

# XXXIII FIMS World Congress of Sports Medicine and Canadian Academy of Sport and Exercise Medicine, From Prevention to Performance, June 18-21, 2014, Quebec City, Quebec, Canada

## Research Presentation Abstracts

### Podium Presentations

Thursday, June 19, 2014

Topic: *General*

#### 9:30 AM—Double Blind Randomised Controlled Trial: Injection of Autologous Blood for Chronic Patella Tendinopathy

Peter Resteghini, PhD, Tamim Khanbhai, MBBS, Shabaaz Mughal, MBBS, MSc, and Ziali Zivardeen, BMedSci

*Affiliation: Homerton University Hospital, London, United Kingdom.*

**Objective:** To determine the efficacy of Autologous Blood Injections (ABI) against saline injections in chronic recalcitrant patella tendinopathy.

**Study Design:** Double blind randomized controlled trial.

**Subjects:** We recruited 22 patients (18 males, 4 females) over the age of 18 years (range 22-61 years) with a diagnosis of refractory patellar tendinopathy between March 2010 and March 2012. All patients had an ultrasound examination to confirm diagnosis.

**Intervention:** Using 2 practitioners, patients were randomized to either receive 2 mL of autologous blood or saline injections, with the practitioner injecting blinded to the substance being injected. All patients were given a standardized eccentric exercise program.

**Outcome Measures:** All patients completed the McGill Pain Questionnaire—short form (MPQ), Visual Analogue Scale for pain (VAS), and the VISA scale. All patients were followed up at 6 weeks, then 3, 6, and 12 months with repeat assessments.

**Results:** Of the 22 patients identified, 11 were randomized to the autologous blood (ABI) group and 11 to the Saline group. The ABI group had a mean duration of symptoms of 16.7 months whilst those in the Saline group were 19.2 months. Following the intervention, the Saline group mean VAS score was reduced from 7.9 to 4.5 ( $P = 0.003$ ) at 1 month and 3.3 ( $P = 0.005$ ) at 1 year. With ABI, the score was reduced from 7.5 to 4.5 ( $P = 0.005$ ) at 1 month and 3.1 ( $P = 0.003$ ) at 1 year. VISA scores improved in the Saline group from 19.6 at baseline to 48.6 after 1 year ( $P = 0.005$ ) and in the ABI group it was 34.1 at baseline improving to 62.5 after 1 year ( $P = 0.003$ ). MPQ scores also improved and were statistically significant in both groups. Importantly, there was no statistical difference at any stage in comparisons between the Saline and ABI groups.

**Conclusions:** This study demonstrated that there was no statistical difference between autologous blood and saline injections. Both groups of patients had an improvement in symptoms leading us to conclude that the needling effect may be accounting for this improvement.

**Acknowledgements:** We are grateful to the Sports & Musculoskeletal Department in Homerton University Hospital.

#### 9:45 AM—Overuse Injuries of Amateur Cyclists Preparing for a 94.7-km Challenge

Dina C. Janse van Rensburg, MD, Alta Van der Walt, MBChB, Lizelle Fletcher, PhD, Catharina C. Grant, PhD, and Audrey Jansen van Rensburg, MSc

*Affiliation: University of Pretoria, Pretoria, Gauteng, South Africa.*

**Objective:** The aim of this study was to investigate and summarize the overuse-cycling injuries during the preparation for the 2012 Momentum 94.7 Cycle Challenge race.

**Study Design:** A retrospective questionnaire.

**Subjects:** All amateur cyclists who entered for the race were allowed to complete the questionnaire.

**Intervention/Observation Technique:** The questionnaire was sent out by the Momentum 94.7 Cycle Challenge race organizers 10 days before the event. The e-mail explained the aim of the study and asked all amateur cyclists older than 18 years to go to the Web link provided to complete the questionnaire. The questionnaire was voluntary and anonymous and participants had the option to abandon the questionnaire at any time.

**Outcome Measures:** The data analysis consisted of frequency tables and cross tabulations to summarize the information. Chi-square tests were conducted to assess the relationship between training habits and injury profile. A multinomial logistic regression was performed to model the relationship between injury and the various factors (eg, sex, training habits) and the covariate (age).

**Results:** It would appear that there is a higher incidence of injuries in females than in males. Only wrist injuries or problems were slightly more common in males than females. Results indicated that the 18 to 20 year age group had a higher incidence of buttock/perineal, hip and knee problems compared to other age groups.

**Conclusions:** There is a need for proactive injury preventing exercise programs designed for women and young (18-20 years old) amateur cyclists.

#### 10:00 AM—Validation of the 3-Step Return to Play Decision-Making Model

Ian Shrier,<sup>1</sup> Gordon O. Matheson,<sup>2</sup> Mathieu Boudier-Riv  ret,<sup>3</sup> Russell J. Steele<sup>4</sup>  
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**Objective:** To examine the validity of the 3-step return to play (RTP) decision-making model recently proposed for sport medicine.

**Study Design:** Crossover study design.

**Subjects:** Clinicians involved in RTP decisions.

**Intervention/Observation Technique:** We provided clinical vignettes of injuries and illnesses in athletes to participants through an online survey. Each vignette included examples of 3 factor types: increasing injury severity, changing risk associated with sport (eg, different positions), and changing noninjury risk factors (eg, financial considerations).

**Outcome Measures:** For each vignette, participants indicated the level of activity restriction they would recommend (No Restrictions, Modified Game Activity, Full Practice Only, Modified Practice Only, Strength & Conditioning Only, No Activity) in accordance with the risk they placed on continued

participation with that condition. We analyzed the data using multiple logistic regression, adjusting for the correlated participant outcomes, to measure how changes in factors affected individual participants.

**Results:** As expected, we found that clinicians increase restrictions as injury severity increases. We also found that changing factors related to sport risk and changing factors that are unrelated to sport risk will affect RTP decisions, although the effect is context-dependent and does not occur equally across all injury severities and clinical cases. The effect was also observed in each subgroup examined that included sex, age, specialty, region of training, academic status, and years of experience making RTP decisions.

**Conclusion:** Our findings that clinicians from a wide variety of backgrounds will change RTP recommendations based on clinical vignettes with changing injury severity, sport risk modifiers, and decision modifiers provides evidentiary support for the 3-step model for RTP decision making recently proposed.

### 10:15 AM—Urinary Incontinence in French Elite Female Athletes: Prevalence and Impact on Performance

Carole Maître, MD, PhD,<sup>1</sup> Marion Guillaume, MSc,<sup>2</sup> Jean-Robert Filliard,<sup>1</sup> PhD, Alain Frey, MD, PhD,<sup>1</sup> and Jean-François Toussaint, MD, PhD<sup>2</sup>

*Affiliation:* <sup>1</sup>French National Institute of Sport, Expertise, and Performance (INSEP), Medical Department, Paris, France; <sup>2</sup>Institut de Recherche en Biomédecine et Epidémiologie du Sport, Paris, France.

**Objective:** First, to investigate the prevalence of stress and urge urinary incontinence in French elite female athletes. Second, to assess the incontinence impact on performance. Third, to examine whether there is a correlation between urinary incontinence and the years of training.

**Study Design:** Observational cohort study.

**Subjects:** Four hundred four nulliparous elite female athletes (mean age = 21.4, SD = 4.43) divided into 3 groups: sports with high dynamic component (SHDC), sports with high isometric abdominal contraction (SHIAC), and technical sports (TC).

**Intervention:** All participants completed an anonymous questionnaire that included: (1) training history, (2) a diagnostic part which distinguished urge and stress incontinence and that included several trigger factors (K Bo Test), and (3) a qualitative part providing information on the impact of incontinence on daily activities, sexuality, training, and competition.

**Outcome Measures:** Chi-squared tests were employed.

**Results:** First, the response rate to the questionnaire was 89%. Second, the prevalence of stress and urge incontinence was, respectively, 72% and 52% ( $P < 0.05$ ) in these young athletes irrespective of their sport group. More specifically, we observed a prevalence of 35% of stress incontinence (SI) and 30% of urge incontinence (UC) for SHDC, 24% of SI and 16% of UC for SHIAC, and 13% of SI and 6% of UC for TC. Third, the most frequent trigger factors of SI were jumping (20.5%), running (17%), performing abdominal muscle exercises (15%), and landing (12%). Fourth, the incontinence discomfort was perceived as important for 27% of the athletes in competitive situations and as moderate to unimportant for 62% of them in daily training situations. Finally, no correlations between the years of training and SI/UC prevalence were found for SHDC and TC. Conversely, a positive correlation was revealed for SHIAC at  $P < 0.0002$ .

**Conclusions:** The urinary incontinence prevalence is important in young elite female athletes and the incontinence pathology is perceived as a nuisance in competition. It is good to have in mind that this pathology is a handicap for these women. The results of the present study also underscore the need for a national incontinence prevention program.

Friday, June 20, 2014

Topic: *Concussion*

### 9:30 AM—Baseline Concussion Assessment Using ImPACT in Varsity Athletes: Identification of Potential Risk Factors

Nicole Lemke CAT (C), MSc,<sup>1</sup> Constance M. Lebrun, MPE, MDCM, CCFP, FACSM,<sup>2,3</sup> Martin Mrazik PhD,<sup>4</sup> Joan Matthews-White CAT (C), PhD,<sup>1</sup> Dhiren Naidu, MD,<sup>2,3</sup> and Abhaya Prasad, MSc

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**Objective:** To identify potential variables through the computerized neurocognitive Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) at baseline that might predict higher incidence of sport-related concussion.

**Study Design:** Prospective cohort.

**Subjects:** Three hundred fifty-seven varsity athletes (217 males and 140 females) in contact and collision sports (hockey, football, rugby, soccer, basketball, and wrestling) at the University of Alberta.

**Intervention:** Athletes completed preseason baseline concussion screening using ImPACT over 3 varsity seasons, from 2010-11 through 2012-13.

**Outcome Measures:** The outcome measures were baseline composite scores from ImPACT (verbal memory, visual memory, visual motor speed, reaction time, and total symptom score or TSS), postconcussion symptom clusters (migraine, cognitive, sleep, and neuropsychiatric) and sport-related concussions incurred over the 3 varsity seasons.

**Results:** During the 3-year period, 73 (51 males and 22 females) athletes suffered a sport-related concussion. Multivariate logistic regression models were used to compare athletes who scored at or below the lowest 10<sup>th</sup> percentile on baseline composite scores and postconcussion symptom clusters compared with athletes who scored above the lowest 10<sup>th</sup> percentile on ImPACT. Female athletes who scored at or below the lowest 10<sup>th</sup> percentile on the visual memory composite score were 4.4 times more likely to suffer a future sports-related concussion. None of the postconcussion symptom clusters were significant for a risk of future concussion in either male or female athletes.

**Conclusions:** In this study, visual memory at baseline on ImPACT testing did help to identify female varsity athletes who went on to suffer a concussion. None of the baseline composite scores identified male athletes who were at risk for a future concussion. The postconcussion symptom clusters at baseline also did not identify athletes at risk for a future concussion. ImPACT is a valuable tool for distinguishing subtle neurocognitive deficits, both at baseline and when making return to play decisions and may identify athletes at risk for a concussion. However, sport medicine professionals should be aware of the limitations of this tool and instruct all athletes in concussion prevention strategies.

**Acknowledgments:** The Canadian Academy of Sport & Exercise Medicine and the Sport Science Association of Alberta for their generous support in research grants.

### 9:45 AM—The Relationship Between Exercise-Induced Elevations in Cerebral Blood Flow Velocity and Headache Following Sport-Related Concussion

Katelyn R. Marsden, BHK,<sup>1</sup> Bradley J. Monteleone, PhD, MD,<sup>1</sup> Philip N. Ainslie, PhD, and Paul van Donkelaar, PhD<sup>1</sup>

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**Objective:** Exercise frequently results in exacerbation of symptoms following a sports-related concussion (SRC). Despite the well-documented characterization of symptoms following an SRC, the mechanism underlying symptom exacerbation following physical exertion is not well understood. It was hypothesized that changes in cerebral blood flow (CBF) velocity would correlate with symptom exacerbation during mild-to-moderate exercise following an SRC.

**Subjects:** Sports-related concussion group—7 subjects (6 male, age 19 ± 2 years, BMI 26 ± 3 kg/m<sup>2</sup>; 1 female, age 19 years, BMI 25 kg/m<sup>2</sup>). Control group—6 subjects (5 male, age 20 ± 3 years, BMI 25 ± 5; 1 female, age 21 years, BMI 22 kg/m<sup>2</sup>).

**Study Design:** Cross-sectional.

**Intervention:** Measurements were performed on Days 3, 7, 14, and 30 post-injury for the SRC group.

**Outcome Measures:** Blood velocity was monitored using transcranial Doppler targeting both the middle and posterior cerebral arteries (MCAv and PCAv). Exercise was performed on a stationary bike at 30% and 70% predicted heart-rate-reserve (HRR) for 2 to 3 minutes and changes in MCAv and PCAv were compared to baseline at rest. Symptoms were evaluated using SCAT2 pre- and postexercise.

**Results:** Throughout mild-to-moderate exercise, there was a significant increase in both MCA and PCA velocity ( $P < 0.0001$ ), but there were no group differences. There was a significant effect of day on both number of symptoms ( $P < 0.01$ ) and symptom severity ( $P < 0.01$ ) reported pre- and postexercise. There was no significant relationship between the changed unit score of both 1) total number of symptoms, and 2) total summation of symptom severity against relative change in MCA or PCA velocity at 70% HRR. However, when compiling all the individual data across each testing session and the changed unit severity score of each individual symptom was compared to the relative change in PCA and MCA velocity at 70% HRR, there was a significant relationship between headache and MCA velocity ( $\rho = 0.690$ ;  $P < 0.001$ ).

**Conclusions:** Exercise-induced alterations in CBF velocity may have an important role in the exacerbation of headache following an SRC as the exercising brain may be less capable of buffering surges in blood pressure and is more vulnerable to mild over-perfusion. This study demonstrates that CBF velocity monitoring is both sensitive and feasible to monitor changes following SRC.

**Acknowledgements:** CASEM Research Grant.

#### 10:00 AM—Relationship Between Beliefs About Protective Equipment and the Risky Behaviour in Rugby Players

Besik Chaduneli, MD, and Milciades Ibanez, Msc

*Affiliation: University of Rosario, Bogota, Colombia.*

**Objective:** To determine the relationship between beliefs about protective equipment and the risky behaviour of Bogotan rugby players.

