Methods

Between 02/2000 and 10/2005 22 patients with a symptomatic osteochondral talus lesion Berndt and Harty grade II-IV were treated with a mosaicplasty (Hangody et al. JBS 2003). The osteochondral grafts were harvested at the ipsilateral knee joint. The analyzed variables were: pain (VAS, 0-10), AOFAS hindfoot score for functional assessment (points 0-100; Kitaoka et al. FAI 1994), clinical examination of donor side morbidity, arthritis grade (x-ray), chondropathy grade (Outerbridge I-V), magnetic resonance imaging and diagnostic arthroscopy.

Results

22 patients with an average follow-up of 4 years and one month were evaluated after reconstruction (range: 4-72 months; average age 34 years (range: 19-51 years old)). The lesions measured in average 1.8 cm<sup>2</sup> (range: 0.25-9cm<sup>2</sup>). 2/3 were located on the lateral edge of the talus, 1/3 on the medial side. 2.5 cylinders were used in average (range: 1-6) between 4.6 and 12.7 mm in diameter. Six patients (27%) showed postoperative knee pain that needed further treatment. Nine patients (40%) showed concomitant chronic ankle instability that was corrected in the same operation. Further results will be discussed at the conference.

Discussion

The ideal therapy for talar osteochondral lesions remains unsolved. One of the options is the reconstruction with autologous bone-cartilage transplantation (mosaicplasty) from the knee joint as described in this report. Although long-term results are lacking concerning function, pain and secondary osteoarthritis, "knee-to-talus mosaicplasty" showed restricted results, and – in the opinion of the authors – causes significant donor side morbidity.

## THE LAUSANNE RECOMMENDATIONS AND BEYOND

Bille, K., Figueiras, D., Schamasch, P., Brenner, J.I., Meijboom, F.J., Meijboom, E.J.

Centre Hospitalier Universitaire Vaudoise (CHUV), Switzerland

**Introduction:** The incidence of sudden death (SD) in athletes is higher (~2/100000/year) than in non-athletes (RR 2.5:1), the cause is cardiovascular in over 90%. This study reports on SCD in sport and aimed at achieving a generally acceptable PPSP endorsed by the consensus meeting (CM) of, and recommended by the IOC.

**Methods:** A systematic review of the literature identified causes of SCD, gender, age, underlying cardiac disease and type of sport. Methods to detect pre-existing cardiac abnormalities were discussed to formulate a feasible and safe PPSP for the CM of the IOC. ([http://www.olympic.org/uk/organisation/commissions/medical/full\\_story\\_uk.asp?id=1182](http://www.olympic.org/uk/organisation/commissions/medical/full_story_uk.asp?id=1182))

**Results:** SCD occurred in 1101(1966-2004) reported cases in athletes under 35 years, 50% had congenital anatomic heart disease and cardiomyopathies and 10% had early onset athero-sclerotic heart

disease. 40% occurred in athletes <18 yrs, 33% <16 yrs; female/male ratio was 1/9. Sports most frequently involved were soccer(30%), basketball(25%) and running(15%). PPSPs, if present at all, were of varying quality and content. The IOC CM accepted the proposed

### ENVIRONMENTAL FACTORS AND HUMAN POWERED MOBILITY FOR CHILDHOOD SCHOOL TRAVEL

**Bringolf-Isler, B., Mäder, U., Ruch, N., Grize, L., Braun-Fahländer, C.**

*Institute of Social and Preventive Medicine of the University of Basel, Switzerland*

Introduction: Environmental factors influencing human powered mobility (HPM) for school travel has become an important Public Health topic. Very limited data exist about travel patterns of schoolchildren in Switzerland and about the extent of walking or bicycling to school. Therefore the SCARPOL study surveyed the commuting mode of Swiss children and determined which objective and subjective factors influence active commuting.

Method: The present study included 1345 Swiss children of three different age groups (kindergarten/1st class, 4th class and 8th class students) living in three communities (Bern: German speaking, Payerne: French speaking and Biel-Bienne: mixed language community). Parents responded to a questionnaire about the children's common commuting mode to school. For 1096 children the home address was available allowing us to allocate GIS-data about the home and the school environment (geographic information system) to these children.

