ECSS 2015: Sustainable Exercise Science

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This report on the 20th anniversary annual conference of the European College of Sport Science focuses on presentations relevant to non-athletic populations. A tribute to a giant in exercise science: Bengt Saltin's research on optimizing muscular performance and health, mitochondrial biogenesis, interdisciplinary physical activity, lifelong endurance training, vascular function during exercise. Physical activity, learning and memory: neurophysiological and sociological aspects of motor learning and memory; neurotrophic factors and exercise. Aging and body functioning: cellular mechanisms and sarcopenia; strength declines during aging; assessment of muscle protein synthesis; brain health; well-being; restricted energy intake; neurodegenerative disorders; inactivity; pharmaceutical drug development. Physical activity promotion – older adults: Physical activity and cardiovascular disease; mobility and leukocyte telomere length; high-intensity interval training; exercise promotion programs; double concentric multi-joint exercise; muscle fat infiltration. Physical activity promotion – children: school-based interventions; physical activity and fitness assessment; maximal oxygen uptake assessment; obesity prevention; inflammation. Neuromuscular performance during lifespan: visco-elasticity and posture; tendon adaptations; static and dynamic postural control; explosive strength assessment and adaptations; balance training and adaptations; motor learning and adaptations. Team sports for health: recreational and motivational aspects of football; floorball; football fans and training; floorball in the elderly. Injury prevention: multifactorial injury prevention; shoes and motion control; dynamic stabilization and functional strengthening. Physical activity and cognitive function: physical activity, exercise and memory; brain function and motor learning; cognitive control and motor coordination in the elderly; neuroplasticity, memory and motor skill acquisition. Occupational health promotion: cost-effectiveness; occupational activity assessment; tailoring of interventions; multilevel interventions. Obesity, body composition and metabolism: whole body cryostimulation and anti-inflammation; irisin and low temperatures; healthy weight interventions; high-intensity training and glucose uptake. KEYWORDS: physical activity, exercise, postural control, cognition, learning, memory, ageing, muscle, tendon, children, interventions, workplace, obesity, clinical.
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The 20th anniversary conference of the European College of Sport Science (ECSS) was hosted by Malmö University, Lund University and Copenhagen University and held at the Clarion Hotel in Malmö, Sweden, 24-27 June 2015. The recently opened, spacious and well-equipped conference center served as an excellent congress venue. Approximately 1600 abstracts were accepted and assigned to four plenary sessions (keynote lectures) with eight presentations, 37 invited sessions with 124 presentations, 113 oral sessions with 589 presentations, 64 mini-orals with 473 presentations and 400 non-debated e-posters. A variety of disciplines (e.g., clinical, biomechanical, neuromuscular, technical, social, psychological, physiological) in sport science contributed to a multidisciplinary program with different methodological views and challenges. *Sustainable sport* was the conference slogan, referring to our responsibility to act sustainably in physical activity and sport. Check out the statistics and logistics in the official debrief, and view a conference collage video on the ECSS YouTube

channel. See also who won the young-investigator awards (summary PDF and links to individuals) and the GSSI nutrition and Aspetar football awards.

This conference report covers a selective summary of talks on exercise and training, primarily concluded from a health perspective. Topics on competitive athletes are considered in a separate report.

The majority of the presented work was of high scientific quality. The applicants for the Young Investigator Award (YIA) mostly presented in a very concise way. Some studies, however, should have provided a clearer and precise rationale, applied a sound study design with an appropriate statistical approach and should have discussed the study limitations critically.

The Malmö conference site includes program pages for each type of presentation and a book of abstracts (PDF file). Videos of plenaries and some invited symposia can be watched via the ECSS.tv page. All abstracts, mini-oral slides and e-posters can be accessed via the Malmö search form or (eventually) via the E*D*SS database (access to which is limited to ECSS members through the login page). The present conference report illustrates the study populations in **blue** color and research objectives (keywords) in dark red (**plum**). We have provided the presenter's name followed by the respective session code in brackets […]. Use the session code in the search form at the conference site to find links to the abstracts. If you are searching the book of abstracts with the advanced search form in a PDF reader, insert only the second part of the code (e.g., insert PL01, not PS-PL01). The first part of the code denotes the following: IS, invited symposium; MO, mini-oral; OP, oral presentation; PP, poster presentation; PS, plenary session.

A tribute to a giant in exercise science

Although the occasion was a sad one, it might be regarded as a fateful symbol that this anniversary conference was co-organized by the University of Copenhagen, the alma mater of founding member, first president and patron of the ECSS, Bengt Saltin, who passed away in September 2014. In honor of this giant in exercise science, two tribute symposia were scheduled. The official symposium [IS-PM02] took place on Wednesday June 24. A further invited session was held on Saturday June 27 and was entitled "**lifelong endurance training**: maintenance of high cardiovascular and oxidative metabolic performance with **aging**: in honor of Bengt Saltin" [IS-PM07]. Bengt Saltin is considered a worldwide acknowledged leading expert in exercise physiology. He applied integrative physiological methods to understand the muscular and cardiovascular basics of **human** performance and health. Even though his outstanding academic achievements seem unrivalled, he is an inspiring person and gives motivation for young researchers. Several of his scholars gave an excellent overview about the main topics of Bengt Saltin's research in human physiology during the last 50 years.