**Study Design:** Cross-sectional study.

**Subjects:** Two hundred eighty-two rugby players with mean age of  $24.2 \pm 4.4$  years from the Bogota Rugby League (228, 80.85% males and 54, 19.15% females).

**Observation Technique:** A questionnaire was designed. The players were asked about the protectors they use and if usage affected their behaviour. Also, the level of knowledge about the concussion prevention and the risk compensation was investigated.

**Outcome Measures:** The principal outcome measure was to estimate the risk compensation using protective equipment. Basically, we focussed on concussion prevention. Significance was established at 0.05 using associations of Chi square of Pearson or Fisher exact test exact and the Mann-Whitney test.

**Results:** To the question "Which protector can protect from the concussion," 76.7% responded "Headgear," 25.8% "Mouthguard," less than 6% other protectors, and 17.6% responded "None." Players with more experience predominantly responded "None," and those with less experience predominantly marked some protector ( $4.76 \pm 5.47$  years, med = 4 vs  $3.64 \pm 4.02$  years, med = 2,  $P = 0.034$ , Mann-Whitney test).

A total of 52.9% of the players reported tackling harder than usual while using protectors, and 29.8% reported increasing collision force if the tackle opponent uses protectors.

Players with less experience reported increasing tackling force while using protectors, compared with more experienced players ( $3.40 \pm 3.43$  years, med = 2 vs  $4.53 \pm 5.01$  years, med = 3,  $P = 0.05$ , Mann-Whitney test).

Only 4.6% considered that protectors could increase the injury risk. Among them were those with more experience and who were older ( $8.92 \pm 8.58$  years, med = 6.75 vs  $3.65 \pm 3.88$  years, med = 2.50,  $P = 0.003$ , Mann-Whitney test, and med = 25.5 years versus med = 23.5 years,  $P = 0.022$ , respectively).

The belief that a mouth guard can protect from concussion was associated with the higher probability of tackling harder than usual while using protectors ( $P = 0.04$ ).

**Conclusions:** More playing experience was the main variable associated significantly with less risky behaviour and more awareness about protector usage. Erroneous beliefs about mouth guard protective capabilities were related to more risky behaviour.

#### 10:15 AM—Incidence and Recurrence of Concussion in High School Football: Can We Achieve Safe Return to Play Using a Multidisciplinary Protocol?

Maxime Provencher, MSc, Catherine Desloges, MSc, Edith Castonguay, BSc, Francesco Pepe-Esposito, BSc, and Pierre Frémont, MD, PhD

*Affiliation: Department of Rehabilitation, Laval University, Quebec City, Quebec, Canada.*

**Objective:** Concussion management based on the resolution of symptoms alone is still prevalent in high school football and can result in early recurrence of symptoms following return to play (RTP). Our objective was to determine the incidence rate and the same-season recurrence rate of concussion following the implementation of a concussion management protocol in high school football.

**Study Design:** Prospective cohort study.

**Subjects:** A football program of 4 teams was followed over the 2012 and 2013 seasons for a total of 334 students  $\times$  year (age 11-17).

**Intervention:** A concussion management protocol was developed with the school's academic and sport management teams and included a baseline computerised neurocognitive evaluation (CNE; ImPACT software) and the modified BESS (mBESS). When medical clearance was needed following clinical recovery, a postinjury CNE was then administered and submitted to the team doctor.

**Outcome Measures:** The main outcome measure was the early recurrence of concussion defined as the recurrence of symptoms during the same season following RTP.

**Results:** Over a total of 14 815 exposures to a game or contact training session, 55 concussions were documented for an incidence rate of 3.7 per 1000 exposures. The first postrecovery CNE was abnormal for 67% of cases despite resolution of clinical symptoms upon intense exercise. Once cleared for RTP after a normalised CNE, no recurrence was observed during the same season.

**Conclusion:** Despite clinical resolution, two-thirds of the concussed high school students in this study presented abnormal findings at the time of their first postconcussion neurocognitive evaluation. Based on the resolution of clinical symptoms, these students would have been returned to play in settings that do not use any form of neurocognitive evaluation such as the SCAT3 or a CNE. The fact that no early recurrence of concussion symptoms was observed following RTP suggests that safe RTP was achieved with the multidisciplinary approach used in this study. These results further demonstrate that concussion symptoms alone should not guide concussion management. Alternatively, in high school contact sports settings where no form of baseline and postinjury neurocognitive evaluation are available, an additional delay should be considered before RTP, once the symptoms have resolved.

Topic: Sport Science

#### 9:30 AM—Sex Differences of Mixed Longitudinal Changes in Motor Performance in Young Children

Osamu Aoyagi, PhD

*Affiliation: Fukuoka University, Japan.*

**Objective:** This study investigates sex differences in longitudinal changes in motor performance in young children using a mixed longitudinal design and a linear model.

**Study Design:** Longitudinal sampling study.

**Subjects:** A total of 208 young children in 2 kindergartens in Fukuoka, Japan, aged from 3 to 5 years old were included in this study.

**Intervention:** The following motor performance skills were assessed: (1) Standing broad jump, (2) 25-m run, (3) Side jumping, (4) Climbing and sliding, (5) Softball throwing, (6) Jumping over a rope while leaning on a large block, (7) Jumping over and crawling under a rope, (8) Shuttle run, (9) Crawling run on hands and knees, (10) Jumping full turn, and (11) Sit-and-reach.

**Outcome Measures:** A linear model including the difference between the 2 measurements of motor ability made 1 year apart as the dependent variable and age and sex as independent variables was conducted. We applied the data into 2 types of linear models: a without-interaction model and a with-interaction model.

**Results:** Significant differences from a null model of both with- and without-interaction models were found in (2), (4), (5), (7), (8), (9), and (11). However, no significant differences were found in (1), (3), (6), and (10). The AICs of all without-interaction models in the 7 items showing significant differences were smaller than those in the with-interaction model, showing that the model excluding an interaction between age and sex better fitted the data. Velocity curves of both sexes were parallel and were not crossed or separated from each other in this age range.

**Conclusions:** The lack of significance in (1), (3), (6), and (10) means that they have the same velocity irrespective of age and sex. Because these 4 items have a common feature in that they assess jumping performance, it is considered that jumping performance develops at a constant rate in young children of both sexes. The parallel-shaped velocity curves in 7 items indicate that no remarkable come-from-behind phenomenon occurred between boys and girls in this age range.

### 9:45 AM—The Age-Performance Relationship: Toward New Models

Geoffroy Berthelot, PhD,<sup>1,2,3</sup> Adrien Marck,<sup>1,2,3</sup> Anne M. Bronikowski, PhD, Pr,<sup>4</sup> Theodore J. Morgan, PhD, Pr,<sup>5</sup> Theodore Garland, Jr, PhD, Pr,<sup>6</sup> Patrick A. Carter, PhD, Pr,<sup>7</sup> Marion Guillaume,<sup>1</sup> and Jean-François Toussaint, PhD, Pr<sup>1,2,8</sup>  
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**Objective:** Here we aim to (1) demonstrate that a biphasic pattern of growth and decline is probably widespread among biological phenomena, and (2) adjust a range of models to estimate the characteristics of the biphasic pattern (peak value, age of death).

**Study Design:** Cross-sectional.

**Subjects:** Human, greyhound, mice.

**Intervention:** Performance data were gathered for human (200-, 400-, and 800-m races,  $n = 5065$ , 5013, and 5080, respectively), greyhound (480-m competitions,  $n = 47$  991), and mice (distance run on wheels during 24 hours,  $n = 14241$ ).

**Outcome Measures:** Several models were fit adjusted to the data: the model of Moore<sup>1</sup>, a revised version of this model including interaction between the 2 processes and 2 other models with either a convex or concave tail.

**Results:** A U-inversed biphasic pattern is found in both the athletic (human Olympians and elite greyhound) and nonathletic (mice) mammals. The 3 new models describe the dynamics of performance with aging with greater accuracy compared with the initial model, based on classical goodness of fit indicators ( $R^2$ , rmse, AIC, BIC). However, the model with convex modelling of the declining process does not perform well.

**Conclusions:** Models producing long-tailed curves (ie,  $\lim_{t \rightarrow \infty} P(t) = 0$ ) provide poor estimates of performance lifespan in the studied species. It suggests that performance development with lifespan among individuals is finite (ie, reaches a plateau). We also assume that a U-inversed biphasic pattern may be found in other species, and we now focus on comparing the age of peak performance in different Olympic disciplines and different types of efforts in order to optimize the selection of athletes in relation to the distribution of performances at different ages.

### The Mechanism and Biomarker of Immunological Responses Associated With Exercise-Induced Oxidative Damage in Plateau Environment

Jingmei Dong, PhD,<sup>1,2</sup> Songhui You, MD,<sup>1</sup> Zhou Ping, MSc,<sup>1</sup> and Peijie Chen, PhD<sup>3</sup>

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**Objective:** To determine the biomarker of immunological responses associated with exercise-induced oxidative stress for preventing the damage of altitude training.

**Study Design:** Cross-over experiment.

**Subjects:** Thirty male volunteers from Shanghai in plain region, who are native to Shanghai, aged from 18 to 25,  $\dot{V}O_2\max$  exceeding 35 mL/min/kg.

**Intervention/Observation Technique:** Thirty subjects were randomly assigned to altitude training in northwest China (group A) and plain training in Shanghai (group P) with a progressively increasing load cycle ergometer for 8 days. The training sites were exchanged after 60 days' rest.

**Outcome Measures:** Blood samples were assayed for biomarkers of oxidative stress and immune response after training every day. Cytokine (IL-8, MPO, TNF- $\alpha$ ) and lipid peroxidation (MDA and) in blood plasma were measured by ELISA. Single cell gel electrophoresis (SCGE) was used to detect DNA damage of lymphocytes. The activity of NADPH-oxidase in PMNs by monitoring the chemiluminescence. The co-localization between gp91<sup>phox</sup> and p47<sup>phox</sup> of the NADPH-oxidase was detected using immunocytochemistry and confocal microscopy.

**Results:** The TNF- $\alpha$ , IL-8 value in blood were increased accompanied by MDA value with training load just in group A, but MPO and MDA value were increased consistently both in group A and group P. There was no DNA damage of lymphocytes in group P, but a little damage in group A. The activity of NADPH oxidase in groups A increased significantly ( $P < 0.01$ ) compared pretraining after 10 days altitude training but not in group P ( $P > 0.05$ ). The co-localization between gp91<sup>phox</sup> and p47<sup>phox</sup> of the NADPH-oxidase emerged in group A after 10 days training. Cross-matching regression analysis showed that there is correlation between the MPO and MDA ( $r = 0.78$ ); the MPO and the activity of NADPH oxidase ( $r = 0.83$ ); the DNA damage of lymphocytes and the MDA ( $r = 0.68$ ); the activity of NADPH oxidase and DNA damage of lymphocytes ( $r = 0.86$ ).

**Conclusion:** The MPO can be regarded as a biological marker of immune response, which can indicate the oxidative stress damage for the early warning in the plateau training. TNF- $\alpha$  increased with a progressively increasing load was associated with increased blood oxidative stress that may be activated by the NADPH-oxidase produced by ROS and lead to oxidative damage.

**Acknowledgments:** This work was supported by grants from the National Natural Science Foundation (No: 31260251).

### 10:15 AM—Analysis of Swimming Individual Anaerobic Threshold

Pedro Figueiredo, PhD,<sup>1,2</sup> Marisa Sousa, MSc,<sup>1</sup> Mónica Gomes, MSc,<sup>1</sup> Kelly de Jesus, MSc,<sup>1</sup> João Ribeiro, MSc,<sup>1</sup> and Ricardo J. Fernandes, PhD<sup>1</sup>  
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**Objective:** To assess the individual anaerobic threshold (IndAnT) velocity in swimmers and compare it with the velocity corresponding to Maximal Lactate Steady State (MLSS).

**Study Design:** Comparative study.

**Subjects:** Fifteen trained male swimmers ( $21.1 \pm 8.23$  years old,  $1.77 \pm 0.04$  m of height,  $69.8 \pm 5.39$  kg of body mass).

**Intervention/Observation Technique:** Swimmers performed an individual intermittent incremental protocol until exhaustion of  $n \times 200$  m, with 30-seconds intervals and 0.05-m/s increments between steps, to assess IndAnT. After a 24-hour rest interval, an MLSS test was implemented; swimmers performed at least two 30-minute trials at different velocities with 24 hours of rest in between. The swimming velocity for the first trial was established based on the IndAnT. The velocity increments/declines between 30-minute repetitions were 2.5% of the initial velocity. The MLSS was defined as the highest swimming velocity during which [La<sup>-</sup>] increased  $< 1$  mmol·L<sup>-1</sup> during the final 20 minutes of the test. Capillary blood was collected from the earlobe at rest, after each stage and at the end of the experimental protocol for [La<sup>-</sup>] analysis (Lactate Pro, Arkray, Inc).

**Outcome Measures:** [La<sup>-</sup>] allowed assessing IndAnT through [La<sup>-</sup>]/velocity curve in MATLAB2010 environment (MathWorks Inc, Natick, Massachusetts).

A paired samples *t* test was used to compare velocity at IndAnT and MLSS. Agreement between computed velocities in the different methods was evaluated by Bland-Altman plot and Passing-Bablok regression. Statistical significance was set at  $P < 0.05$ .

**Results:** No difference was found ( $P > 0.05$ ) between the velocity at IndAnT ( $1.22 \pm 0.95$  m/s) and the velocity at MLSS ( $1.21 \pm 0.13$  m/s). In the Bland-Altman plot, the mean of the differences were low and close to zero (0.013 m/s), indicating that the methods produced similar values. The corresponding limits of agreement (mean  $\pm 1.96$  SD) ranged between  $-0.176$  and  $0.176$  m/s. The Passing-Bablok regression analysis reported slope and intercept values including 1 and 0 (no deviation from linearity), respectively.

**Conclusions:** The results showed that IndAnT method allows the computation of the anaerobic threshold velocity, being a good evaluation tool to assess swimmer's aerobic capacity development, as an alternative to the MLSS method.

**Saturday, June 21, 2014**

Topic: *Exercise is Medicine*

### 9:30 AM—Influence of Strength Exercise on Physical Fitness, Insulin Sensitivity and Quality of Life in Morbidly Obese

Ariadna del Villar Morales, MD, Andrea Pegueros Pérez, MSc, José L. Molina Andón, MD

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**Objective:** To determine the effectiveness of a strength training circuit program on the modification of fat mass, cardiorespiratory capacity, insulin sensitivity, and the perception of quality of life in subjects with morbid obesity.