Results: Overall, the prevalence of commuting by car or by bus appears to be rather low among Swiss children (21% in summer and 24% in winter) but differs between the language areas. Whereas in Bern more than 90% of children use HPM to get to school, only 75% do so in Biel-Bienne and less than 60% in Payerne. The reason for this difference cannot be reduced to cultural differences. According to the GIS-data children from Payerne have significant longer ways to school than children from the other two communities and they have to cross more dangerous crossroads. This fact is important because parents who perceive the way to school as dangerous accompany their children more often and this influences the mode of transport to school. In contrast to studies from Anglo-Saxon countries only 5% of Swiss parents are worried about violence by adults the children may experience on their way to school whereas nearly 90% perceive traffic as a major hazard for their children.

Conclusion Although passive commuting is still not very common among Swiss school children efforts are necessary to maintain active commuting rates or even to increase them. To encourage human powered mobility for children's commuting to school a broad range of environmental and family related factors have to be taken into account.

### OPTIMISATION OF EXERCISE PERFORMANCE IN WHEELCHAIR RACING ATHLETES

**Mueller, G.**

*Swiss Paraplegic Research, 6207 Nottwil, Switzerland*

Wheelchair racing is a paralympic discipline where exercise performance is at the highest level in many categories. To win a medal at the paralympic games, athletes have to exercise and prepare for such competitions as able-bodied olympic athletes do. However, spinal cord injured (SCI) athletes have additional problems to consider due to their impairment. Such problems may cause special or additional exercise training, supplementation, or other arrangements to be used in order to reach the highest possible exercise performance level.

Some of these additional problems are the absence of the sympathetic nervous system regulation in tetraplegic and high lesion

paraplegic athletes, the absence of thermoregulation below the lesion level, the lower amount of active muscle mass which also affects respiratory muscles e.g. abdominals and in tetraplegic athletes even most expiratory muscles. This leads to an altered coenaesthesia which needs special attention throughout the whole training process.

In order to

### MATHEMATICAL MODELS IN SPORT PHYSIOLOGY

**D'Angelo, C., Quarteroni, A.**

*EPFL (Ecole Polytechnique Fédérale de Lausanne), Switzerland*

Physical exercise involves extremely complex physiological processes. For instance, it is known that several biochemical phenomena with a number of chemical reactants take place during efforts such as running, swimming and almost all sport activities. They are highly interdependent, and the way they interact changes with respect to workload and other physiological parameters. Performing an accurate analysis of sport physiology based on individual characteristics is therefore a difficult task. Due to the intrinsic interest of such analysis for a number of applications, for instance in the pharmacological study of drug administration, we propose some mathematical models, aiming at obtaining relevant informations about the response of the body to the effort condition.

The main actors among the physiological processes sustaining exercise are

1. the biochemical reactions in skeletal muscle;
2. the substrate (oxygen, glucose, lactate, . . . ) transfer between blood and tissues;
3. the cardiovascular feedback with respect to the arterial pressure and substrate concentrations (i.e. the baroreflex and chemoreflex effect).

We describe suitable models for these three phenomena and show how they can be coupled together. The coupled models can describe the autoregulation effects that typically affect the cardiovascular system and the metabolism of tissues. Our approach involves lumped models as well as distributed models.

Lumped models feature several compartments that describe different parts/organs of the human body (skeletal muscles, blood vessels, other tissues, ...).

The variables of such models are averaged quantities on each compartment rather than spatial distributions, so that the computational cost of simulation is reduced. To apply the model, the identification of unknown parameters related with metabolism and biochemical reactions is required: typically they are obtained by optimization techniques.

Distributed models are proposed for flow analysis and chemical transport processes in blood vessels. They are able to account for the geometry of vessels or tissues; on the other hand, they have a more pronounced computational cost. We show some examples of the use of the so-called 1D models for analysing blood flow and mass transport, and of more complex 3D/1D models.

Some typical applications will be discussed as well.