Physical activity, learning and memory

Jens Nielsen, University of Copenhagen, and Richard Tinning, University of Queensland, had the pleasure to open the first plenary (keynote) session. The Wednesday session entitled "Changes and Challenges for Physical Activity and Learning – Sustainable Movements and Movement Cultures" [PS-PL01] dealt with both **neurophysiological** (Nielsen) as well as **sociological aspects** (Tinning) of learning and physical activity. Nielsen presented an interesting overview of associations between physical activity and **motor learning and memory**. Mostly obtained from **animal studies**, available evidence suggests that exercise can facilitate learning/memory of cognitive and motor tasks. Weaker but still promising evidence has been found in **humans**. However, underlying physiological mechanisms remain unclear and longitudinal studies are still needed. The role of few neurotrophic factors that are released from active muscles and the nervous system during exercise including lactate, brain-derived neurotrophic factor (BDNF), noradrenalin, and dopamine was discussed. **Lactate concentrations** in exercise have shown interesting relationships with learning. However, it is still unclear whether lactate has a causal or coincidental role.

Aging and body functioning

Stephen Harridge, Kings College London, presented data on biological **aging and disuse of the skeletal muscle**. He explained cellular mechanisms that contribute to sarcopenia and a massive type-2 fiber decline. Decreasing motor units and infiltration of connective tissue and

fat into the muscle seem to account for this finding. A decrease of muscle force per unit area (specific force) may result. He also explained tracer techniques that enable the assessment of muscle protein synthesis. He presented evidence of reduced sensitivity to exercise and amino-acid feeding in the elderly. Recent experiments on **very active older people** revealed that muscle mass, function and quality can all be well maintained. Stephen Harridge stated that we need to reconsider our perceptions on the interactions between aging, exercise and physiological function. Dose-responsive ways of investigating exercise training in the elderly through studies in the long term are needed.

The Friday's plenary session was entitled "Exercise, energy intake, **brain health** and **well being**" [PS-PL03]. Mark Mattson from the Johns Hopkins University, School of Medicine (Baltimore, Maryland, United States) presented interesting data on the effects of **restricted energy intake** and exercise on brain health [PS-PL03]. His research group observed promising results in terms of intermittent energy restriction (for example, fasting for a period of 24 hours several times a week) and brain health. They assumed that energy restriction may lead to an elevated neuronal activity and energy demand resulting in a coordinated activity of signaling pathways that promote neuroplasticity and cellular stress resistance (involving brain-derived neurotrophic factor, mitochondrial biogenesis, DNA repair and removal of oxidative damaged proteins and organelles). Peripheral changes in energy metabolism (ketone bodies as alternative energy source may activate signaling pathways as well) could also contribute to such effects. It is especially interesting that vigorous exercise obviously causes similar effects. In terms of **neurodegenerative disorders** (e.g., Alzheimer's, Parkinson's) or acute brain injuries (e.g., stroke), neuroprotective and -regenerative effects have been shown mostly in **animal studies**. Further research in humans is needed in order to derive practical recommendations for maintaining, restoring or improving brain health.

Janice Thompson (University of Birmingham, England) held the second talk of this session, "Can exercise and physical activity optimize the well-being of populations?" [PS-PL03]. Although numerous researchers have examined **mental well-being** following acute and chronic exercise in small groups, only limited evidence on **community or population level** is available. She highlighted a lack of consistent definitions of well-being accompanied with the application of diverse questionnaires on well-being. Although rare data on well-being during the life span exist (with an undulating pattern through lifespan), little is known about whether ethnical and cultural differences affect the perception and assessment of well-being. She presented information about two ongoing multi-disciplinary interventions to optimize wellbeing of populations in Europe and the United States.

On Saturday 27 June the plenary session was entitled "**Inactivity** and the **ageing population**" [PS-PL04] and organized as a point-counterpoint debate. First, an impressive Stephen Blair showed evidence that increasing physical activity levels might be the key component for a healthy life and a high quality of life. People in most industrial countries have changed to a sedentary lifestyle. **Inactive people** have a two-fold higher risk for various health conditions compared to their active and well-trained counterparts. Steven Blair pointed out clearly that the population attributable risk factor "inactivity" accounts for 16% of deaths, far higher compared with other risk factors. Based on an enormous number of his own studies, Stephen Blair emphasized the need for physical activity in all settings of daily living (home, leisure time, at work). Societal, environmental and individual efforts are required to engage people in habitual physical activity.

The second talk of this plenary session was given by William Evans (adjunct professor at Duke University and vice-president of the Muscle Metabolism Discovery Performance Unit of GlaxoSmithKline). He argued about "**pharmaceutical drug development** as a key of offsetting age-related dysfunction and chronic disease". William Evans examined mainly **very frail seniors** who often do not exercise regularly or suffer from particular circumstances in which resistance exercise is either not appropriate or hardly applicable (e.g., bed rest after surgery). As skeletal muscle plays an important role for human health beyond its contractile properties, maintenance of muscle mass and function is crucial. A slow-down of age-related loss of muscle mass could be supported by

pharmacological treatment. A new generation of pro-anabolic therapies (including selective androgen receptor modulators, ghrelin, antagonists of the TGF-beta superfamily) might be effective to treat frail and weak elderly patients, particularly in situations of increased inactivity. This approach might enable a break of the cycle of inactivity, disability and ill-health.