**Study Design:** Prospective, quasi-experimental, controlled, clinical trial.

**Subjects:** Nine females with BMI of  $45.07 \pm 4.16$  kg/m<sup>2</sup>.

**Intervention:** Subjects performed a program of strength training circuit of isotonic exercise with intensity interval of 60% to 70% of 1RM, 1 to 3 sets with 8 to 12 repetitions, rest interval of 1 to 2 minutes, from low to moderate speed, frequency of 2 to 3 days/week with duration of the intervention of 12 weeks.

**Outcome Measures:** Measurements of % fat mass through Weltman's formula, waist circumference, area under the curve (AUC) for glucose and insulin from the oral glucose tolerance test, insulin sensitivity (Matsuda), insulin resistance (HOMA-IR),  $\dot{V}O_2$ max, METs, and perception of quality of life through the SF-36 Health Survey questionnaire were evaluated at the beginning and end of the intervention. Comparison of the outcomes measurements were evaluated by the Wilcoxon signed rank test.

**Results:** At the end of the intervention, a significant change was observed in waist circumference and body fat percentage as well as  $\dot{V}O_2$ max and METs, considered as significant improvement in physical fitness; changes in Matsuda and HOMA-IR indices were not observed; however, the insulin curve showed a tendency to reduce its secretion for the glucose metabolism. The perception of quality of life by women showed significant change in mental health and a discrete improvement for physical health.

**Conclusions:** The results suggest that a program of strength training circuit for 12 weeks can improve fitness of subjects with morbid obesity; however, the volume and type of physical work were not enough to stimulate insulin sensitivity suggesting the need of prescribing a strength exercise program with greater volume or complement it with aerobic exercise to continuing modifying the fat mass, improve the response of insulin sensitivity, and thus reduce these risk factors for the development of comorbidities.

### 9:45 AM—Exercise and Future Clinical Practice

Kara Solmundson, MD, Michael Koehle, MD, PhD, and Don McKenzie, MD, PhD

*Affiliation: The University of British Columbia, Vancouver, British Columbia, Canada.*

**Objective:** To determine residents' perceived importance of exercise prescription in future practice and to assess their perspectives regarding exercise medicine training.

**Study Design:** Cross-sectional 49-item survey.

**Subjects:** Three hundred ninety-six family medicine residents registered in first or second year at The University of British Columbia during June 2013 to August 2013.

**Intervention:** The data were analyzed using descriptive and inferential statistics to assess significant relationships between each independent variable, resident physical activity levels, attitudes/beliefs, current counseling/prescribing behaviors, awareness/knowledge of physical activity guidelines, self-perceived competence in exercise prescription, and perception of training received to their perceived importance of exercise prescription in future practice. The data were analyzed as continuous or categorical variables using regression and bivariate analysis with statistical significance set at  $P = 0.05$ .

**Outcome Measures:** (1) The importance of exercise prescription in future practice; (2) Resident perception of their training in exercise medicine.

**Results:** Response rate was 80.6% (319/396). Ninety-five percent of residents indicated exercise prescription would be important in their future practice with 37.5% strongly agreeing (termed "prescribers"). Prescribers had stronger beliefs in the importance of physical activity in health ( $P < 0.001$ ), physical inactivity in disease ( $P < 0.001$ ), higher current exercise counseling/prescription rates ( $P = 0.001$ ), and higher competence prescribing exercise ( $P = 0.005$ ) compared to their colleagues. There was no difference between prescribers and nonprescribers with level of personal physical activity, knowledge, or perception of training. Only 18.6% of residents feel they receive adequate training in exercise medicine and 91% desire more.

**Conclusions:** Exercise prescription is important to residents, but residency is not sufficiently preparing new physicians to prescribe exercise effectively.

### 10:00 AM—Physical Fitness Profile Among Iranian and Afghan Adolescent Girls: Report from Tehran Suburb

Mina Akbari, MSc,<sup>1</sup> Hamid Agha-Alinejad, PhD,<sup>2</sup> and Babak Farzad, MSc<sup>3</sup>

*Affiliation: <sup>1</sup>Health Assessment Department, Turbotec Co., Tehran, Iran; <sup>2</sup>Tarbiat Modares University, Tehran, Iran; <sup>3</sup>Kharazmi University, Tehran, Iran.*

**Objective:** Improving physical fitness is a public health priority in developed and developing countries to curb the substantial and growing prevalence of lifestyle-related diseases. Since physical activity is an important factor related to weight control, there is renewed interest in the relationship between physical activity and the body composition of adolescents, as well as in the importance of physical activity in maintaining good health and well-being. Obesity has increased substantially in developed and developing countries during the last few decades, and it is probable that this trend will continue. Therefore, this issue should be considered by specialists. The present study was designed to compare some motor- and health-related fitness parameters between Iranian and Afghan girls.

**Study Design:** Cross-sectional.

**Subjects:** The study was conducted with 150 Iranian girls and 150 Afghan girls aged 8 to 12 years who live in Tehran suburb.

**Intervention:** All subjects underwent anthropometric measurements and motor- and health-related fitness tests.

**Results:** Afghan girls were better performers in modified pull-ups and hand-grip strength and had greater predicted  $\dot{V}O_2$ max than Iranian Girls ( $P \leq 0.05$ ). However, there were no significant differences in flexibility, modified sit-ups, agility shuttle run, and 20-m sprint test between the 2 ethnicities. Compared to their counterparts, overweight and obese adolescents demonstrated inferior performance in most motor- and health-related fitness parameters ( $P \leq 0.05$ ).

**Conclusions:** We found that Iranian girls had inferior physical fitness compared to Afghan girls and being overweight and obese were associated with poor fitness performances. The findings provided evidence to support the establishment of tailored physical fitness intervention programs to manage and prevent obesity in Iranian adolescent girls.

### 10:15 AM—Exercise and Folic Acid Supplementation Improves Endothelial Function in HIV-Infected in Use of Antiretroviral Therapy: Preliminary Results of ECR

Paula A. B. Ribeiro, PhD, Shana Grigoletti, MSc, Eduardo Sprinz, PhD, and Jorge P. Ribeiro, PhD

*Affiliation:* Federal University of Rio Grande do Sul, Porto Alegre, Brazil.

**Objective:** To determine the effect of supervised exercise and folic acid supplementation on endothelial function in HIV-infected individuals.

**Study Design:** Randomized clinical trial, double blinded, pilot study.

**Subjects:** Sixteen HIV-infected individuals, antiretroviral therapy (at least 6 months) with undetectable viral load (<50 copies/mL) and CD4 count >200 cells/mm<sup>3</sup>.

**Intervention:** The subjects were randomized to aerobic exercise (n = 5) and daily intake for 4 weeks of 5 mg of folic acid (n = 6) or placebo (n = 5) groups.

**Outcome Measures:** To assess endothelial function, venous occlusion plethysmography in the brachial artery with the protocol of reactive hyperemia was performed. The aerobic protocol consisted of cycling exercise, 3 times/week at 60% to 80%  $\dot{V}O_{2max}$ , for 4 weeks.

**Results:** Exercise improves reactive hyperemia ( $\Delta 6.5$  mL/min/100mL) and folic acid ( $\Delta 7.3$  mL/min/100mL), but there was no difference in the placebo group (from  $\Delta -0.3$  mL/min/100mL, time  $P < 0.001$ , interaction  $P = 0.02$ ).

**Conclusions:** Results demonstrate that supervised exercise and folic acid supplementation in a very short time improves endothelial function in HIV-infected individuals. As exercise and folate supplementation are safe and relatively inexpensive, this finding deserves more attention in large randomized clinical trials in an attempt to reduce cardiovascular risk in HIV-infected population.

### Topic: Orthopedics

### 9:30 AM—Practice Efficiencies Afforded by a Combined CCFP-Sports + Orthopaedic Surgeon Multidisciplinary Team

Diphile Iradukunda, MD, Megan Dash, MD, CCFP, and Jeremy Reed, MD, FRCSC

*Affiliation:* University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

**Objective:** This study aimed to elucidate whether a combined multidisciplinary team, a sports medicine fellowship-trained family physician and orthopedic surgeon, results in higher surgical hit rates.

**Study Design:** Retrospective chart review.

**Subjects:** Patients referred to a community-based sports medicine clinic for orthopedic surgical evaluation.

**Intervention/Observation Technique:** Measured independent variables included demographics, age, gender, date of referral, and surgical intervention.

**Outcome Measures:** Measured dependent variables included the percentage of new consultations that resulted in surgical interventions in a 6-month period before and after the formation of the interdisciplinary team.

**Results:** The control group included 167 new referrals seen solely by the orthopedic surgeon in the 6 months before the addition of the sports medicine trained family physician. The mean age was 46.41, with 66% of those being female. The study group included 180 new referrals in 6 months who were initially screened by the sports medicine-trained family physician. Appropriate referrals were forwarded to the surgeon. The median age in the study group was 39.00, with 47% being female. There was a statistically significantly proportion of surgeries performed in the study group, 77 of the forwarded 94 (78%), as compared to the control group, 88 of the 167 (53%) ( $\chi^2 = 15.86$ ,  $df = 1$ ;  $P < 0.001$ ). The odds of having surgery in the study group resulted in a 3-fold increase in the surgeon's surgical hit rate (OR = 3.12; 95% CI, 1.76-5.53;  $Z = -3.31$ ;  $P < 0.001$ ). Of those needing surgery, the study group had shorter median wait times after seeing the surgeon (MD 45 days; IQR 35-82 days) as compared to the control group (MD 81.5 days; IQR 48-129 days) ( $Z = -3.31$ ;  $P < 0.001$ ). However, there was no statistically difference in the overall wait times between the initial referral and time to surgery in both groups ( $Z = -0.135$ ;  $P = 0.89$ ).

**Conclusions:** A combined interdisciplinary team results in more appropriate consults seen by the orthopedic surgeon. The combined efficiency results in a 3-fold increase in the overall surgical hit rate.

### 9:45 AM—Assessment of Factors that Contribute to Laxity Following Anatomic Anterior Cruciate Ligament (ACL) Reconstruction

S. Mark Heard, MD,<sup>1,2</sup> Laurie A. Hiemstra, MD, PhD,<sup>1,2</sup> Gregory M. Buchko, MD,<sup>1</sup> C. L. O'Brien, MD, and S. Kerslake BPHTY<sup>1,3</sup>

*Affiliation:* <sup>1</sup>Banff Sport Medicine, Banff, Alberta, Canada; <sup>2</sup>University of Calgary, Department of Surgery, Calgary, Alberta, Canada; <sup>3</sup>University of Alberta, Department of Physical Therapy, Edmonton, Alberta, Canada.

**Objective:** The objective of this study was to assess the factors that contribute to ACL laxity following a primary anatomic hamstring autograft ACL reconstruction.

**Study Design:** Prospective cohort.

**Subjects:** One thousand ninety-two ACL reconstruction patients.

**Intervention:** All patients received a unilateral primary hamstring autograft ACL reconstruction.

**Outcome Measures:** Postoperative ACL laxity assessment using the Lachman and Pivot-shift tests was completed independently on each patient by a physiotherapist and an orthopaedic surgeon at 6, 12, and 24 months postoperative. Descriptive statistics were used to calculate the degree and frequency of postoperative laxity. Multiple regression analysis using Pearson r correlation coefficient examined the relationship between postoperative laxity and, gender, age, body mass index (BMI), operative limb, smoking, Beighton score, meniscal repair, meniscal resection, and chondral lesions.

**Results:** At 6 months postoperative 13.2% of patients demonstrated a positive Lachman ( $\geq 3$  mm side-to-side difference) and/or Pivot-shift test. This increased to 14.4% at 1 year and 14.7% 2 years after ACL reconstruction. At 2 years postoperative 2.8% of patients demonstrated complete graft rupture.

A statistically significant increased risk of postoperative laxity was determined for meniscal resection ( $P = 0.03$ ) and age less than 19 years ( $P = 0.05$ ). There was some evidence of an association between laxity and BMI ( $P = 0.14$ ), Beighton score ( $P = 0.15$ ), and intraoperative evidence of chondral lesions ( $P = 0.15$ ) but none of these factors reached statistical significance. There was no evidence of a relationship between postoperative laxity and gender, meniscal repair, or smoking.

**Conclusions:** This study demonstrated that up to 15% of patients had clinically measurable ACL graft laxity up to 2 years following primary anatomic hamstring autograft ACL reconstruction. Meniscal resection and age were associated with an increased risk of laxity. Further assessment of the relationship between laxity and BMI, Beighton score, and chondral lesions is warranted in a larger cohort.

### 10:00 AM—Biomechanical Analysis of the Anterior Cruciate Ligament Cross Pin Fixation in the Tibia

Edmar Stieven-Filho, MD, PhD, Luis A. R. Bauer, MD, Mario M. Namba, MD, MSc, and Isabel Z. Costa, BPE, BSc

*Affiliation:* Division of Orthopaedic Surgery and Traumatology, Federal University of Parana, Curitiba, Parana, Brazil.

**Objective:** To verify whether the combination of tibial cross pin fixation and femoral screw fixation presents biomechanical advantages when compared to femoral cross pin fixation and tibial screw fixation for the reconstruction of the anterior cruciate ligament (ACL).

**Study Design:** Experimental study in animal models.

**Subjects:** Twenty-eight porcine knees and bovine extensor digitorum tendons were used as the graft materials.

**Intervention Technique:** The tests were performed in 3 groups: (1) standard, used 14 knees, and the grafts were fixated with the combination of femoral cross pin and a tibial screw; (2) inverted, used 14 knees with an inverted combination of tibial cross pin and a femoral screw; (3) control, 10 control

tests performed with intact ACL. After the grafts fixation, all the knees were subjected to tensile testing to determine yield strength and ultimate strength. **Outcome Measures:** The outcome measurements were yield load and ultimate load. To perform the tests the knees were positioned in a 30 degree angle between the femur and the tibia in a universal material test system MTS 810 (Material Test System Corporation, Minneapolis, Minnesota), with 10 kN capacity load cell MTS (Material Test System Corporation). The knees were stabilized through the fixation of the bone diaphysis on the system with screw and nut. The tensile tests were performed with a 10 N load and a 20-mm/min velocity until the tendon rupture. With the values of yield load, ultimate load, and the cross section area of the ligament, the yield strength and ultimate strength were determined using the direct reason of the strength and area variables. The results were compared using the Kaplan-Meier survival analysis.

**Results:** There was no statistically significant difference in the survival of the techniques regarding yield load and ultimate load. There was a higher survival in the standard group when comparing the curves of yield strength ( $P < 0.05$ ).