### NO DIFFERENCE IN TIME TO EXHAUSTION AT MAXIMAL LACTATE STEADY STATE BETWEEN CYCLING AND RUNNING

**Fontana, P., Boutellier, U., Knoepfli-Lenzin, C.**

*ETH-University of Zurich, Switzerland*

Introduction: Heart rate (HR) and blood lactate concentration (Lac) in cycling and running are different, at exhaustion as well as at a comparable submaximal intensity (Roecker et al., 2003). The purpose of the present study was to investigate if the above mentioned

results lead to differences in time to exhaustion at maximal lactate steady state (MLSS) between cycling and running. Methods: 15 moderately endurance trained men (age:  $30 \pm 6$  years, height:  $180 \pm 5$  cm, weight:  $77 \pm 6$  kg, maximal oxygen uptake:  $50 \pm 4$  ml/kg/min, exercise activity: 2-6 h/week) performed a lactate minimum test to determine anaerobic threshold and several constant load tests (CLT) until criteria for MLSS were fulfilled (Lac in a CLT is constant ( $1 \text{ mmol/l}$ ) over 20 min after initial 10 min for reaching steady state and increases ( $> 1 \text{ mmol/l}$ ) in a second CLT in the same time when power (5 W) or speed (0.25 km/h) are elevated). MLSS was determined on a cycle ergometer and a treadmill, respectively. During the CLT Lac and rate of perceived exertion (RPE) were measured every 5 min, oxygen uptake and ventilation were recorded continuously, HR every 5 s. Results: Time to exhaustion ( $37.5 \pm 8.6$  vs.  $38.3 \pm 5.9$  min) and RPE ( $7.5 \pm 1.5$  vs.  $7.4 \pm 1.4$ ) were equal in cycling and running. Oxygen uptake ( $3.1 \pm 0.3$  vs.  $3.4 \pm 0.3$  l/min,  $p < 0.001$ ), ventilation ( $95 \pm 13$  vs.  $105 \pm 17$  l/min,  $p < 0.01$ ) and HR ( $166 \pm 8$  vs.  $176 \pm 9$  min<sup>-1</sup>,  $p < 0.01$ ) were lower, Lac ( $5.6 \pm 1.6$  vs.  $4.4 \pm 1.3$  mmol/l,  $p < 0.05$ ) was higher in cycling than in running. MLSS parameters referred to maximal values (%) showed no difference in ventilation ( $70 \pm 11$  vs.  $76 \pm 8$ %), HR ( $92 \pm 4$  vs.  $94 \pm 3$ %), Lac ( $57 \pm 17$  vs.  $48 \pm 12$ %) and RPE ( $79 \pm 17$  vs.  $82 \pm 14$ %) between cycling and running, only oxygen uptake ( $86 \pm 5$  vs.  $89 \pm 5$ %,  $p < 0.05$ ) was slightly lower in cycling than in running. Conclusions: No difference in time to exhaustion at MLSS between cycling and running was found. Absolute differences in ventilation, HR and Lac disappeared when compared relatively with the exception of oxygen uptake, which was absolute as well as relative slightly lower in cycling than in running.

Roecker K., H. Striegel, and H.-H. Dickhuth: Heart-rate recommendations: transfer between running and cycling exercise? *Int J Sports Med* 24: 173-178, 2003.

### HEAT TRANSFER CHARACTERISTICS OF ROWING HEADGEAR WITH RADIANT HEAT FLOW

Bogerd, C.P., Brühwiler, P., Heus, R.

*Empa Material Science and Technology, Switzerland*

The head is one of the strongest sensors determining human thermal comfort. For this reason several thermal manikin studies have been conducted in reducing heat stress on the head. These studies focused on optimizing convective and/or evaporative heat loss. Radiant heat flow, though often mentioned as a potential factor, has been studied relatively little. Considering that radiant heat flow easily delivers 25 W to the head alone during the summer in temperate climates, this suggests that large differences among different headgear (types) could exist. Shielding solar heat flow while maintaining heat loss close to optimal favors comfort perception and might reduce heat strain. These considerations motivated the development of a prototype rowing headgear (PRH) (Bogerd et al., 2005). The goal of this study is to compare that PRH with other widely-used sports headgear in a non-sweating condition on i) net heat transfer, ii) radiant heat flow, and iii) convective heat flow.