Physical activity promotion – older adults

Numerous studies revealed that seniors are less physically active compared to their younger counterparts. Data from the "Norwegian Monitor on Social and Cultural Change" (from 1985 to 2013, collected every second year), presented by Fasting et al. [IS-SH 05] indicated that **Norwegian seniors**, particularly women, showed secular trends of **increasing physical activity** between 1985 and 2013. The largest increase was observed for the category "3 - 4 times physically active per week". Regular physical activity improves various cardiovascular risk factors and disease conditions. Very high dosages of lifelong physical activity could, however, attenuate these beneficial effects. This conclusion was based on very recent findings of O'Keefe and colleagues published this year in the Journal of the American College of Cardiology. A further talk by Maessen et al. [YIA, OP-PM02] investigated a group of 15-km **hill runners**. Lifelong physical activity exposure was measured by metabolic equivalents of task minutes (MET×min). **Cardiovascular risk** (1184 cases to 5285 controls) **and -disease** (133 cases to 4406 controls) cases were calculated as odds ratios. A high dosage of lifelong exercise did not significantly increase cardiovascular risk and -disease. This study, in turn, is not supporting an upper limit of exercise health benefits.

Biological aging is associated with telomere shortening. An interesting study on this topic was presented by a group coming from the University of Jyväskylä. Sillanpää et al. [OP-PM61] examined associations between mobility and **leukocyte telomere length** in **older women** during an 11-year follow-up period. They followed 386 twin sisters and measured telomere length (baseline), mobility (6-min walking test; baseline and 3-year follow-up) and physical activity (questionnaire; baseline, 3-year and 11-year follow-up). The main finding of this investigation was that leucocyte telomere length was associated with physical activity level at baseline, but does not predict mobility decline in older females.

Taylor et al. [OP-PM04] presented an interesting study entitled "Individual responses to a novel exercise intervention in **older adults** with multi-morbidity: A pilot randomized controlled trial". This study adds further evidence that **high-intensity training** is an efficacious approach to improve aerobic fitness in a clinical population of elderly people. The inspiring aspect of this study was the analytical approach, in which the authors quantified the individual responses to this training regimen. They applied linear mixed modelling to calculate the probability that the true population effect was larger than the minimal clinically important difference, the likely range for the true response (free from noise) in each subject, and the probability that each subject was a true responder. Researchers should be encouraged to apply such analysis more frequently in future.

From Michael Kjaer's group in Copenhagen (Bechshøft et al. [OP-PM04]) came an innovative study of **heavy resistance training** in 30 **very old individuals** (at least 83 years old). Muscle strength and mass were assessed before and after a 12-week training period. Participants were randomized into two groups. Both groups received a protein supplement and one group added high-intensity resistance training. Heavy resistance training improved muscle strength and power, whereas protein supplementation alone did not. However, the authors emphasized that "due to the physical strain caused by the training, subjects' health, expected gain and risk of injuries have to be considered thoroughly before applying a training regime like this in such very old subjects".

Pfister and coworkers [IS-SH06] from the University of Copenhagen pointed to a growing popularity of the "master games movement". They emphasized that strategies to promote physical activity of the elderly should also meet **seniors**' personal needs and interests. From a methodological viewpoint, Diketmüller [IS-SH05] claimed for a "geragogical" perspective of **exercise promotion programs** in order to better understand underlying self-concepts of physical activity and inactivity patterns in the elderly.

From a molecular perspective on sarcopenia as a key trigger of **strength declines during**

aging, Heisterberg and colleagues [OP-PM10] stated that satellite cells are important for the plasticity and regenerative capacity of the skeletal muscle. An aging-induced decline of satellite-cell function seems to be linked with an increased TGF-beta signaling. This mechanism was previously identified by Carlson et al. (EMBO Molecular Medicine, 2009). Blocking angiotensin II (by means of Losartan) in sarcopenic mice down-regulates TGF-beta and IGF-1 that might enhance muscle adaptation following exercise training. Twenty-six **elderly men** (64+ years of age) performed one bout of heavy one-legged resistance exercises comprising 5x12 repetitions of concentric work (70% of 1RM) and 4x6 repetitions of eccentric work (110% of 1RM). The authors did not find any effect of Losartan on the muscle response to acute exercise. The authors, however, stated that longer treatments and exercise periods might yield larger effects.