**Conclusion:** There is no biomechanical advantage, observed in animal models testing, in the combination of tibial cross pin fixation and femoral screw when compared to femoral cross pin fixation and tibial screw.

### 10:15 AM—The Effect of the Knee Flexion Angle During Tibial Fixation on Outcomes Following Anterior Cruciate Ligament Reconstruction: A Meta-Regression Analysis

Ujash Sheth, MD,<sup>1</sup> Tim Dwyer, MD,<sup>1</sup> Thomas Zochowski, MD, MSc,<sup>1</sup> Timothy Leroux, MD,<sup>1</sup> David Wasserstein, MD, MSc,<sup>1</sup> Bernard R. Bach Jr., MD,<sup>2</sup> Paul Marks, MD,<sup>1</sup> Arman Bhatti, BA,<sup>3</sup> Daniel Whelan, MD, MSc,<sup>1</sup> Darrell J. Ogilvie-Harris, MD,<sup>1,3</sup> and Jaskarndip Chahal, MD<sup>1,3</sup>

*Affiliation:* <sup>1</sup>University of Toronto Sports Medicine Program at Women's College Hospital, Toronto, Ontario, Canada; <sup>2</sup>Division of Sports Medicine, Rush University Medical Center, Chicago, Illinois; <sup>3</sup>University Health Network Arthritis Program, Toronto, Ontario, Canada.

**Objective:** To determine the effect of the knee flexion angle (KFA) during graft fixation on outcomes following anterior cruciate ligament reconstruction (ACLR).

**Study Design:** Meta-regression analysis.

**Intervention/Observation Technique:** A systematic review of Medline, EMBASE and www.clinicaltrials.gov was performed to identify all randomized controlled trials (RCT) comparing single-bundle trans-tibial bone patellar tendon bone (BPTB) and hamstring (HS) autografts for ACLR. The KFA during graft fixation on the tibial side was noted for eligible studies and a meta-analysis and meta-regression analysis was conducted to determine the effect of this variable on postoperative outcomes.

**Outcome Measures:** Graft failure rates, extension loss  $>5$  degrees, KT-1000 scores, International Knee Documentation Committee score (IKDC), Tegner activity scores, Lysholm scores.

**Results:** Thirteen RCTs met our inclusion criteria ( $n = 1227$ ). Seven studies ( $n = 716$ ) described fixing the knee in full extension during tibial fixation, while 6 studies ( $n = 511$ ) reported a KFA between 10 to 30 degrees. Pooled analyses demonstrated no significant difference in KT-1000 scores, Tegner activity scores, Lysholm scores, and graft failure rates. In the uncontrolled pooled analysis, patients in the flexion group had fewer cases of extension loss  $>5$  degrees [BPTB: flexion 0% (CI: 0% to 5.4%) versus extension 3.7% (CI: 0% to 21.4%),  $P = 0.003$ ; HS: flexion 0% (CI: 0% to 1.3%) versus extension 1.0% (CI: 0% to 10.6%),  $P = 0.12$ ]. Patients in the flexion group also had greater proportion of IKDC A or B (normal or nearly normal) scores [BPTB: flexion 81% (CI: 65% to 94%) versus extension 66% (CI: 46% to 85%),  $P < 0.001$ ; HS: flexion 94% (CI: 85% to 99%) versus extension 75% (CI: 54% to 92%),  $P < 0.001$ ]. A meta-regression analysis failed to identify knee flexion angle utilized during tibial fixation of the ACL graft as an independent predictor of the above outcomes.

**Conclusion:** Although the overall pooled analysis favored the flexion group in terms of restoring full range of motion and improved IKDC scores, KFA

was not confirmed as an independent predictor of outcome in the meta-regression analysis. A well-designed RCT would help clarify the optimal KFA for ACL graft fixation.

## Poster Presentations

Thursday, June 19, 2014

Topic: *General*

### Seasonal Injury Patterns in Italian Adolescent Elite Soccer Players

Paolo Cugia, MD, Francesco Piras, MD, Marco Scorcu, MD, and Massimiliano Pau, PhD

*Affiliation:* FMSI Sardinia, Cagliari Calcio S.p.A, University of Cagliari, Italy.

**Objective:** To analyze the injury patterns in adolescent soccer players who compete in national level tournaments for the 2012-13 agonistic season.

**Study Design:** Prospective cohort study.

**Subjects:** Seventy-eight male players belonging to Under 19, 17, and 15 teams.

**Intervention:** The medical staff of the team recorded exposure time for each player and injury history using the FIFA F-MARC report form.

**Outcome Measures:** Injury Incidence, number of days of absence subsequent to an injury.

**Results:** Within the observed period, correspondent to an exposure of 2783 hours of matches and 21 660 hours of training, 87 and 47 injuries occurred, respectively, during training sessions and matches. The injury incidence for training in U15, U17, and U19 was 2.69, 7.17, and 2.63/1000 hours, respectively, while in the case of matches, the incidence rate increased to 13.31, 17.32, and 25.64/1000 hours. Such values are consistent to those reported by FIFA for youth leagues in case of U15 and U17 teams, while the U19 team injury incidence is similar to what is observed for professional players. Generally speaking, traumatic injuries are most frequent (75.4%) with respect to overuse (24.6%).

Lower limbs are the most common injured part of the body (62.7% of all injuries) and, in particular, the highest incidence of injuries occurs to thighs (23.1%), followed by knee (14.9%), ankle (11.9%), leg (9%), and foot (3.7%). Lastly, even though the mean number of days of absence in U19 team was found to be lower with respect to both U15 and U17 (18.5 vs 28 days) and the injuries occurring during a match corresponded to higher periods of absence (28.5 vs 21.3 days for training sessions), a 3-way ANOVA performed setting playing position, age, and session (training/match) as independent variables failed to detect any significant effect of such variables on the number of days of absence consequent to an injury.

**Conclusions:** Detailed and reliable injury data represent an essential tool for medical staff to plan suitable preventive and rehabilitative programs. In the case of young players, it must be considered that high-level U19 players exhibit patterns of injuries very similar to professional players.

### Position Differences in Strategic Views of Positioning in the Half-Court Defense in Basketball Games

Tsuyoshi Kawazura,<sup>1</sup> Akihito Yaita, MSc,<sup>1</sup> and Osamu Aoyagi, PhD<sup>2</sup>

*Affiliation:* <sup>1</sup>Kyushu Kyoritsu University, Fukuoka, Japan; <sup>2</sup>Fukuoka University, Fukuoka, Japan.

**Objective:** This study examined position differences of strategic views of positioning for the half-court defense in basketball games.

**Study Design:** Questionnaire survey.

**Subjects:** Subjects were 110 male and 82 female university basketball players who belonged to Divisions I and II of the Kyushu Collegiate Basketball Federation.

**Intervention:** Subjects were asked to evaluate how well the defense did after looking at 2 arrow-diagrammed figures with players' symbols of before and

after each game scenario; evaluations were made using a 5-point scale in which higher scores represented a better assessment.

**Outcome Measures:** Questionnaire items evaluating the defense on the half-court defense consisted of the following game scenarios: Cuts (Straight-cut, Step-and-front cut, and Back cut), On-ball screens (Drive-to, Cut-away, Early-release, Open-shot, and Jump shot), Off-ball screens (Backdoor play, Cut-in, Cut-away, Out-in, and Double-low-post), Back screen, Outside screen, Dribble screens (Dribble-to, Cut-away, and Jump shot) and Outside screen plays (Cut-away, Pop-out, Screen-and-jump shot, and Drive-to). Data obtained were tallied by positions (PG, Point guard; SG, Second guard; SF, Shooting forward; PF, Power forward; C, Center) and an analysis of variance (ANOVA) and multiple comparison test were applied to the 5 means.

**Results:** The evaluation scores of the C were higher than those of the SG in Back cut of Cuts and Backdoor play and Back screen of Off-ball screens; higher than those of the SF in Cut-away and Jump shot of Off-ball screens, Backdoor, Cut-away, Cut-in, and Back screen of Off-ball screens, Dribble-to and Jump shot of Dribble screens, Out-in and Back screen of Off-ball screens, and Drive-to of Outside screens; and higher than those of the PF in Back screen of Off ball screens. The evaluation of the PF was higher than that of the SF in Out-in of Off-ball screens.

**Conclusions:** Only the C showed significantly higher evaluations of most items. The C is generally tall and has a long reach. Even though players at other positions cannot cover the offense, the C may be able to do so using this long reach.

### Risk Factors Associated With Achilles Tendinopathy: An Observational Study

Amit A. Chauhan, BSc,<sup>1</sup> Peter Malliaras, PhD,<sup>1</sup> Otto Chan, MBBS,<sup>2</sup> Onebienne Ana, MBBS,<sup>1</sup> Robert-Jan de Vos, MD, PhD,<sup>3</sup> Nikos Malliaropoulos, MD, PhD,<sup>4,5</sup> Nicola Maffulli, MD, PhD,<sup>1</sup> and Dylan Morrissey, PhD<sup>1,2</sup>

*Affiliation:* <sup>1</sup>Centre for Sports and Exercise Medicine, William Harvey Research Institute, Bart's and the London School of Medicine and Dentistry, Queen Mary University of London, Mile End Hospital, London, United Kingdom; <sup>2</sup>The London Independent Hospital, London, United Kingdom; <sup>3</sup>Department of Orthopaedics, Erasmus Medical Center, Rotterdam, the Netherlands; <sup>4</sup>Thessaloniki Sports and Exercise Medicine Clinic, Thessaloniki, Greece; <sup>5</sup>National Athletics Sports and Exercise Medicine Center, Thessaloniki, Greece.

**Objective:** To develop a better understanding of the aetiology of Achilles tendinopathy by surveying relevant groups for potential risk factors. Further, to investigate validity and reliability of the survey tool.

**Study Design:** Observational cohort study.

**Subjects:** Four hundred twenty-one subjects were recruited. Data were analysed for differences between groups: 158 active symptomatic Achilles tendinopathy subjects, 174 active asymptomatic subjects, and 89 inactive control subjects. Consistency between clinician and online administration was measured in a subsample of 35.

**Intervention/Observation Technique:** A literature search identified potential risk factors, which were combined with the VISA-A (0-100) questionnaire in a Web-based questionnaire.

**Outcome Measures:** The relationship between associated factors and VISA-A scores across the 3 groups were analysed. Matched groups analyses were conducted for age and weight as potential confounders. Agreement between online and paper administration was also measured. For all calculations, 95% confidence intervals were used, and *P* values <0.05 were considered statistically significant.

**Results:** The active symptomatic group had significantly worse mean (SD) VISA-A scores than the inactive control and active asymptomatic groups respectively [64.3 (22.2) vs 88.4 (12.0) vs 98.4 (2.1); *P* < 0.01]. The symptomatic group was more likely to be male and report pronated foot type, hypercholesterolaemia, contraceptive use, and postmenopausal status (all *P* < 0.01). However, age- and weight-matched analysis demonstrated that the strongest associated factors for AT were a history of hamstring or calf strain, ankle sprain, back pain, tight hamstring or calf muscles, and hypertension. For reliability, kappa scores ranged from 0.66 to 1.00 for included risk factors and the VISA-A ICC (3,1) was 0.98.

**Conclusions:** This accessible online questionnaire has identified novel information about potential risk factors for AT, particularly affecting the lower limb posterior chain. The questionnaire had good validity, and most items of the questionnaire had acceptable reliability. Further research is warranted in specific subgroups, such as those with long-term conditions which may represent comorbidities, or prospective studies in high risk cohorts.

### Genetic Risk Factors for Mid-Portion Achilles Tendinopathy: A Systematic Review

Amit A. Chauhan, BSc,<sup>1</sup> Dylan Morrissey, PhD,<sup>1</sup> Paul R. Jones, MBBS,<sup>2</sup> Manuela Angioi, PhD,<sup>1</sup> Henning Langberg, PhD,<sup>3</sup> Nicola Maffulli, MD, PhD,<sup>1</sup> and Peter Malliaras, PhD<sup>1</sup>

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**Objectives:** To determine which loci have been detected to be associated with mid-portion Achilles tendinopathy and could be used as biomarkers in tendinopathy risk models or as therapeutic targets.

**Study Design:** Systematic review.

**Data Sources:** Eight electronic databases were searched from inception to October 2013 for cross-sectional, prospective cohort and case-control studies that included empirical research investigating genes associated with mid-portion Achilles tendinopathy. Publications were assessed by 2 independent reviewers for inclusion and quality. Quality was evaluated using a validated scale.

**Main Results:** Thirteen studies that investigated genetic risk factors for Achilles tendinopathy were identified. Strong evidence was found for 3 variables: polymorphisms and binding sites of the collagen (COL) gene, the tenascin-C (TNC) gene, and the *Bacillus stearothermophilus* U458 (BstUI) and *Diplococcus pneumoniae* G41 (DpnII) genes. Moderate evidence was found for 5 variables: the caspase (CASP) and nitric oxide synthase (NOS) genes, the microRNA-608 (MIR608) gene, transforming growth factor  $\beta$ 1 (TGF $\beta$ 1) and growth differentiation factor 5 (GDF5) genes, interleukin (IL) genes, and matrix metalloproteinase (MMP) gene variants. The thrombospondin-2 (THBS2) and cartilage oligomeric matrix protein (COMP) genes were not associated with AT. The quality of included studies varied (4/12 to 8/12).

**Conclusions:** There are genetic differences between subjects with and without Achilles tendinopathy. This may have implications for its prevention and management. To further elucidate these findings, prospective studies using larger samples of more varied ethnicity are needed. Gene therapy may have a role in the healing of tendons, but further research is necessary to develop risk models and establish the most advantageous genes to transfer.

### MRI Dynamic Study of Lumbo-Sacral Rachis in Athletes Affected by Persistent Low Back Pain

Giovanni Boni, PhD,<sup>1</sup> Emanuele Bizzi, MD,<sup>2</sup> and Silvana Giannini, PhD<sup>3</sup>  
*Affiliation:* <sup>1</sup>Ambulatory Sport Medicine, ANTLAGE, Foligno, Italy; <sup>2</sup>Department of Rheumatology, S. Pietro FBF Hospital, Rome, Italy; <sup>3</sup>Department of Radiology Service, Villa Stuart, Rome, Italy.

**Objective:** The aim of this study was to highlight the relevance of dynamic axial MRI under charge in athletes affected by persistent low back pain that limits physical activity in the absence of significant disc protrusions or radicular involvement.