The following headgear were studied: i) the PRH, ii) a white cotton cap (CW) and iii) a black cotton cap (CB). The experiment was carried out for different radiant arrangements: i) without radiation (NoRad), ii) with 18.7 W radiant heat flow from directly above (90°) and iii) with 9.6 W radiant heat flow from an angle of 65° (65°). Wind, ambient temperature and humidity were kept constant at 4 m/s, 22 °C and 50%. The measurements were then repeated for arrangements NoRad and 90° with headgear PRH, CW and CB in combination with a wig.

All headgear reduced the radiant heat flow: ~80% for the caps and 95% for the PRH. Furthermore, the radiant heat flow contributed maximally for 13% to the net heat transfer indicating that convective heat flow is a more important heat transfer parameter under the tested condition. The PRH reduced convective heat flow only minimally and was therefore the only headgear outperforming the nude head in a radiant environment. The extra heat transfer ob-

tained with the PRH in the most optimal condition and compared with the nude head is 12 W. It is known from studies with artificial cooling that a cooling power as low as 12 W results in a reduction of heat strain for pilots carrying out a flight simulator in a warm environment (Williams & Shitzer, 1974). However, it is unknown if the PRH results in a reduction of heat strain for athletes. Wearing a wig greatly reduces convective heat flow but shows similar qualitative results. The PRH is shown to be more effective in reducing heat stress of the head compared to traditional rowing headgear under the tested conditions.

Bogerd CP, Heus R & Willems JWM (2005). A sun shading headgear used by a Dutch Olympic sculler: A comparative study. Proceedings of ICEE, Ystad, Sweden, 22-26 May: 396-399.

Williams BA & Shitzer A (1974). Modular liquid-cooled helmet liner for thermal comfort. *Aerospace Med.*, 45, 1030-1036.

### HEAT TRANSFER VARIATIONS OF BICYCLE HELMETS- WHAT WORKS BEST?

Brühwiler, P., Buyan, M., Huber, R., Bogerd, C.P., Sznitman, J., Graf, S.F., Rösigen, T.

*Empa, Materials Science and Technology, Switzerland*

Bicycle helmets exhibit complex structures so as to combine impact protection with ventilation. A quantitative experimental measure of the state of the art and variations therein is a first step towards establishing principles of bicycle helmet ventilation. A thermal headform mounted in a climate-regulated wind tunnel was used to study the ventilation efficiency of 24 bicycle helmets at two wind speeds. Flow visualization in a water tunnel with a second headform demonstrated the flow patterns involved. The influence of design details such as channel length and vent placement was studied, as well as the impact of hair.

Differences in heat transfer among the helmets of up to 30% (scalp) and 10% (face) were observed, with the nude headform showing the highest values. On occasion, a negative role of some vents for forced convection was demonstrated. A weak correlation was found between the projected vent cross-section and heat transfer variations, as well as between exposed scalp area and heat transfer. A simple analytical model is introduced that facilitates the understanding of forced convection phenomena in such helmets. Adding a wig reduces the heat transfer by approximately a factor of 8 in the scalp region and up to one-third for the rest of the head for a selection of the best ventilated helmets. The role of the visor was also studied, and showed large variations from helmet to helmet and as a function of angle. Similar variations were observed with regard to solar radiant heat flow rejection.

The results suggest that there is significant optimization potential within the basic structure represented in modern bicycle helmets. Given the good correlation between heat transfer variations as measured with a thermal manikin, and variations felt by human subjects [1, 2], we conclude that wearer comfort would benefit from a more systematic approach to bicycle helmet design. For elite athletes, performance benefits of improved designs are anticipated on the basis of improved heat transfer.

[1] P.A. Brühwiler, C. Ducas, R. Huber, P.A. Bishop, Bicycle helmet ventilation and comfort angle dependence, *European Journal of Applied Physiology* 92 (2004) 698-701.

[2] M. Buyan, P.A. Brühwiler, A. Azens, G. Gustavsson, R. Karmhag, C.G. Granqvist, Facial Warming and Tinted Helmet Visors, *International Journal of Industrial Ergonomics* 36 (2006) 11-16.

### TRAINING IN HYPOXIA FOR SEA LEVEL PERFORMANCE: POTENTIAL MECHANISMS AND EVIDENCE

Vogt, M., Angermann, M., Graber, F., Flück, M., Hoppeler, H.