Beside heavy resistance exercise, high intensity aerobic exercise training has been successfully applied to **seniors**. Many exercise modes and systems enable the application of high exercise intensities. Also **double-concentric** (d-c) **multi-joint** exercise devices have been developed for this purpose: Hurst and colleagues [OP-PM49] examined the variability of the d-c device, in comparison to cycle ergometry. Twenty seniors completed a **HIT** protocol with 3 sets of 4 repetitions in both conditions. The work-rest ratio was 1:1 applying 75, 60, 45 and 30-s HIT sessions. Heart rate and expired gas exchange data were collected. Both systems did not differ in terms of acute cardiac and ventilatory response. It has been emphasized that future research should comparatively investigate the impact of d-c high intensity training on neuromuscular and cardio-circulatory outcomes. Regarding interventional effects of **high intensity interval training** (HIIT), Dideriksen and colleagues [OP-PM54] observed positive effects of HIIT (6 wk, 3 d/wk) on maximal oxygen uptake (↑2.5%) and body composition (visceral fat, ↓5.5%) in the **elderly**: 17 **healthy but overweight sedentary subjects** completed 5 x 60-s bouts of cycling at nearly 140% of maximal work load interspersed with 90-s recovery. Further HIIT research presented by Bruseghini and colleagues [OP-PM10] revealed that 8 weeks of **high-intensity cycling** (3 d/wk) at 90% of maximal oxygen uptake might reduce **muscle fat infiltration**. However, these data are still under debate and need to be elucidated in future studies using appropriate randomization procedures and adequate sample sizes.

Physical activity promotion – children

Since all **kids** have to attend school, schools are potentially the most important setting for physical activity promotion in children and youth. It is not surprising that school-based physical activity interventions were an important topic at this conference. An invited session [IS-PM14] covered interventions from three countries (Denmark, Norway and Switzerland). In summary, **school-based physical activity interventions** notably improve aerobic fitness, body composition and cardiovascular-risk parameters. A similar invited session dealing mainly with implementation issues was given at the ECSS conference in Amsterdam last year. This year's session focused on the efficacy of such approaches.

Japanese researchers presented an interesting study on "Associations between **various intensities of physical activity and physical fitness** in **adolescents**" [MO-PM01]. This mini-oral was awarded first place in the young investigators award. Physical activity was objectively assessed by accelerometers over a consecutive period of 14 days in 289 adolescents (age, 13 y). Adjusted logistic regression analyses provided odds ratios comparing physical activity quartiles. They found strong associations between physical fitness variables and vigorous physical activity in both sexes. This was however a cross-sectional study, so a causal relationship cannot be assumed. In a group of >100 **primary school children**, Bürgi and colleagues [OP-PM57] collected **physical activity intensity and location** via GPS and accelerometry. The rational of this study was to examine activity patters of children. They applied multilevel analyses and found that children spent 38% of their time at home, 27% at their own school, 1% at other schools and 14% on streets. Only 20 minutes (0.7%) were recorded in recreational facilities such as parks or sports fields. The authors summarized that streets and school grounds are meaningful locations to achieve the amount of recommended activity level. It seems that the school environment is more appealing to boys rather than girls in terms of physical active. The high use of streets might be an indi-

cator for active transportation that importantly contributes to an active lifestyle.

Another group from Japan reported interesting results on the relationship between **academic performance, obesity and fitness** level in 421 **children** (12 y old) [MO-PM14]. Associations between academic achievements (a summary score of eight school subjects) and obesity as well as physical fitness (particularly with aerobic fitness assessed by the 20-m shuttle run) were investigated. The authors also adjusted their analyses for socioeconomic confounders. Interestingly, physical fitness was mainly positively associated with academic achievements in boys, and body mass index was inversely correlated with academic achievement in girls.

Two interesting studies on **maximal oxygen uptake** in **pubertal children** were presented by researchers from Norway. Hetlelid and colleagues [OP-PM49] dealt with end criteria for reaching maximal oxygen uptake in 69 13-year old boys and girls during treadmill testing. As maximal oxygen uptake is the gold standard for assessing aerobic fitness, objective exhaustion criteria need to be achieved. Therefore, peak respiratory exchange ratio (RER), a VO_2 plateau, peak rating of perceived effort (RPE) and peak heart rate were assessed. They found that RER≥1.0 and RPE≥17 were fulfilled by 93% and 99%, respectively. Only 9% achieved a true plateau in VO_2 during the last two minutes of the test, whereas 52% achieved a levelling off in VO_2 during the same period of time. Thirty-five percent reached peak heart rate ≥95% of the age-predicted maximum. They concluded that voluntary exhaustion and RER≥1.0 as well as RPE≥17 serve as efficient end criteria for adolescents. Stricter criteria did not result in higher VO_2max values. Another Norwegian study employed **maximal oxygen uptake** measurements in a more applied setting. Riiser et al. [OP-PM 13] aimed at investigating correlations between change scores of maximal oxygen uptake and hemoglobin mass in 30 12- to 13-year old **schoolchildren** over one year. They found that changes in maximal oxygen uptake were highly correlated with a change in hemoglobin-mass (r=0.71). Changes in maximal oxygen uptake were also highly correlated with changes in muscle mass (r=0.74), but only moderately associated with changes in body weight (r=0.39). These anthropometric and fitness indicators (fitness has been assessed in a field setting here) can be used to assess the impact of living areas on health-related parameters. Such a study was presented by Tishukaj and coworkers [OP-PM57]. Three-hundred fifty-four 15-year old **adolescents** of the Kosovo region were cross-sectionally examined. Nearly 40% came from a rural environment and 60% from an urban area (Pristina). There was a high prevalence of **underweight** (14%) and **overweight** (24%) adolescents. Rural or urban environments had no influence on anthropometric variables and only a modest and controversial impact on physical fitness. The reasons for these findings remain speculative and could be socioeconomic conditions, access to sports facilities, and differences in general lifestyle behavior.