**Study Design:** Case control.

**Subjects:** We studied, by the use of MRI, 18 athletes (13 high level professionals and 5 amateur players) with an age range of 17 to 36 years, 14 males and 4 females.

**Outcome Measures:** All patients underwent an MRI examination, 1.5 Tesla with synergy spine coil Philips, multiplanar sequences T1 and T2 weighted, and T2 with fat tissue suppression. At the end of examination all patients underwent an axial charge examination by the use of amagnetic tools over an amagnetic

table inserted into the gantry provided with a thrust system exerted by apposite compressor. For every patient a thrust equivalent to 80% of body weight was exerted on the lumbar region, and, by T2 weighting, a sagittal and axial scan was performed with an examination time extension of about 8 minutes.

**Results:** Eighteen athletes coming from different sports activities (football, basket, rugby, etc) underwent this examination. Sixteen patients presented a vertebral instability and in 3 patients it was possible to observe, during compression, a cyst of capsulo-ligamentous interapophysary complex that determined a compression of nerve root. In 2 patients we were able to observe a small intraforaminal hernia under compression that reduced the foramen space and periradicular space of the nerve.

**Conclusions:** In athletes affected by low back pain that apparently has no explanation after MRI, the use of functional dynamic MRI may be essential for a correct diagnosis, as in our small cohort of patients it granted the possibility of making a diagnosis of segmentary instabilities that may be the cause of pain.

### Diagnostic Process and Treatment of Myo-Tendinous and Insertional Grade II and III Lesion of Hamstring. Validity of Treatment with Growth Factors in the Accelerated Recovery to Athletic Ability of Both Amateur and Professional Levels

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**Objective:** The objective of this study was to evaluate effectiveness of PRP injections associated with a specific rehabilitation protocol in accelerating healing processes of myo-tendinous lesions of athletes, affected by a grade II or III lesion of proximal ischio-crural tendon.

**Study Design:** Case control.

**Subjects:** We evaluated and treated 70 patients (45 professional and 25 amateur athletes) with this kind of lesion.

**Outcome Measures:** All patients were evaluated by static and dynamic ultrasound imaging with a linear device, 17.5 MHz. A sonoelastographic analysis with color Doppler was also performed when necessary. An MRI examination was also performed in order to estimate the extent of lesions and eventual involvement of ischiatic nerve. Patients with a recent tear, without fibrosis, were treated with PRP; 15cc of PRP were distributed under ultrasound guidance on lesion areas. If hematoma was present it was drained beforehand.

Fifty athletes performing different sports (football, basket, hockey, etc), 40 males and 10 females, age 19 to 39, were treated by this protocol, performing 2 injections, once every 10 days. After every injection, patients were instructed on a rehabilitation protocol comprehending stretching and progressive strengthening and were on a differentiated program of exercises. Twenty patients (15 females and 5 males) were treated by the use of compressive bandage and rest for 8 days and then started the same rehabilitation program.

**Results:** Patients treated by PRP had a mean recovery time for walking without pain of 7 days, patients not treated with PRP had a mean recovery time of 18 days. Patients undergoing PRP injections were able to restart sports activity after a mean of 30 days; patients not undergoing to PRP recovered in a mean time of 45 days.

**Conclusions:** All athletes undergoing to PRP injection protocol had a shorter recovery time respect to patients undergoing to noninterventional treatments.

### Contribution of Individual Digit in Grip Strength of Interuniversity Archery Players: A Cross-Sectional Study

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**Objective:** To determine the individual digit contribution in hand grip strength of archery players.

**Study Design:** Cross-sectional.

**Subjects:** Archers and controls of age group 18 to 25, with no history of injury at finger or hand were included. One hundred three were archers (45 females and 57 males) and 101 were controls (46 females, 55 males) were included. Total sample size was 204.

**Intervention:** The readings of handgrip and individual digits were taken with a calibrated handheld dynamometer. A generic splint was used to exclude the digit except the target digit.

**Outcome Measures:** The outcome measurements were the total handgrip strength, second digit strength, third digit strength, fourth digit strength, and fifth digit strength of both hands (right and left).

**Results:** The maximum contribution or strength possessed by both the archery player group and the control group is by little finger (38%-43%) followed by the index finger (23%-28%), followed by the ring finger (18%-23%), and least by the middle finger (11%-14.5%).

**Conclusions:** The order in which the digits have maximum strength is little, index, ring, and middle.

### Process of Psychologically Accepting Athletic Injury and Athletic Rehabilitation Behavior

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**Objective:** To examine the causal relationships between psychological acceptance process of athletic injury and athletic rehabilitation behavior.

**Study Design:** Retrospective questionnaire survey.

**Subjects:** One hundred forty-four athletes who have injury experiences participated in this study. Among them, the data for 133 participants (mean age = 20.21 years, SD = 1.07; mean weeks without playing sports = 7.97 weeks, SD = 11.26) who completed sufficient amount of answers were analyzed.

**Outcome Measures:** The main outcome measurements were provisional version of the Psychosocial Recovery Scale (PSRF-S), existing version of the Athletic Injury Psychological Acceptance Scale (AIPA-S), and Athletic-Rehabilitation Dedication Scale (ARD-S).

**Results:** The results of factor analyses indicated the following 4 factors for the PSRF-S: the "emotional stability," the "social competence in the team," the "temporal perspective," and the "communication with the teammates." Internal consistency reliability of this scale was examined with Cronbach's coefficient alpha and confirmed sufficient reliability,  $\alpha = 0.81$ . Next, the causal model in which psychosocial recovery factors are mediated by psychological acceptance for athletic injury, and influence on rehabilitation behaviors, was examined by the structural equation modeling (SEM). The final model indicated a goodness of fit of GFI = 0.97, AGFI = 0.90, CFI = 0.99, and RMSEA = 0.05. The results of SEM indicated that the factors for the emotional stability and the temporal perspective were mediated by the psychological acceptance for the injury, which positively influenced the devotion to rehabilitation behaviors. However, if the emotional stability was not mediated by the psychological acceptance for the injury, it influenced negatively the devotion to rehabilitation behaviors.

**Conclusions:** The causal model was confirmed to be valid. These results suggest the needs of a psychological intervention that especially focuses on the recovery of the emotional stability and the temporal perspective, which will facilitate the psychological acceptance for the athletic injury and attribute to the devotion to the rehabilitation behaviors.

**Acknowledgement:** This study was supported by Grant-in-Aid for Scientific Research from Japan Society for the Promotion of Science, KAKENHI-No.25560332 to the presenter. I appreciate this support.

### Situational Assessment High-Ordered Factorial Structures of Individual Offensive Positions in Basketball

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**Objective:** This paper attempts to statistically clarify the factorial structures of the situational assessment ability in a variety of play situations involving individual offensive positions in basketball.

**Study Design:** Test and statistical analysis.

**Subjects:** One hundred fifty-eight university basketball players (87 men and 71 women).

**Intervention/Observation Technique:** University basketball players were given a situational assessment ability test wherein the participants were shown recordings made during actual games which were then paused during play and participants were asked to choose what sort of situation was occurring and what plays would follow. Test items were a total of 41 scenes composed of the 4 processes such as “fundamental recognition of opponent defense style” (19 items), “selective attention to game situation” (12 items), and so on. Factor analysis was repeatedly applied to test scores at the first time and to the factor scores on and after the second time until only 1 factor was derived.

**Results:** As a result of factor analysis of the 85 situational assessment test items, 23 factors were extracted, including “pass reception during zone defense” and “cut in pass reception.” Once again applying factor analysis using the factor scores of these 23 factors, 7 factors were extracted, such as those rendered “when the wing is aiming to coordinate with post,” “when the opposition has been broken,” and “when the opposition is being maintained.” After further applying factor analysis using the factor scores of these 7 factors, 3 factors were extracted, which can be rendered as “one-on-one situation requiring coordination with another player,” “when the defense has already been broken through with the ball in possession”, and “when the defense is being maintained,” and it was possible to create a 4-tier model of the causal structures. Finally, the only 1 factor was derived from the 3 factors.

**Conclusions:** It is thought that curriculum creation based on the structure obtained in this study would contribute to the coaching of team tactics and training.

### Scottish Women’s National Football (Soccer) Team: A Five-Year Prospective Study of the Medical Workload of the Team Physician

Stephen H. Boyce, MSc, MBChB

*Affiliation: Scottish Football Association & SportScotland Institute of Sport, Scotland.*

**Objective:** To determine the medical workload of the team physician for the Scottish women’s national football (soccer) team.

**Study Design:** Prospective observational study.

**Subjects:** Training venues and competitive matches with the national team in Scotland and away from home in Europe.

**Intervention/Observation Technique:** All consultations with players were documented prospectively by the team physician over a continuous period of 5 years (2008-2012).

**Outcome Measures:** Consultations were divided into 3 categories: training ground injuries, general medical presentations, and injuries sustained during competitive matches.

**Results:** The national team played 41 competitive matches during the study period. Overall, 377 medical consultations took place. These are subdivided as follows:

1. Training ground musculoskeletal injuries—148 (Groin strain, soft tissue injury knee, muscular haematoma lower leg, etc)
2. General medical -181 (Headache, URTI, toothache, dysmenorrhoea, etc)
3. Injuries sustained during competitive matches—48 (Hamstring strain, ankle sprain, traumatic epistaxis, etc).

The incidence of injury in competitive matches was 2.9/1000 hours. The exact diagnoses of all these consultations will be presented.

**Conclusions:** The medical workload of the team physician is significant and ranges from the management of musculoskeletal injuries, general medical conditions and rarely serious medical illness or injury. This does not include the other remits of the team physician, that is, education, hydration, diet, anti-doping, injury prevention, and foreign travel advice.

### Medical and Physical Profiling of Elite Female Football (Soccer) Players

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**Objective:** To perform medical and physical profiling on elite female football (soccer) players.

**Study Design:** Observational.

**Subjects:** Twenty players from the Scotland national football team were profiled.

**Intervention/Observation Technique:** Medical profiling consisted of history, physical examination, ECG, echocardiogram, and blood tests (full blood count, ferritin). Physical profiling consisted of a musculoskeletal examination and dynamic testing (small knee bend, single leg landing, star excursion balance test (SEBT) in 3 planes, single hop, and arabesque). Photographs and video were used to highlight alignment and measurements taken for SEBT and single leg hop test.

**Outcome Measures:** Medical conditions, risk factors, and medications.

**Results:** Medical examinations were normal. No significant ECG abnormalities were detected. All echocardiograms were within normal limits. Three players had clinical iron deficiency anaemia. Eighteen players had suboptimal ferritin levels, with 9 requiring oral supplementation. On dynamic profiling the main findings were general poor rotational control, and unilateral imbalances of lower limb muscular strength and control were demonstrated. In addition, all players achieved lower than 85% expected bilateral SEBT scores indicating a high risk of lower limb injuries.

**Conclusions:** Profiling elite female football players yielded significant problems both medical and physical and is a worthwhile exercise. Suboptimal ferritin levels can lead to impaired performance and recovery. Dynamic profiling demonstrated a high risk of lower limb injuries. Injury prevention is important in female football players. All players received individual feedback, demonstrated with clinical photographs and video to improve understanding of their dynamic instabilities. In conjunction with S&C coach, individual programs were devised for each player to address these weaknesses.

### A Comparison of the Awareness of Doping in Sport Between International and Elite Youth Soccer Players

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**Objectives:** To compare awareness of doping in sport between international and elite youth soccer players.

**Study Design:** Survey.

**Subjects:** International level and academy age group soccer players.

**Intervention/Observation Technique:** Questionnaires were completed by all members of a Full International squad and all members of an under-18 English Premier League academy side. Forty-four questionnaires were completed (a response rate of 100%).

**Outcome Measures:** Players’ knowledge of the prohibited substance list; use of permitted supplements; how to check a substance; whether players sought advice, and if so from whom, about their use of supplements/medication; their experience of being tested and educated on doping and who prescribes their medication; and to use this data to compare the knowledge of International level players and academy age group players.

**Results:** A total of 18.18% of international and 14.64% of academy players stated that they had never received education on doping throughout their career; those that did receive advice reported an average of 2.22 (international) and 2.5 (academy) sessions throughout their career. In total, 27.27% of internationals and 50% of academy players were unsure of how to check if medications were on the banned substance list. Ten percent of international players and 27.27% of academy players were taking medications prescribed by someone other than their club doctor.

Fifty percent of the international sample and 86.36% of the academy sample admitted to using supplements; 81.81% of international players and 45.45%

of academy players had been tested within the last 2 years; less than 15% of internationals had ever been tested out of competition; 72.72% thought that it was very likely that they would be tested whilst on international duty. None of the academy sample had ever been tested in the off-season.

A total of 81.81% of internationals and all the academy sample (100%) stated that they were 100% sure that the supplement(s) they were taking were not on a banned substance list. A total of 18.18% of internationals said they could not be sure.

**Conclusions:** There is a need to ensure that footballers are given appropriate advice about the use of medications/supplement. Athletes must be provided with the correct information and health advice. National associations need to ensure that they provide players and medical staff with education and resources to assist in the fight against doping in football.

### Developing an Athlete Injury Database: Assessing the Impact of Injury in Canadian Intercollegiate Sport

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**Objective:** To develop an injury surveillance database for Canadian Interuniversity Sport (CIS) athletes. The CIS is the governing body for university sports in Canada. The CIS is committed to providing all athletes with the best medical support in the country, yet a comprehensive tracking of CIS athletic injuries does not currently exist.

**Study Design:** A retrospective chart review of CIS athletes who had sought sport injury related medical care during the years 2009 to 2012.

**Subjects:** Sixty-six CIS football athletes from a mid-sized Canadian university.

**Observation Technique:** An online athlete injury database was created and piloted at a mid-sized Canadian university. For this pilot, the review of injuries was restricted to football. CIS athlete rosters were cross-referenced with online medical records held by the team's sports medicine physician, athletic trainers, and physiotherapists for the last 3 academic years. This resulted in a total sample size of 45 out of 66 players reporting an injury once or more throughout their university football career.

**Outcome Measures:** The outcome measurements were principal body part injured and injury mechanism.

**Results:** Preliminary results showed that the most common anatomical sites for first documented CIS injuries were the shoulder (18%), followed by knee (13.3%), and ankle (13.3%). In patients reporting more than 1 injury, the most common injury sites for the second injury were knee injuries (27%), shoulder injuries (20%), and ankles (20%). The majority of injuries were caused due to contact with another player (46.7%). However, there were a large proportion of cases (35.6%) for which the cause of the injury was not documented. Of the 45 athletes reporting an injury for the first time, 9 required surgery.