*University of Bern, Switzerland*

Altitude training is very popular among endurance athletes. It is used to increase endurance exercise performance or to prepare for competition at altitude. Although well controlled studies showed increases of performance determining variables, endurance athletes in general respond very differently to acute altitude exposure and to altitude training. For example there are individual differences in the altitude dependent decrement of maximal oxygen consumption and exercise performance as well as in the response to hypoxia challenges.

Mechanisms which lead to this individual response are not well known. To search for possible muscular factors explaining individual differences of the acute performance decrement at altitude we recently tested Nordic combined skiers under simulated hypoxic conditions corresponding to an altitude of 3200m. High decrement of maximal oxygen consumption at altitude was associated with high intramuscular lipid content and low myofibrillar density in deltoideus muscle. These results suggest that ultrastructural characteristics of skeletal muscles may explain at least to a part the altitude dependent loss of aerobic performance in trained athletes. Currently, there are two seemingly opposite training paradigms proposed to use altitude (or hypoxia) as an ergogenic aid. Beside "live high – train low" by which an improvement of the oxygen transport capacity is expected, the concept of "live low – train high" has also received attention. For this latter regime, athletes train under simulated or natural hypoxic conditions, while recovery time is spent at sea-level or normoxia. Several studies show that aerobic and anaerobic endurance performance can be improved with "live low – train high". Molecular analysis reveals that a transcription factor called Hypoxia-Inducible Factor 1 (HIF-1) acts as a master gene in the regulation of hypoxia dependent gene expression. In human skeletal muscle "live low – train high" induces the expression of glycolytic enzymes, antioxidative enzymes, the angiogenic factor VEGF, myoglobin as well as the increase of capillarity and mitochondrial content in parallel to the induction of the HIF-1 system. In trained human skeletal muscle, these adaptations cause a shift of substrate selection to an increased oxidation of carbohydrates as well as to an improvement of the conditions for transport and utilization of oxygen.

We gained experience with using hypoxia in the training of top-level athletes. This training mode may have practical implications of using hypoxia as an ergogenic aid.

## DIFFERENT CONTRIBUTION OF STEP RATE AND STEP LENGTH TO 40M-SPRINT RUNNING PERFORMANCE IN SWISS JUNIOR NATIONAL TEAM SOCCER PLAYERS

Tschopp, M., Hübner, K., Zürcher, S.

*Swiss Federal Institute of Sports Magglingen, Switzerland*

Sprint running plays an essential role in the performance of soccer. High sprint running speed is achieved by both a high step rate and long step length<sup>2</sup>. Little evidence exists to which extent each of these two factors influence running speed over the acceleration phase (0-40m) of sprint running. This may be of particular interest in soccer since most sprint bouts during a soccer game are shorter than 40m. The aim of the study was to determine to what extent step rate and step length differentiate between junior elite soccer players with different sprint abilities in the acceleration phase.

Methods 39 junior elite soccer players (age:17.4±0.8 y), all members of a Swiss junior national team, participated in the study. A maximal-effort 40m-sprint was performed. Step rate, step length, contact time and flight time were measured with the Optojump Microgate measuring system (Bolzano, Italy). According to their 40m sprint running time, the subjects were divided into quartiles. For data analysis, the fastest group (FG: n=11; 40m sprint time: 5.31±0.12sec; 16.9±0.6y; height: 177.5±4.5cm; body weight: 72.4±5.2kg) was compared with the slowest group (SG: n=10; 5.68±0.07sec; 17.3±0.6y; 183.1±10.0cm; 75.7±11.0kg). Multivariate approach to repeated measures ANOVA with the kinematic variables (average values of every 10m) as dependent variables and

group as the independent variable was used for statistical analysis. \* p<0.01; \*\*p<0.001