Two further exemplary randomized controlled trials in obese children investigated the effects of 12 weeks of school-based aerobic and resistance training on inflammatory markers, cardiorespiratory fitness and physical activity in obese girls. The first study of Lopes et al. [OP-PM58] investigated 33 **obese girls** between the age of 14 and 15 years. They observed significant decreases of **leptin** levels after the training period. However, most inflammatory cytokines and acute phase factors remained unchanged. It seems that the power of the study and baseline variation of cytokines require a larger sample size to address inflammatory changes with more certainty. The second controlled trial was done by Batalau and colleagues [OP-PM58]. The authors enrolled 77 **obese primary school children** from Portugal. The intervention group completed a **physical-activity intervention** with three meetings **for children and parents**, an additional 1-hour activity class and six educational sessions related to physical activity. The control group had no intervention. The intervention group performed a higher amount of moderate activity. Similar results were found for vigorous activity. No differences were found between groups in sedentary behavior breaks.

Neuromuscular performance during lifespan

Beside well-developed cardiorespiratory fitness, appropriate neuromuscular function affects adequate functioning in sports and daily life. The majority of the presented studies on neuromuscular performance measured either

tendon properties during aging, postural control of human standing (including viscoelastic and electrophysiological contribution), and indices of strength or power (e.g., rate of force development) in cross-sectional and longitudinal study designs. Interesting new methodological insights were provided: One invited symposium [IS-BN06] dealt with tendon properties and adaptations during the process of aging and following exercise training. Researchers coming from the Norwegian School of Sport Sciences and the University of Jyväskylä talked about **tendon responses to exercise** and stress as well as **aging-induced changes of tendon** properties. As connecting and transmitting tissue (e.g. tendons) have been reported to increase blood-flow and glucose uptake in response to loading (based on work of the presenter), the presentation of Bojsen-Moller reviewed the existing knowledge on **tendon response** to loading of **habitual exercise training**. It has been mainly summarized that low-intensity loading increases intra-tendinous glucose uptake in the Achilles tendon, regular loading can cause tendon hypertrophy and stiffens the human patellar tendon, and region-specific adaptations are dependent on load character. The second talk held by Seynnes (also Norwegian School of Sport Sciences) focused on the relationship between **mechanical tendon properties** and **daily stress level**. Previous studies suggested that tendon cross-sectional area is linked to daily stress levels. Seynnes stated that these findings are based on models including tendon morphology as a modulator variable to daily stress. However, these findings are inconsistent in terms of **human** tendon hypertrophy in training studies on the other hand. His findings were obtained from **animal studies** and in vivo tendon testing. The final speaker in this symposium (Stenroth, University of Jyväskylä) reviewed literature on the similarities and differences between the effects of **aging and disuse**. The functional impact of tendon adaptations related to aging and disuse were discussed on the basis of findings that emphasized that tendons do adequately respond to strength training even in old age. It seems that collagen and non-collagen factors affect these modifications. It has been also emphasized that very recent studies (Thorpe et al.; Depalle et al., both 2015) on tendon micromechanics showed a link between tendon matrix factors and tendon properties. This association might explain possible alterations in load transmission within tendon structures due to aging or disuse.

Two interesting studies from Japan examined viscoelastic contribution to human standing. The first study presented by Tomida et al. from Kyoto University [OP-BN01]. He calculated a viscoelastic ellipse from the **ground reaction force** signal in a small group of five subjects. The length of the ellipse represents the magnitude of maximal stiffness and viscosity. Their findings indicate that human standing has relatively large viscoelasticity components in the anterior-posterior and medio-lateral directions. Interestingly, most muscles had their preferred stiffening directions in the diagonal directions. However, further research on validity and reliability in larger sample sizes are needed to verify this methodological approach. These ideas have also been included into models on **viscoelasticity and joint control** strategies [Tanabe et al., OP-BN01]. This study showed for the first time that joint viscoelasticity and each viscoelasticity parameter in a **model-based approach** contributes to a reliable control strategy resulting in a robust model fit. Thereby, a quadruple inverted pendulum with intermittent control (as a model of tiptoe standing in the sagittal plane) was created.

From a perspective of strength testing and training during the life span, maximal strength measures have been frequently collected in order to predict functional performance or fall risks in the elderly. In this regard, the ability to produce power rapidly has gained increasing interest during the last few years. A symposium this conference [IS-BN09] focused on functional relevance of explosive muscle strength, factors that influence rate of torque development, and the response of force production to acute exercise and physical training. Briefly, Folland et al. emphasized that reliable assessments of **rate of force/torque development** require high sampling rates, a clear purpose (functionally related to the sport background, multi-joint vs single-joint depending on the purpose, fast or explosive contraction), clear feedback and multiple attempts in isometric settings. Blazevich et al. nicely summarized that the **rate of force development (RFD)** is influenced by **monoaminergic drive** from supraspinal centers (locus coeruleus, raphe nuclei) and afferent feed-