**Conclusion:** A large proportion of CIS athlete injuries are currently untracked. This pilot project highlights the need for a tracking tool to be developed to consistently track and report on athlete injuries in all CIS institutions. Such a tool has the potential to improve treatment procedures, modify risk factors, and work to develop and enhance return to play policies and protocols for athletes.

### Twenty Seasons of Medical Surveillance of Judo Competitions in France: A National Analysis of the Traumatology of Judo in Competition

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**Objective:** The French Judo Federation (F.F.J.D.A), 4th federation number of licensees, brings together a number of judoka who practice the competition. It begins in a manner adapted to the departmental level with the benjamins to

finish at the highest international level with seniors. Judo practice may cause a number of injuries inherent in combat himself.

**Study Design:** Open prospective study.

**Subjects:** Age groups found in competition ranging from benjamins to seniors. Women represented between one-quarter and one-third of the competitors.

**Intervention/Observation Technique:** The MD supervising the competition collected in a plug computer the number of combatants by sex, the number of fights, the number of calls on the tatami, the number of stops to fighting, and the number of evacuations of the wounded. They also noted serious injuries with the following parameters: age, sex, rank, and pathology. This fact sheet was sent by mail to the national coordinator medical doctor.

**Outcome Measures:** Analysis of the data was for 20 included 1993 to 2012 seasons. Injuries were collected by sex, level of competition, location, and diagnosis.

**Results:** A total of 303 502 competitors were included in the study in 1800 competitions organized and monitored by an MD. A total of 3845 judoka were arrested (1.26% competitors), and 1243 were evacuated to the hospital (0.41% of competitors). Topographically, injuries by descending order were shoulder, elbow, knee, cervical spine, and ankle. Encountered pathologies by descending order were sprains, fractures, and dislocations, all joints together.

**Conclusions:** Analysis of competition data show that judo is not so traumatic as it seems. Most competitors at the top level are prepared and hurt themselves less. On the other hand, the more difference there is in the level between 2 fighters, the greater the risk of injury. Analysis of these data helped to put in place preventive measures to reduce the incidence of injuries in competition.

### Efficiency of Ultrasound Therapy in the Treatment of Athletes' Knee Injury

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**Objective:** Ultrasound therapy is chosen as a thermal agent that selectively affects the deep structures and increases mobility through the decrease of muscular spasm elevating the pain threshold level. The aim of this study was to demonstrate the efficiency of ultrasound therapy on the decrease of pain and contractures and in improvement of knee functions and walking distance.

**Study Design:** Prospective cohort study.

**Subjects:** A total of 100 athletes with knee injuries participated in the study.

**Intervention:** The study was performed for 10 months, from January 2013 until October 2013, and parameters for athletes with knee injuries treated at the outpatient department of Physical Medicine and Rehabilitation Clinic in Prishtina were analyzed.

**Outcome Measures:** Subjects were divided into 2 groups: interventional group (n = 51) in which physical therapy and ultrasound was applied, and control group (n = 49) in which only physical therapy was used, every day for 3 weeks. Condition of the subjects was validated through Western Ontario and McMaster University Arthritis Index (WOMAC), as well as a 6-minute distance walking test at the beginning of the study, at the end of the first week, and the end of the third week when the treatment was finished.

**Results:** Subjects from both groups had the same test results at the beginning of this study ( $P = 0.01$  difference in WOMAC,  $P = 0.18$  difference in walking distance). Result average of WOMAC test was better for the treatment group compared with the control group at the end of the first week ( $P < 0.001$ ) and also at the end of the third week ( $P < 0.001$ ). Average 6-minute walking distance test showed improvement in the treatment group in comparison to the control group at the end of the first week (37 m) and at the end of the third week (58 m);  $P < 0.001$ .

**Conclusion:** Ultrasound therapy proved to be an important predictor in rehabilitation success. A complimentary goal in the rehabilitation of athletes with

knee injuries is pain management. Our results suggest that ultrasound therapy is beneficial in the treatment of knee injuries.

### Sports-Related Hip Injuries in Children: A Comparison of Males and Females

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**Objective:** To analyze male-female differences in characteristics of pediatric sports-related hip injuries.

**Study Design:** Cross-sectional epidemiological study.

**Subjects:** Patients 5 to 17 years treated between 1/1/2000 to 12/31/2009 for sports injuries at a tertiary level academic pediatric medical center division of sports medicine.

**Intervention:** Retrospective chart review of a 5% random probability sample of all new patient visits evaluated over the 10-year time period. Injuries were stratified by diagnoses, sport, sex, age (preadolescent vs adolescent), acute/traumatic versus overuse, and bony versus soft tissue. The interaction of sex and growth/maturation with regard to hip injury over time was examined by a 2-way (sex × age) analysis of variance (ANOVA).

**Outcome Measures:** Hip injuries in children by diagnosis, sport, age, sex, injury mechanism, and injury type.

**Results:** A total of 2133 charts were reviewed; N = 87 hip injuries. Leading diagnoses for females included labral tear (59.0%), tendonitis (14.8%), snapping hip syndrome (6.6%), strain (4.9%), and bursitis (4.9%); for males leading diagnoses were labral tear (23.1%), avulsion fracture (11.5%), slipped capital femoral epiphysis (11.5%), dislocation (7.7%), and tendonitis (7.7%). Age by sex comparison revealed that males showed a greater proportion of the total hip injuries during preadolescence (5-12 years), as compared to females, in the same age category (38.5% and 8.2%, respectively). However, in the older age group (13-17 years) hip injury proportion was significantly greater in females, as compared to males, (91.8% and 61.5%, respectively);  $P < 0.001$ . Injury mechanism and type differed by sex with females sustaining more chronic/overuse (95.1%) and soft tissue type injuries (93.4%), as compared to males (50.0% and 53.8%, respectively;  $P < 0.001$ ). Females were found to have a sharper increase in hip injury proportion as they progress through puberty as compared to males (2-way ANOVA sex-by-age interaction  $P < 0.001$ ).

**Conclusions:** Hip injury type and mechanism differed significantly between males and females in this study cohort. Notably, analysis revealed that the proportion of hip injuries in the young female athletes showed a significantly greater increase with advancing age as compared to males. Hip injuries in children and the interplay with growth, as it relates to injury predisposition, require further understanding in order to move prevention efforts forward.

### Injury Reporting at the 2013 International Children's Games (Multi-Sport Event)

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**Objective:** This study explored the nature of self-reported injuries among athlete participants at the 2013 International Children's Games, a multi-sport event held in Windsor, Ontario, Canada.

**Study Design:** Prospective cohort study.

**Subjects:** A total of 1099 athletes (594 male and 505 female) under the age of 19, who participated in the multi-sport summer event (8 sports).

**Intervention:** Web-based forms were used to capture real-time injury occurrences in combination with standardized injury characteristics and information on simultaneously occurring causal factors through the use of mobile technology.

**Outcome Measures:** The outcome measures were the self-reported injuries recorded on-site by venue-based volunteer medical personnel.

**Results:** There were 87 reported injuries during the event. Where participant sex was indicated, female participants reported more injuries (8.3 per 100) than male participants (5.4 per 100). Overall, 70% of the reported injuries were minor including sprains, strains and contusions. Injury characteristics included overuse and reoccurrence, while causal factors included contact and noncontact with other athletes, moving or stationary objects. There were no reported concussions at this event.

**Conclusions:** Injury data collection was based on a clear and concise definition of injury and included simultaneous descriptions of standardized injury characteristics and causal factors. Injury data are useful for future host organizing committees to understand the potential for injury in these types of events and prepare informed medical response strategies. As well, better tracking of injury data across a number of multi-sport events will help facilitate long-term trend analysis to inform prevention, management, and staffing protocols. Using an alternative method of data collection provided a rich database of injury occurrences in real-time throughout the event. Web-based and mobile technology may offer new opportunities to capture injury data in multi-sport systems.

### Risk Factors for Injuries in Professional Football Players

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**Objective:** The aim of this study was to identify risk factors related to the occurrence of injuries in football players.

**Study Design:** Prospective cohort study.

**Subjects:** A total of 216 football players from 12 teams in the Elite Football League participated in the study.

**Intervention:** Football-related injury data were collected prospectively during the competitive season 2012/2013.

**Outcome Measures:** Baseline information on player characteristics: anthropometric measurements (weight, height, BMI, subcutaneous adipose tissue), playing experience, injury history, physical fitness performance test (agility run), and peak oxygen uptake were recorded at the beginning of the study. During the competitive season 2012/2013 the rate, type, and severity of injuries and training and game exposure times were prospectively documented for each player.

**Results:** A majority of the players (N = 155, 72%) were injured during the observation period. The overall rate of injury was 6.3/1000 athlete-exposures. The rate of injury per 1000 athlete-exposures was greater during competitions (20.7) than during practices (3.21).

Multivariate logistic regression showed that playing experience [odds ratio (OR) = 0.44; 95% CI, 1.49-2.81;  $P < 0.01$ ], age (OR = 2.05; 95% CI, 1.49-2.81;  $P < 0.01$ ) and a previous injury (OR = 4.4; 95% CI, 2.14-9.07;  $P < 0.01$ ) were significantly related to increased risk. Body mass index was not associated with risk of injury. Strains (34.19%) and sprains (25.81%) were the major injury types, the lower extremity being the site of 85.16% of the injuries reported. Direct contact was reported to be involved in 49.7% of all injuries. Twenty-seven percent of injured players were absent from football for more than 1 month, with knee injuries (25.42%) the most serious.

**Conclusions:** Risk factors that increase injury rates in football players were previous injury, older age, and playing experience. Future research should include adequate rehabilitation program to reduce the risk of injuries.

### Prediction of Hamstring Muscle Injuries by Isokinetic Assessment in Professional Football: Assessment of Ten Football Seasons

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**Objective:** The aim of our study was to evaluate the isokinetic tests' ability to predict the occurrence of hamstring muscle injuries in the season.

**Study Design:** Retrospective.

**Subjects:** One hundred thirty-six professional football players (only males) who had an isokinetic test early in the season.

**Intervention:** Two populations were identified. First, the occurrence of hamstring muscle injury in the season that followed the tests ( $n = 65$ ; age  $25.2 \pm 4.2$  years; height  $180.8 \pm 4.6$  cm; weight  $76.1 \pm 6$  kg), or, second, the absence of it ( $n = 285$ ; age  $22.5 \pm 4.8$ ; height  $180.4 \pm 5.8$ ; weight  $75.2 \pm 6.9$  kg).

**Outcome Measures:** Three hundred fifty isokinetic tests were performed early in the season on 136 professional football players between 2001 and 2011.

**Results:** No significant difference was found between the 2 populations for the various bilateral and unilateral conventional and mixed ratios. The mixed ratio IJexc 30/Qcon 240  $< 0.80$ , the conventional ratio IJ/Qcon 180  $< 0.47$ , and the bilateral ratio IJ/Icon 60  $< 0.85$  are the most predictive parameters for predicting the occurrence of hamstring muscle injury. Conventional ratio IJ/Qcon 60  $< 0.47$  predict the occurrence of an injury according to its severity, and this regardless of the time the isokinetic tests were taken. In case of abnormalities of these 3 ratios, the probability of occurrence of hamstring muscle injury can reach 72%.

**Conclusions:** In order to predict the occurrence of hamstring muscle injury in the season, we propose performing an isokinetic test early in the season to all professional football players according to the following protocol: 3 to 5 concentric repetitions of flexors and extensors at 60°/seconds and at 240°/seconds and 5 repetitions flexor eccentric at 30°/seconds to calculate different predictive ratios.

### Effectiveness of an Isokinetic Rehabilitation Program After Autologous Chondrocyte Implantation for Isolated Cartilage Defects of the Knee

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**Objective:** To determine the effectiveness of an isokinetic rehabilitation program for strengthening of flexors and extensors and reduction of muscular imbalance in subjects with autologous chondrocyte implantation (ACI) for isolated cartilage defects of the knee.

**Study design:** Prospective, pretest-posttest-type, clinical trial.

**Subjects:** Seven males with TCA surgery in rehabilitation phase.

**Intervention:** Subjects performed 27 sessions for muscular strengthening of flexors and extensors in electronic dynamometer within 3 phases: the first one with maximal short range of motion (ROM); the second phase with submaximal ROM; and the third phase with maximal ROM.

**Outcome Measures:** A bilateral isokinetic evaluation was performed at the beginning and end of the intervention for measurement of the peak torque of flexors and extensors, muscle balance, and strength ratio between involved and not involved pelvic members. Comparison of the outcome measurements were evaluated by the Wilcoxon signed rank test.

**Results:** At the end of the exercise program, the involved members increased the peak torque of flexors and extensors with a tendency to normalize the agonist/antagonist ratio ( $68.8 \pm 13.9$  %); less differences of the strength between involved and not involved pelvic members were observed and the

profiles of the muscular fibers recruitment in the morphological isokinetic curves became normal.

**Conclusions:** The isokinetic exercise program was not effective to restore the complete strength of the extensor apparatus of the knee in subjects with ACI; however, it improves the muscle balance agonist/antagonist safely for the patient and the implant as a whole.

### Compliance of Preventive Neuromuscular Training Program in Female Athletes: Comparison of Coaches' and Athletes' Compliance Rates

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**Objective:** To compare coaches' and athletes' compliance of preventive neuromuscular training (NMT) that aims to reduce traumatic knee injuries such as anterior cruciate ligament (ACL) injury in young female athletes.

**Study Design:** Prospective, randomized, placebo controlled, double-blinded clinical trial.

**Subjects:** A total of 56 (439 female athletes) middle and high school female athletic teams (basketball, soccer, and volleyball) were randomly allocated either experimental or control arm and followed for 1 athletic season.

**Intervention:** Experimental group ( $N = 32$ ; 14 basketball, 6 soccer, and 12 volleyball teams) performed an NMT program that aims to reduce traumatic knee injuries through trunk stabilization and hip strengthening program. Control group ( $N = 24$ ; 13 basketball, 5 soccer, and 6 volleyball teams) performed resistive rubber band running program.

**Outcome Measures:** Compliance rates of the assigned NMT interventions protocol (3 times per week during preseason and 2 times per week in-season) obtained from coaches (coaches' compliance rate) and athletes (athletes' compliance rate) were compared between the study arms (experimental vs control) based on school levels (middle and high schools) and sports (basketball, soccer, and volleyball).