Results Significant effects of group membership were found in step rate (SR)\*, contact time\*\* and - trivially - speed\*\*, with the FG having higher speed (highest values: FG 9.05±0.27 vs. SG 8.33±0.10ms<sup>-1</sup>) and SR (4.82±0.15 vs. 4.53±0.31Hz) and lower contact time (112±4 vs. 125±7ms) values respectively. No differences between FG and SG were found in step length (SL) and flight time. In both groups, speed\*\*, SL\*\* and flight time\*\* increased over the course of 40m. SR\*\* and contact time\*\* decreased significantly. However, there was no change in SR between the first and the second 10m, whereas contact time did not further decrease in the forth 10m-segment. Interaction between kinematic variables and group membership was found in SR and SL. The highest SR in the SG group was found between 0-10m, whereas for the FG it was 10-20m. The FG had a higher increase in SL between the third and the forth 10m-segment. Conclusion Better sprint time in the FG was achieved predominantly by higher step rate over the whole 40m. Higher step rate was linked with shorter contact time. Sprint training should therefore include aspects that generate short contact times and high step rates. Yet, it should be considered that improvement in sprint running by increasing step rate occurs only if step length does not decrease concomitantly at the same rate, since different sources of negative interaction between step rate and step length do exist<sup>2</sup>.

1 T. Stolen et al.; Sports Med; 2005. 2 J. Hunter et al.; Med Sci Sports Exerc.; 2004

## COMPARISON OF TWO SPECIFIC ICE HOCKEY ENDURANCE FIELD TESTS, ON-ICE AND OFF-ICE, WITH A CYCLE ERGOMETRY-LACTATE THRESHOLD TEST IN JUNIOR ELITE PLAYERS

Clenin G., Fluri P., Altorfer R., Zürcher S., Tschopp M., Marti B.

*Swiss Federal Institute of Sports Magglingen, Switzerland*

Introduction: The endurance capacity of ice hockey players is believed to play an important role in performance. Lactate threshold tests conducted on a cycle ergometer are commonly used. However, there is a lack of sport specific ice hockey field tests in performance assessment.

Research question: How does the endurance capacity of elite ice hockey players as assessed by a laboratory lactate threshold test on a cycle ergometer compare to a) a progressive stage test using a Slidingboard method (off-ice) and b) a progressive Skating stage test (on-ice)?

Methods: 29 Ice hockey players from the Swiss National Junior team (18.7y ± 0.6, 182cm ± 5.6, BMI 25.5 ± 2.0) completed over the course of 3 days 3 different endurance capacity tests: The slidingboard-Test (SB) is an off-ice test, where the athlete attaches a gliding board on the bottom of his shoes, which slide on a mat the width of two leg lengths. The athletes slide sideways from one end of the mat to the other at a given rhythm by a cadence meter. This pacing starts at a cadence of 18/min and increases gradually with the best performance at a cadence of 31/min.

The ice skating test in a figure eight (8erT) is an on-ice test with full equipment with a length of the figure eight of 160 meters. The initial pacing is at 15km/h, with an increase per stage of 1 km/h for every 320 meter.

The incremental lactate threshold test on a cycle ergometer was used to determine the individual anaerobic threshold (LTT). First stage was at 130 W and increased 30 W every 3 minutes. All tests were completed to voluntary exhaustion. Heart rate, lactic acid concentrations and rating of perceived exertion (RPE) were collected.

Results: The maximal speed in the 8erT had a high correlation (r=0.73; p<0.01) with the LTT in W/kg, whereas the maximal performance in SB test had a low correlation (r=0.39) with the LTT. The correlation between the 8erT and the LTT was less strong when compared in absolute terms (r=0.56). Time to exhaustion in the LTT was 22min, in SB 11min and in the 8erT only 9min. Maximal lactate concentration was significantly (p<0.001) higher in the LTT than in SB

or 8erT, but in SB clearly lower. Maximal RPE was significantly lower in the 8erT than during the LTT.

Conclusions: Assuming that the performance level in the field test on-ice (8erT) is most relevant to icehockey specific endurance capacity, we found a surprisingly good correlation between the 8erT and the cycle ergometry test (LTT), and only a low correlation between the two tests thought to be both hockey-specific (8erT, SB). We feel that the SB test is not an adequate test to measure endurance capacity of ice hockey players. However the results of the LTT when reported in relation to BW, over estimated the endurance capacity of the lightweight players, while the results in absolute terms overestimated the endurance capacity of the heavy players.