back alteration (stretch-sensitive receptors) via the Ia feedback loop. He stated that a combination of Ia activity and a meaningful monoaminergic drive might provide a perfect condition for fast rates of muscle activation. He doubted the importance of tendon stiffness for a fast RFD. In line with other studies on force transmission through the tendon, transmission time of a few milliseconds seems to be too small to have meaningful impact on the RFD. Maffiuletti et al. from the Schulthess Clinic in Zürich ended up with a comprehensive summary on the effects of **physical training on RFD**. He suggested that strength and plyometric-type training elicit meaningful RFD improvements. However, heavier and slower strength training approaches also cause notable improvements in RFD. These newer findings seem contradictory to the common understanding of RFD training (fast, explosive with lower weights). Nevertheless, he emphasized that RFD training has been successfully conducted in **various populations** (e.g. clinical, elderly, child, injured) including strength, speed, plyometrics and muscle stretching.

Postural control also serves as a key measure of neuromuscular performance. Postural control can be investigated under static (e.g., upright standing) and dynamic (e.g., gait) conditions. The control of standing balance relies on spinal and supraspinal input. Electrophysiological measures and data obtained from force plates allow assessment of postural steadiness and complexity. In addition to previous investigations of unstable shoes on proprioception (e.g., B. Nigg), the study of Buchecker and Müller [OP-BM08] aimed at investigating the complexity of **center of pressure** (COP) signals through quantifying the fractal- and entropy-based indices and multi-scale entropy calculations (based on Duarte and Stenard, 2008). Therefore, 29 **healthy men** were tested in bipedal standing wearing an "M-walk" MBT shoe and a flat shoe. Interestingly, unstable shoes caused postural responses closely related to the dynamics of a "random" walk with numerous, active postural adjustments. This finding can be explained by the fact that COP deviations occurred along smaller time-scales with more predictable sequences.

A study of the Baudry Group (Johannsson et al.) at the University of Brussels showed that postural threat affects **postural control during upright stance** in **younger and older subjects** [OP-BN10]. Spinal and corticospinal excitability was measured in 12 young (25 y) and 9 elderly (70 y) adults. They found decreased H-reflex amplitudes during upright stance facing the stairs. The background EMG did not change. These findings suggest increased presynaptic inhibition of muscle spindle pathway that decreases reflex activity, impairing balance during postural threatening conditions. Elderly people, however, are still capable of modulating muscle-spindle pathways, depending on standing conditions. Absence of a motor-evoked potential did not support an increase of corticospinal contribution to control upright standing when postural threat is increased. Penzer et al. (also from the Baudry Group) observed in 15 **young** (~23 y) **and** 14 **elderly adults** (~70 y) that the contribution of **vision and proprioception during postural control** differs with age. They found that age-related impairments of the somatosensory system (Shaffer and Harrison 2007) decreased depending on the muscle spindle afferents. They indicated a shift toward a greater reliance on visual information to control balance in elderly adults. A German group from the University of Konstanz further examined whether **balance** is a set of specific skills or a general ability [OP-PM51]. This is a relevant question in order to adequately design balance training programs and to address whether training adaptations are task-specific or of a general nature. Two intervention groups of **young, healthy students** completed six training sessions on two different balance training devices (one device in each group). They were compared with a control group. Participants were tested before and after the intervention in the trained tasks as well as in two additional untrained tasks on the applied devices. The researchers observed highly task-specific training effects and no transfer effects, and they concluded that balance should be considered as a set of specific skills rather than a general ability. These findings have been recently accepted in the journal Human Movement Science and are in line with findings of the Basel group in Switzerland (Donath et al. 2013 to 2015).

Beside postural control measurements during upright standing, gait analyses also contribute to a better understanding of impaired dynamic balance resulting in a higher risk of falls. Therefore, various temporal and spatial parameters

(e.g., stride length, width and variability) serve as promising fall risk factors. Higher asymmetry during gait and leg strength has been also shown to differentiate between fallers and non-fallers. In a further step, Hammes and coworkers (Basel group) investigated the association between **asymmetry indices of strength, gait and balance** parameters [OP-PM60]. They found that plantar flexion force and RFD showed a meaningful link to gait and balance asymmetries and variability in 48 **healthy seniors**. He concluded cautiously that the development of symmetric strength might be a strategy to improve gait and balance performance leading to a reduced fall risk.

Team sports for health

The Danish research group of Krustrup et al. has focused on health benefits of **recreational football**, with 70 scientific publications in the last six years. In his talk [IS-PM08], he summarized results from studies dealing with the **prevention of chronic diseases**. Small-sided games (3v3 to 7v7) have been shown to be very efficacious on a broad spectrum of fitness and health parameters. The character of small-sided games combines elements of high-intensity interval training, traditional endurance training as well as strength training. These games elicit notable effects on cardiovascular function, muscle mass and function, postural control and bone health. Those effects have been shown in **healthy populations** and clinical populations (e.g. hypertension, type 2 diabetes and prostate cancer).

Motivational aspects of football might be a big advantage compared with more traditional exercise programs. Recreational football and the application of football programs targeted for specific population has great potential to achieve public health benefits. Krustrup also mentioned possible negative effects of football, such as **injury risk**, but studies are scarce. In this regard, the risk-benefit ratio of exercise programs should be considered in future research, not only for football programs but also for exercise programs in general.