**Results:** Coaches' compliance rate was significantly greater in the experimental group ( $58.8\% \pm 18.7\%$ ; mean of  $1.4 \pm 1.2$  times per week during preseason and  $1.3 \pm 0.5$  times per week during in-season) compared to the control group ( $44.1\% \pm 11.8\%$ ; mean of  $1.1 \pm 1.0$  times per week during preseason and  $1.0 \pm 0.3$  time per week during in-season). ( $P = 0.002$ ) The greater coaches' compliance rate was observed in the experimental group at high school ( $P = 0.003$ ) and in basketball ( $P = 0.027$ ). There was no difference in athletes' compliance rate between the 2 study arms at school levels and in sports.

**Conclusions:** The difference in coaches' compliance rate may stem from content of the prescribed NMT intervention and/or busy competition schedules. Nearly 90% of athletes performed greater than two-thirds of the assigned NMT interventions. Because previous studies reported an inverse dose-response relationship between preventive NMT compliance/dosage and number of ACL injuries, it is essential to focus on strategies to enhance and maintain high compliance among coaches to prevent female athletes from traumatic knee injuries.

Friday, June 20, 2014

Topic: Concussion

### Reliability of a Computerized Neurocognitive Test in Baseline Concussion Testing of High School Athletes

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**Objective:** Baseline assessments using computerized neurocognitive tests are frequently used in the management of sport-related concussions. Such testing is often done on an annual basis. Reliability is a fundamental test characteristic that should be established for such tests. Our study examined the test-retest reliability of 1 computerized neurocognitive test in high school athletes over 1 year.

**Study Design:** Repeated measures design.

**Subjects:** High School athletes (N = 117) participating in American football or soccer during the 2011-2012 and 2012-2013 academic years.

**Intervention:** All study participants completed 2 baseline computerized neurocognitive tests taken 1 year apart. The test measures performance on 4 cognitive tasks: identification speed (Attention), detection speed (Processing Speed), 1 card learning accuracy (Learning), and 1 back speed (Working Memory).

**Outcome Measures:** Reliability was assessed by measuring the intraclass correlation coefficients (ICC) between the repeated measures of the 4 cognitive tasks. Pearson's and Spearman's correlation coefficients were calculated as a secondary outcome measure.

**Results:** The measure for identification speed performed best (ICC = 0.672; 95% CI, 0.559-0.760) and the measure for 1 card learning accuracy performed worst (ICC = 0.401; 95% CI, 0.237-0.542). All tests had marginal or low reliability.

**Conclusions:** In a population of high school athletes, computerized neurocognitive testing demonstrated low to marginal test-retest reliability on baseline assessments 1 year apart. Further investigation should focus on (1) improving the reliability of individual tasks tested; and (2) identifying the ideal time interval to repeat baseline neurocognitive testing in high school athletes.

### The Incidence of Concussion at the 2013 Canadian National Age-Grade Rugby Championship

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*Affiliation: Allan McGavin Sports Medicine Centre, The University of British Columbia, Vancouver, British Columbia, Canada.*

**Objective:** To determine the incidence of concussion during a 5-day rugby tournament, as well as the relationship between concussion incidence and age, sex, and number of games played.

**Study Design:** Retrospective chart review.

**Subjects:** Nine hundred fifty athletes participated in the tournament. Charts from all athletes who were assessed by a tournament physician were reviewed.

**Observation Technique:** History and SCAT3 clinical tool.

**Outcome Measures:** Clinical concussion diagnosis.

**Results:** Twenty-seven athletes (2.84%) were diagnosed with concussion during the 5-day tournament. The overall incidence of diagnosed concussion was 9.57 concussions per 1000 player hours (95% CI, 6.57-13.93). The incidence was significantly higher in females than males (15.56 vs 6.77,  $P = 0.023$ , 95% CI for incidence rate difference, 16.53-1.05). The incidence was significantly higher in males aged 13 to 15 compared to those aged 16 to 19 (33.2 vs 1.23,  $P = 0.003$ , 95% CI for incidence rate difference, 11.3-52.6). There were only 2 males over the age of 15 who were diagnosed with a concussion. There was insufficient data to assess the relationship between concussion incidence and number of games played.

**Conclusions:** Incidence of concussion at the 5-day tournament was much higher than previously published rates for rugby as well as other collision sports. The majority of previous studies have had coaches or players report injuries themselves, but it has been shown that reported injury rates are higher when the diagnosis is being made and reported at the time of injury by a trained individual, as occurred in this study. The incidence in males aged greater than 15 was low and suggests they may not have been presenting for medical care. The high incidence in males under the age of 15 should prompt further assessment of the safety of play in this age group and what could be done to decrease the frequency of concussion.

### Do Baseline ImpACT Scores Change Following Recovery from Concussion?

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**Objective:** To compare ImpACT baseline scores preconcussion and postconcussion resolution.

**Study Design:** Retrospective chart review.

**Subjects:** Ten previously concussed student-athletes from the University of Regina's women's hockey and soccer teams, as well as the men's hockey team who performed pre- and postconcussion baseline ImpACT testing.

**Intervention:** ImpACT testing. Signed consent was obtained from all participants used in this study.

**Outcome Measures:** The primary outcome measurement is the difference in baseline ImpACT scores before and after concussion.

**Results:** The data will be examined with regards to its suitability for parametric analyses. If the data is normally distributed, a paired samples  $t$  test will be used to compare mean pre- and post-ImpACT baseline scores, otherwise the nonparametric alternative, the Wilcoxon signed ranks test, will be used. The time period between baseline testing, the gender and age of the athlete, as well as the number of previous concussions experienced will also be commented on. The findings presented in this study will provide beneficial insight into concussion screening protocols utilized by sporting organizations worldwide.

**Conclusions:** Surprisingly, our review of the initial data set (6 subjects) shows improvement between pre- and postconcussion baseline scores. In all 6 subjects, the cognitive efficiency index improved after their concussions. Once all 10 participants' data is collected, statistical analysis will be completed. We anticipate conclusions to be complete in 1 month.

### The Effect of 15 Minutes of Passive Rest on SCAT3 Scores Following Maximal Aerobic Exercise

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**Objective:** To determine whether a 15-minute rest period following maximal aerobic exercise is an adequate amount of time for Sport Concussion Assessment Tool—3<sup>rd</sup> Edition (SCAT3) scores to return to baseline.

**Study Design:** Prospective observational study.

**Subjects:** Twenty-six healthy active subjects participated (20 males and 6 females).

**Intervention/Observation Technique:** Each participant was assessed using the SCAT3 to obtain baseline measures, followed by a graded exercise test (GXT) to determine participants'  $\dot{V}O_{2\max}$  and ensure maximal exhaustion. Participants were then given 15 minutes of passive rest and reassessed using the SCAT3.

**Outcome Measures:** The outcome measurements were scores for each section of the SCAT3: number of symptoms, symptom severity score, orientation, immediate memory, concentration, delayed recall, double leg/single leg/tandem stance, tandem gait, and coordination. Paired  $t$  tests were used to detect differences in SCAT3 scores, using a significance level of  $P < 0.05$ .

**Results:** The mean age, height, and mass of participants were  $27.0 \pm 4.0$  yr,  $176 \pm 11$  cm and  $80.3 \pm 14.0$  kg, respectively. The number of symptoms increased from  $1.7 \pm 1.5$  to  $5.0 \pm 3.6$  during pre- and post- $\dot{V}O_{2\max}$  SCAT3 assessment, respectively ( $P < 0.05$ ). Symptom severity scores also increased from pre- to post- $\dot{V}O_{2\max}$  SCAT3 assessment ( $2.2 \pm 2.1$  vs  $7.0 \pm 5.2$ , respectively;  $P < 0.05$ ). Time to complete tandem gait decreased from pre- to post- $\dot{V}O_{2\max}$  assessment ( $14.9 \pm 3.0$  s vs  $13.5 \pm 3.4$  s;  $P < 0.05$ ).

**Conclusions:** Our data suggests that 15 minutes of passive rest following maximal aerobic exercise may not be enough time to allow the number of

symptoms and symptom severity scores to return to baseline in SCAT3 assessment. While symptom scores are subjective, it remains possible that the observed differences may be due to the effects of exercise. Furthermore, the decrease in time to complete tandem gait post- $\dot{V}O_2$ max indicates that this parameter may be sensitive to a training effect.

**Acknowledgements:** Financial assistance was provided by the Pan Am Clinic Foundation.

### Quantitative Assessment of Sensorimotor Dysfunction and Recovery Using Robotics in Athletes Sustaining an Acute Sport-Related Concussion

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**Objective:** To determine the clinical utility of a novel robotic assessment tool to aid with acute sport concussion assessment and management.

**Study Design:** Prospective case series.

**Subjects:** A total of 313 male and female elite youth ice hockey players, University of Calgary and Southern Alberta Institute of Technology ice hockey players, and Canadian National bobsleigh, skeleton, luge, and alpine athletes (mean age, 21 years) competing during the 2011-2012 athletic season.

**Outcome Measures:** Baseline and postconcussion (physician diagnosed) robotic assessments of neurological function (reaction times, divided attention, working memory, visuo-spatial planning, proprioception, and movement coordination) using the KINARM end-point robotic device in 5 different tasks.

**Results:** Twenty-nine of the 313 athletes (9.3%) completing a baseline clinical and robotic assessment in 2011 sustained an acute sport concussion during the 2011 to 2012 season. Many of the concussed athletes declined in performance on the postconcussion robotic testing compared to their baseline assessments. Twenty-two concussed athletes demonstrated deficits in a test of position sense ( $P = 0.005$ ). Nineteen demonstrated slowing of their movement speed in a bimanual interactive task requiring subjects to hit and avoid various virtual shapes (left hand,  $P = 0.03$ ; right hand,  $P = 0.09$ ). Twenty-two of the concussed athletes demonstrated significantly longer times when performing an automated version of the Trails B neurocognitive test ( $P = 0.002$ ). In general, performance trended back towards baseline in the weeks following the concussion.

**Conclusions:** The clinical use of robotics in postconcussion assessment shows promise in objectively quantifying degradation of sensorimotor performance and recovery that is not always evident using existing standard clinical tools. Further analyses are warranted including the development of baseline sensorimotor normative data for high-risk athletic populations and comparing the sensitivity of this device with other standardized measures of clinical concussion recovery (ie, symptoms, neurological examination, balance, and neurocognitive).

**Acknowledgements:** Own the Podium, Canada; University of Calgary Sport Medicine Centre; BKIN Technologies, Queen's University; Jim Smith, Calgary, Alberta; Canadian Sport Institute Calgary; participating team Athletic Therapists, Physiotherapists, and Coaches; KINARM robot technicians: Sarah Snow and Kerri Downer.

### Retrospective Review of Baseline Sport Concussion Assessment Tool 3 Scores in Elite Adolescent Hockey Players During a Preseason Physiological Testing Combine

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**Objective:** To retrospectively review preseason baseline SCAT3 scores in a cohort of adolescent male AAA hockey players collected during a preseason physiological testing combine.

**Study Design:** Retrospective cohort study.

**Subjects:** Two hundred fifty-seven adolescent (age 13-17 years) male AAA hockey players.

**Intervention/Observation Technique:** Baseline SCAT3 results were retrieved and analyzed from a preseason testing combine.

**Outcome Measures:** Results were analyzed using descriptive statistics to generate mean, standard deviation, and range for subjective and objective components of the SCAT3. The effect of level of play and previous concussion history was examined using 1-way ANOVA.

**Results:** A total of 257 male athletes with a mean age of  $14.4 \pm 1.2$  years (range, 13-17 years) underwent baseline SCAT3 testing. Mean baseline symptom severity score for the entire cohort was  $3.8 \pm 5.5$  (range, 0-42) with a mean total number of symptoms reported of  $2.4 \pm 3.0$  (range, 0-14). Sixty-five percent of athletes reported 1 or more symptoms at baseline. Significant variability was observed in objective components of the SCAT3 including orientation (3-5), immediate memory (9-15), concentration (1-5), and SAC delayed recall (2-5). Errors per stance on balance examination were  $0.01 \pm 0.09$  (range, 0-1) for double stance,  $0.75 \pm 0.90$  (range, 0-4) for tandem stance, and  $2.91 \pm 2.20$  (range, 0-10) for single leg stance. An effect of age but not concussion history was found on certain subjective and objective aspects of baseline SCAT3 testing.

**Conclusions:** Significant variability in baseline SCAT3 scores exists among adolescent male hockey players in the absence of concussion. Future studies are needed to examine the impact of exercise and administration setting on baseline SCAT3 testing.

**Acknowledgements:** Financial assistance was provided by the Pan Am Clinic Foundation.

### Postconcussion Syndrome is a Major Problem for Many Athletes

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**Objective:** To determine the clinical features of the postconcussion syndrome (PCS) in 138 athletes.

**Study Design:** Retrospective chart review.

**Subjects:** Two hundred eighty-five consecutive concussed patients seen in the Toronto Western Hospital between 1997 and 2013.

**Observation Technique:** A chart review of clinical and demographic data was performed. A total of 138/285 patients had sports-related PCS.

**Outcome Measures:** Demographic data and sports-related PCS based on 3 or more postconcussion symptoms lasting 1 month or longer.

**Results:** The mean age of 138 athletes with PCS was 22.8 years, and 70 (50.7%) were 18 years old or less (range, 10-60). There were 87 (63.0%) males and 51 (37.0%) females. They averaged 3.4 concussions (range, 1 to >12). There was only 1 concussion in 19.6%. Ice hockey caused the highest number of the most recent concussions at 72 cases (52.2%). Soccer, snow skiing, equestrian sports, and basketball were other frequent causes. The average number of persistent symptoms was 7.6, and the median duration of PCS was 6 months at first examination.

**Conclusions:** There has been little research about PCS in sports, and there is no universally accepted definition. The DSM and ICD definitions are most commonly used, but considerable differences exist between them and each has arbitrary, non-evidence-based criteria. The predictors of PCS are unknown, although previous concussions appear to be important: more than 80% of PCS cases had more than 1 previous concussion. It was striking that in 20% of cases PCS occurred after a single concussion. Also remarkable was the young age of athletes with PCS: half were 18 years old or less. PCS was associated with many different symptoms and a large number of symptoms per case (7.6). The duration of PCS and the number of symptoms were not related to the number of previous concussions, loss of consciousness (LOC), or return to play (RTP).

Further research on mechanisms, treatment, and prevention of PCS is required.