### ASSESSING COLLECTIVE DECISION MAKING IN SPORT BY A POSTERIORI METHODS: CASE STUDY IN TEAM HANDBALL

Lenzen, B. 1, Theunissen, C. 2, Cloes, M. 2

1 University of Geneva (Switzerland), 2 University of Liège (Belgium), Switzerland

Team sports provide a big challenge in term of decision making for players and pupils, coaches and teachers, and researchers. Most of the research on decision making in sport has been conducted in connection with expertise, and the majority of researchers working on cognitive expertise have adopted an information-processing framework for studying decision making in simulated settings. In contrast, we prioritized a posteriori methods within the framework of the ethnomethodologic approach of situated action. Three aspects of this theory are of particular interest for research on decision making in sport: (a) the relation between planning and action; (b) the perception-action coordination; and (c) the distinction between first person and third person representations. The first one is expressed by the distinction between strategy and tactics in team sports. The second one results in the recommendation that perception and action should be coupled for the analysis of performance. Finally, the third aspect deals with the risk of confusion between the frame of reference of the decision maker and the one of the scientist studying him or her, and means to reduce it.

Aiming to demonstrate the interest and the validity of a posteriori methods for exploring the relation of knowledge and action to the particular and ever-changing circumstances of complex sport situations, we submitted six elite female handball players to self-confrontation interviews about two previously played and video recorded championship matches. Players were notably asked the following questions: (a) Can you describe what happened at this moment (the moment illustrated by a previously selected video sequence)? (b) Which information did you take into account? (c) What was the principle that you applied? (d) What is the origin of this principle?

Findings emerging from the qualitative analysis of players' retrospective verbalizations may be distinguished depending on whether they (a) provide help understanding how subjects make decision in already studied simulated settings or (b) prefigure novel variables that can be used for further model specification. We describe as non-situated elements those referring to strategy, which influence players' decision making independently of the context of the game situation (e.g., visual cues, offensive/defensive tactical concepts) and as situated elements those which depend strongly on the context of the game situation (e.g., auditory/tactile cues, knowledge about oneself's weakness/strengths, knowledge about teammates' weakness/strengths, knowledge about the opponent's usual play, difficulty of the match). The latter deal more deeply with the collective aspects of the decision making process. These situated elements need to be further addressed before models in decision making can be applicable to real-world sport settings, in a way to develop on this basis more effective training and teaching sessions.

### 'METHODS FOR TESTING SLIDING PERFORMANCE ON SNOW'

Rhyner, H., Lüthi, A., Fauve, M.

Swiss Federal Institut for Snow and Avalanche Research (SLF) Davos, Switzerland

Sliding of skis on snow is influenced by many variables. The following ones are important for us: Concerning the skier: its his weight and aerodynamics. For the ski: its hardness and dynamical behaviour. For the ski base: its hardness, surface roughness, heat conductivity and wetting behaviour are the main factors regarding sliding on snow. Snow is the other side of the sliding system where following variables are important: surface temperature, roughness and hardness. At snow temperatures around zero degree Celsius the liquid water of snow is another important variable. The influence of all these variables can be analysed in field tests, under the condition that all variables are measured on the same scale and remain constant during the tests. We have conducted over 2500 test runs during which we have analysed the influence of some of the aforementioned variables. Such field tests are very time-consuming and expensive. Therefore we have developed a device which allows sliding tests under laboratory conditions. The friction coefficient of small ski samples on ice or snow is measured on a 180 cm diameter turn-table under constant conditions. These laboratory measurements allow comparisons between different sliding materials and systems on a small scale before whole skis can be built. Measurements with this device is used as well for the development of a new friction model..

### BILATERAL STRESS FRACTURE OF THE MALLEOLUS MEDIALIS OF A TEAM HANDBALL PLAYER – AN EXTRAORDINARY CASE REPORT

Weisskopf, L., Rist, H.J., Segesser, B., Martin, U.

Praxisklinik Rennbahn, Switzerland

Stress fractures in sports are very common. They sports specifically happen at typical anatomical locations. The involvement of the malleolus medialis is rare. Using instructive illustrations and pictures the interesting case of a bilateral stress fracture of the malleolus medialis of a 30 year old elite team handball player is described. The clinical history was documented by x-ray and computer tomography in such a way that the development of the fracture can be comprehended well. Furthermore, the surgery, the functional after treatment and possible aetiologies are discussed.