Hunt et al. from the University of Glasgow investigated the motivational aspect of playing football [IS-PM08]. Research has recognized the importance of gender differences in sport participation and health-promoting interventions. In this regard, football-based organizations may be utilized to engage **"hard-to-reach" men**. Hunt et al. developed a comprehensive health and fitness program called **"Football Fans in Training" (FFIT)** that includes individual and group-based physical activity as well as behavioral change techniques. The pitch-side group-based physical activity conducted by football coaches includes "normal" aerobic, muscle strengthening, and flexibility training, but not playing football itself. Nevertheless, in terms of participation, the implementation of such a program through a football organization seems highly effective. A large randomized-controlled trial with 747 Scottish men proved the effectiveness of FFIT on weight-loss. This study demonstrated the potential power of football in terms of health-promoting strategies (including cultural and sociological aspects).

As mentioned above, extensive research during the last decade has shown that small-sided football training represents a multimodal, motivating and health promoting exercise intervention. Evidence for other team sports in this regard is currently scarce. A Danish work group (Vorup et al.) is investigating the effects of 12 weeks of **floorball** training on **body composition** in **elderly untrained men** [OP-PM61-03]. This study is still in progress, but preliminary data indicated that floorball training has the potential to reduce body fat in elderly untrained men. We are curious about the final publication of these data and whether these preliminary results can be confirmed.

Injury prevention

Goossens et al. [OP-PM33-4] presented an interesting study entitled "A **multifactorial injury prevention** program in **physical education teacher** education students: Process evaluation using RE-AIM". A randomized trial was conducted on curriculum managers, sports lecturers and students from the Physical Education Teacher Education (PETE) programs. Changes in self-reported behavior, autonomous motivation and knowledge were measured through questionnaires. Sports lecturers tended to have a greater increase following the intervention than the control group for the delivery of dynamic stabilization and functional strengthening. Static stretching, dynamic stabilization and core stability were used most often by sports lecturers of the intervention group, while students in

the intervention group had a greater increase in knowledge.

Shoes with motion control systems (MCS) are usually recommended for **runners** with pronated feet. Malisoux et al. [OP-PM33-2] investigated whether runners using shoes with MCS sustain fewer running-related injuries than runners using neutral shoes. They applied a double-blind randomized control design. Training and injury data were collected over 6 months using an internet-based platform. An adjusted Cox regression analysis revealed that runners from the MCS group had a lower hazard rate for running-related injuries. When participants were stratified by **foot morphology** only those runners with pronated feet beneficiated adequately from MCS shoes.

Physical activity and cognitive function

On Friday 26 June an invited symposium entitled "Effects of exercise on **brain function**, learning and memory" was held. Aberg et al. [IS-PM04] from the University of Gothenburg, Sweden presented data from a large **population-based** cohort study. Over 1.1 million of Swedish male participants were longitudinally examined for up to 42 years. This enormous dataset was collected from **cardiovascular** and **cognitive tests** during the recruitment exams for Swedish military service. Data collection was linked to a national database for information on school achievement, socioeconomic status and hospital registers. The authors showed that fitness and cognitive function are positively correlated, and that this association is not determined by genetic factors. Poor physical fitness in younger years serves as a promising predictor for the risk of depression, suicide, epilepsy, stroke and dementia in later life. Despite these strong data, only an observational design has been applied. Intervention studies in this area are still scarce.

Mogensen et al. from the University of Copenhagen, Denmark [IS-PM04] provided insights on effects of **exercise on neural processes** after traumatic and vascular **brain injury**. His overview elucidated the lack of a comprehensive understanding of underlying physiological mechanisms. He emphasized the importance of research on exercise timing, the optimal intensity, and the mediating role of stress in terms of developing effective rehabilitation measures. As many data were obtained from animal studies, a valid transfer to humans represents a notable research challenge. Research in humans inherently contains methodological issues, such as adjusting for the type and severity of injuries, but also for cognitive parameters used in studies.

Finally, Lundbye-Jensen (University of Copenhagen) presented various intervention studies on humans focusing on **neuroplasticity** and **memory** including **motor skill acquisition** [IS-PM04]. Besides exercise intensity, he also reported on **exercise timing**. Interestingly, one bout of aerobic exercise after motor skill practice resulted in greater improvements than aerobic exercise before motor skill practice, and both strategies were superior to a control condition without any aerobic exercise. Although these results provide important information for practical applications, it has to be kept in mind that most of the studies dealt with acute or short-term exercise effects. Longitudinal studies are needed in future. To summarize this session, physical activity stimulates cognitive functions. Underlying mechanisms and the optimal design of exercise programs are interesting topics for further research.

Several other presentations on exercise and cognitive function during the life span were scattered through the conference. It seems important to consider specific age groups, and populations. For instance, Swinnen and colleagues (Movement Control & Neuroplasticity Research Group, KU Leuven, Belgium) emphasized different **brain activation levels** of older adults compared to young adults [IS-BN05]. Functional magnetic resonance imaging (fMRI) studies indicated that **older adults** showed an increased **cognitive control of motor coordination** tasks. This elevated activation was considered a compensatory strategy. Exercise might then serve as an effective strategy to reduce the activation level through training-induced neuroplasticity.

Aadland et al. [MO-SH09] showed that physical activity, motor skills and cardiorespiratory fitness are associated with **executive function** in 10-year-old **children**. The observational study design does not allow the conclusion that "training of motor skills is similarly important as general physical activity and increased cardiorespiratory fitness in order to improve cognitive function". An intervention study by Hartman et al. [MO-SH09], however, showed that a

primary school-based physical activity program (22 weeks, 3 d/wk for 20-30 min) led to greater improvements in **mathematical test scores** compared to a control group.

Occupational health promotion

Dalager et al. presented a randomized controlled trial that investigated the effects of **personalized high-intensity training** programs on musculoskeletal health in **office workers** [OP-PM02]. The training group showed improvements of muscle strength and reductions of musculoskeletal pain compared to the reference group. The authors concluded that individually tailored high-intensity training during working hours can reduce musculoskeletal neck as well as shoulder pain and can improve muscle strength. Whether companies will implement high-intensity training during working hours (is the health of their staff a sufficient reason?) seems doubtful. Economic cost-benefit estimations (e.g., return on investment, presented by van Mechelen, University of Amsterdam) may be required to convince companies (see below).

A very comprehensive session on health-enhancing physical activity interventions at the workplace was held by a group of extremely distinguished researchers in this field [ISBN03]. Søgaard et al. introduced the fact that many occupational sectors have **employees** with high **physical workloads**. In contrast, their **leisure-time physical activity** levels might not be health enhancing. In line with Dalager and coworkers, she emphasized that work exposure and the exercise profile should be analyzed and conceptualized on an individual basis. Ainsworth et al. provided an entertaining and precise talk on the **history of physical activity assessment and** its **future implications**. She emphasized that an improved estimation of **occupational** demands can be provided by assigning MET values to job tasks and classification systems. As job profiles and titles change over time and increased emphasis is placed on the impact of sedentary behaviors on health, the MET-based classifications must be updated to cover today's occupations. Van Mechelen at al. presented **workplace physical activity interventions** from a **cost-effectiveness** perspective. He emphasized that companies should be informed about effects of such interventions on productivity, sick leave and the overall economics of a sustainable work environment. Financial benefits should be scientifically evaluated in order to influence politicians and policy makers. He stressed the fact that costs of the program should be minimized in order to make them efficient. The return on investment varied between the approaches, but the financial backflow on every invested dollar or Euro was notable. The fun and, in turn, sad fact of his presentation was that all his meetings with politicians (on the basis of a couple of these findings) did not go well. He summed up that politicians seemingly do not have a good memory and conscience.

Obesity, body composition and metabolism

Whole body **cryostimulation** has received increasing attention as a potential means of recovery support in high performance sports. Although under extensive debate, the myokine "irisin" seems to play an important role in the regulation of human metabolism. Extremely low temperatures may induce a similar release of irisin as compared to exercise. Thus, Ziemann and colleagues evaluated the effect of 10 sessions of cryostimulation (3 min at -120 °C) in **middle-aged obese men** [OP-PM11-4]. The authors found no effect on irisin concentrations. However, a decrease of pro-inflammatory proteins was observed. This anti-inflammatory effect might be more relevant compared to the expected metabolic and thermogenic effects in the investigated population.

Brown et al. systematically reviewed **healthy weight interventions** in **primary school children** [OP-PM58-3]. The review included 18 randomized and non-randomized controlled trials. School-based studies that aimed at improving BMI through increasing physical and improved dietary habits were included. The authors concluded that school-based interventions that involve multiple environmental, educational, and physical strategies–and not education only–appear to most likely result in BMI reductions. This fact is not new, as lifestyle interventions are known to be important in reducing and managing overweight in the long-term. Compliance is therefore considered the most crucial component in lifestyle interventions. Jørgensen et al. studied whether maintaining **weight loss** is associated with a better compliance to a **lifestyle intervention** as compared to weight regain [OP-PM03-2]. A 10- to 14-wk lifestyle intervention focused on diet and

physical exercise was applied. The cross-sectional follow-up examination took place 5 y after the intervention. As expected by the researchers those **men** who maintained their weight loss had a higher lean mass-adjusted VO_2peak and a higher mitochondrial oxidative capacity. In **women**, however, no differences between those who maintained and regained weight were observed.

Søgaard reported on the effects of **high-intensity training** on **insulin-mediated glucose uptake** in 13 **overweight and sedentary older adults** [OP-PM20]. VO_2max, glucose infusion and clearance rates increased as a result of the training. Improvements were more pronounced in men. This study lacked a control group and was based on a small number of participants. However, the findings are promising, and larger randomized-controlled trials are warranted. In conjunction with the results of Jørgensen et al., gender differences in metabolic and oxidative adaptations to exercise seem to be a further topic for future research.

In conclusion, this anniversary ECSS conference confirms an impressive scientific development of the comparatively young European College of Sport Science. Many experts coming from all over the world contributed to an outstanding and broad scientific program of high quality and meaningful impact. We are looking forward to visit Vienna for next year's conference, July 6-9, 2016.

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