### Association of Interleukin 6R Genetic Polymorphism and Prospective Concussion in a Multi-Center Prospective Cohort Study of College Athletes

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**Objective:** To investigate associations between genotypes previously found to be associated with traumatic brain injury or other neurological disorders [APOE promoter G-219T, Tau exon 6 Ser53Pro, Tau exon 6 Hist47Tyr, Interleukin (IL)-6, IL-6R 572, PARP-1, tumor necrosis factor alpha (TNF-alpha), and TNF-alpha2] and prospectively occurring and self-reported prior sports-related concussions.

**Study Design:** Multi-center prospective cohort study.

**Subjects:** A total of 3247 college athletes who play football, soccer, and ice hockey at 21 universities.

**Observation Technique:** Participants completed baseline self-report concussion/medical history questionnaires, provided blood, buccal, or saliva samples for genotyping, were genotyped for the above noted polymorphisms, and were followed prospectively for witnessed acute concussion(s).

**Outcome Measures:** Prospective and self-reported prior concussions.

**Results:** A total of 335 concussions were documented prospectively. Prospective concussions were directly associated with a prior SRP concussion and being a male. By Chi-square analysis, prospectively diagnosed concussions were more common among those with the IL-6R CC genotype ( $P = 0.01$ ) and less common among those with the IL-6R AA genotype ( $P = 0.007$ ); and SRP concussions were more common among those with the IL-6R CC genotype ( $P = 0.07$ ), and tended to be less common among those with an IL-6R A allele ( $P = 0.11$ ). No statistically significant associations between IL-6 572 or any of the other genotypes with prospective concussion were observed.

**Conclusions:** These findings suggest that persons with an IL-6R CC genotype may be at higher risk for concussion, but provide little support for associations of the other measured genotypes for the APOE, tau, PARP-1, or TNF proteins with concussion risk.

**Acknowledgements:** Grant funding was provided by NOCSAE (National Operating Committee on Standards for Athletic Equipment), the American Medical Society for Sports Medicine Foundation, and the University of Tennessee Medical Center PMERF.

### Reliability of Balance Error Scoring System (BESS) Test for Concussion in Different Field Conditions

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**Objective:** To compare Balance Error Scoring System (BESS) test performance with cleats-on and barefooted conditions.

**Study Design:** Repeated measure design.

**Subjects:** Sixty athletes from football ( $n = 39$ , all males) and soccer ( $n = 21$ , 11 males and 10 females) teams of McGill University.

**Intervention:** Participants were asked to perform modified BESS test with 3 stances (2 legs, single leg, and tandem) in 3 conditions which were barefooted, with cleats on turf, and with cleats on hard surface. Each performance was scored by 3 observers.

**Outcome Measures:** Performances were averaged from 3 observers and paired  $t$  tests were used to assess mean differences in BESS performances with cleats-on conditions compared to barefooted condition. Reliability was assessed by intraclass correlation coefficient (or ICC).

**Results:** Modified BESS scores were on average 2 points less than barefoot conditions for both cleats-on turf [difference = 2.1; 95% confidence interval (95% CI), 1.6-2.1] and cleats on hard surface (difference = 1.9; 95% CI, 1.3-2.4). A moderate to high inter-observer reliability ( $0.61 \leq \text{ICC} \leq 0.74$ ) was observed for BESS test under 3 conditions.

**Conclusions:** BESS appeared reliable with cleats-on conditions. This study indicates a 2 points lower cut-off from an expected cut-off for suspected concussion when using BESS with cleats-on field conditions.

### Violence-Related Brain Injuries Sustained in Youth Ice Hockey: Implications for Prevention

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**Objective:** The objective was to define and compare the incidence, characteristics, and outcomes of brain injury in youth ice hockey due to violent versus nonviolent mechanisms of injury, and to examine the association between brain injury and violence.

**Study Design:** Case-controls study.

**Subjects:** Canadian youth aged 0 to 19 years of age who presented to the emergency department with an injury resulting from participation in ice hockey. Youth were identified from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), an emergency department-based surveillance system administered by the Public Health Agency of Canada.

**Intervention:** Violence was defined as physical assault or other physically harmful actions by a player that were intended to cause physical pain or injury to another player. Based on narrative descriptions of the mechanism of injury, each youth was categorized as having sustained a violence- or nonviolence-related injury.

**Outcome Measures:** In order to examine outcomes following brain injuries in ice hockey, the outcome was admission to the hospital (cases) or discharge from the emergency department (controls). In order to examine the relationship between brain injury and violence, the outcome was brain injury (cases) or a non-brain injury (controls). Logistic regression was used to determine the associations controlling for potential confounders. Results were presented as odds ratios with 95% confidence intervals.

**Results:** In total, 56 835 youth suffered an injury related to ice hockey. Eleven percent ( $n = 6293$ ) were brain injuries. Youth who engaged in violence were at significantly higher odds of sustaining a brain injury as opposed to an injury to another body part (OR, 1.67; 95% CI, 1.55-1.80). Youth who sustained violence-related injuries were at significantly higher odds of being admitted to the hospital compared to youth who sustained non-violence-related injuries (OR, 2.34; 95% CI, 1.49-5.68).

**Conclusions:** Youth who engage in violence are at higher odds of sustaining a brain injury, and of being admitted to the hospital. Immediate implications for prevention include enforced, stricter penalties for coaches, players, teams, and leagues; economic incentives and disincentives; increased supervision in sports areas; and rule changes that foster greater emphasis on fair play.

### Does the Timing of ImPACT Testing Affect an Athlete's Test Performance?

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**Objective:** To compare the test-retest neurocognitive performances of 2 separate cohorts of clinically asymptomatic college and professional football players.

**Study Design:** Retrospective, cross-sectional, cohort design.

**Subjects:** Ninety-seven (97) male university and professional football players.

**Intervention:** All participants completed baseline pre-season ImPACT. Repeat testing was performed on 2 separate groups: Group 1 (66 subjects) consisted of players who, following a documented concussion, had been medically cleared to return to play pending ImPACT testing. Group 2 (31 subjects) consisted of asymptomatic players performing postgame ImPACT within 24 hours of game participation.

**Outcome Measures:** One-way analysis of variance (ANOVA) was performed on both groups' composite scores across 5 domains (Verbal Memory, Visual Memory, Visual Motor, Reaction Time, and Impulse Control). Additional post-hoc analysis was performed to assess for inter-group differences using Bonferroni correction. *P* values were adjusted to correct for the familywise error rate.

**Results:** One-way ANOVAs demonstrated statistically significant differences between the 2 test groups' ImPACT composite scores in 4 of 5 domains: Verbal Memory ( $F = 4.023$ ,  $P \leq 0.019$ ), Visual Motor ( $F = 5.160$ ,  $P \leq 0.007$ ), Reaction Time ( $F = 6.261$ ,  $P \leq 0.002$ ), and Impulse Control ( $F = 5.631$ ,  $P \leq 0.004$ ), but not Total Symptom Score ( $F = 1.354$ ,  $P = 0.26$ ). Post-hoc analysis found that compared to baselines, Group 1 demonstrated significant improvement in Verbal Memory ( $P \leq 0.18$ , Visual Motor ( $P \leq 0.05$ ), and Reaction Time ( $P \leq 0.002$ ), whereas Group 2 did not demonstrate a significant change. Group 2 was found, however, to have poorer Impulse Control scores compared to baselines ( $P \leq 0.006$ ) and Group 1 ( $P \leq 0.007$ ).

**Conclusions:** Football players undergoing ImPACT testing just prior to being medically cleared for play demonstrated significantly higher scores on 4 of 5 cognitive domains compared with those without a concussion but tested within 24 hours of game participation. This finding, combined with the poorer Impulse Control observed within Group 2, raises questions about motivation for athletes during ImPACT testing when returning to play versus during an asymptomatic state. Further research regarding optimal testing conditions for athletes is warranted.

### Topic: Sport Science

### The Effects of Different Types of Training on Core Temperature and Sweat Losses in Adolescent Soccer Players

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**Objective:** To investigate the influence of different types of soccer training (high-intensity aerobic and anaerobic training) on core temperature and sweat losses in adolescent soccer players.

**Study Design:** Controlled experimental.

**Subjects:** Eighteen acclimatized male, elite adolescent soccer players (mean age:  $15.5 \pm 0.5$  y, fat:  $12.1 \pm 1.9\%$ , BMI:  $22.4 \pm 1.9$ ) were selected for this study.

**Intervention:** All participants performed 2 different soccer training sessions separated by 1 week. Both sessions performed at an ambient temperature of 20–24°C (relative humidity: 55%–65%) and consisted of 3 parts: (1) standardized warm up, (2) strength training, and (3) small-sided games. Strength training volume and intensity were similar in both experimental sessions. On the contrary, during the first session participants performed three 7 versus

7 games of total duration 30 minutes and during the second session they performed four 4 versus 4 games of total duration 20 minutes.

**Outcome Measures:** Core temperature was measured before and exactly after the end of both trainings using infrared tympanic thermometry. Intake of water and sports drinks and urine output were recorded. Sweat losses and sweat rates were estimated through changes of body mass before and at the end of the training session with correction for the mass of any fluid consumed. Heart rate maximum and Lactate threshold were assessed in previous testing sessions. Training load and % time of training above threshold were assessed using Polar Team System 2.

**Results:** Analysis of the results did not reveal any significant differences on sweat rates, % time of training above threshold and core temperature ( $P > 0.05$ , 95% CI) between the 2 experimental trainings despite the significantly different training load ( $P = 0.00$ , 95% CI). Furthermore, univariate analysis did not show any significant effects of training load and % time of training above threshold on sweat rates ( $P > 0.05$ , 95% CI).

**Conclusions:** Despite the different training loads and the completely different type of trainings—high intensity aerobic training in the first training session and anaerobic training in the second session—core temperature and sweating rates did not significantly change. This observation suggests that other factors such as ambient temperature plays a more important role on individual sweat rate.

### Genetic Predisposition to Sport Injuries in Young Football Players

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**Objective:** Injuries in sports, and the subsequent functional recovery, are the result of the interaction between environmental stimuli and genotype. DNA sequence variations in relevant genes have been associated with specific phenotypes involved in athletic performance, including the individual susceptibility to injuries. The purpose of this study was to analyze the influence of 5 genetic polymorphisms (COL5A1 rs12722, rs1049434 MTC1, VDR Apal, BsmI VDR, and VDR FokI) on the injuries incidence in elite young football players.

**Study Design:** Prospective study.

**Subjects:** Sixty-four young male football players were recruited from 3 teams participating at the Official Italian Football Championship in different categories (Giovannissimi (G),  $n = 17$ , age  $14 \pm 2.7$  years; Allievi (A),  $n = 32$ , age  $15.8 \pm 0.7$  years; Primavera (P),  $n = 26$ , age  $17.6 \pm 0.7$  years) during the season 2012–2013.

**Intervention:** The sample was genotyped for the 5 single nucleotide polymorphisms (SNPs) and injury data were collected during the entire season. Genomic DNA was extracted from buccal swab.

**Outcome Measures:** Injuries incidence was calculated per 1000 hours of exposure to training and matches [ $(\sum \text{injuries} / \sum \text{exposure hours}) \times 1000$ ]. The combined influence of the polymorphisms on injuries was analyzed through the Total Genotype Score (TGS) method.

**Results:** The estimated total incidence was  $3.47 \pm 3.7$  injuries per 1000 hours of exposure (G =  $2.8 \pm 3.1$ ; A =  $3.3 \pm 3.9$ ; P =  $4.9 \pm 3.6$ ). Sixty-three injuries recorded during the season accounted for a loss of 2339 days, that is, absence from training in the pre-season and regular competitive season. Significant positive correlation was found between training volume and incidence of injuries ( $r = 0.27$ ;  $P < 0.05$ ). No significant differences between injuries and single genotypes ( $P = 0.508$ ) were present. Nevertheless, the combined influence of training volume and TGS significantly predicted the injuries rate explaining 10% of the variability of injuries incidence ( $R^2 = 10.36$ ,  $df = 2.61$ ,  $F = 3.52$ ,  $P = 0.03$ ).

**Conclusions:** The training volume together with the combined influence of the polymorphisms included in the study seem to predict the individual susceptibility to development of injuries in elite young football players, while the action of single genotypes does not appear to be sufficient to influence the incidence of injuries in the same group of athletes.

### Effect of “Touch Rugby” Training on the Cardiovascular Autonomic Control in Sedentary Subjects

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**Objective:** To explore the effects of 3 months of “touch rugby” training on the cardiovascular autonomic control in sedentary subjects.

**Study Design:** Cardiorespiratory recordings were achieved before (PRE) and after (POST) the period of touch rugby training at the medical sportive center of the general council of Essonne.

**Subjects:** Twenty healthy sedentary adults (males, 37-62 years old) were involved in this study.

**Intervention:** Continuous cardiorespiratory measurements were achieved during 10 minutes. Subjects were supine and their breathing frequency was paced at 0.25 Hz via audio feedback. In addition, each subject had a medical examination and the visit ended by a graded maximal running test on a treadmill.

**Outcome Measures:** ECG, blood pressure, and breathing flow were digitized and recorded with a PowerLab device. Beat-to-beat RR intervals and systolic blood pressure (SBP) were then respectively extracted from ECG and blood pressure signal. Tidal volume (Vt) and breathing frequency were computed from breathing flow. The Smoothed Pseudo Wigner-Ville Distribution provided instantaneous time frequency components of RR and SBP variability in low (LF-RR and LF-SBP) and high frequency (HF-RR and HF-SBP) bands. In addition, the baroreflex sensitivity was assessed in LF (LF-BRS) and HF (HF-BRS) bands.  $\dot{V}O_2\max$  was measured with a gas analyser (Oxycon, Carefusion, Germany) during the exercise test on a treadmill.

**Results:** Between PRE and POST, resting heart rate ( $74 \pm 10$  vs  $69 \pm 12$  beats·min<sup>-1</sup>,  $P < 0.05$ ), Vt ( $1.53 \pm 0.46$  vs  $1.27 \pm 0.38$  L,  $P < 0.05$ ) and SBP ( $118 \pm 19$  vs  $103 \pm 22$  mm Hg,  $P < 0.01$ ) decreased. For heart rate variability (HRV) components: RMSSD ( $34.6 \pm 30.1$  vs  $47.6 \pm 34.8$  ms,  $P < 0.001$ ), HF-RR ( $590 \pm 288$  vs  $1262 \pm 767$  ms<sup>2</sup>,  $P < 0.001$ ), and HF-RR normalized with Vt ( $424 \pm 288$  vs  $1015 \pm 622$  ms<sup>2</sup>,  $P < 0.001$ ) increased whereas LF/HF ratio ( $3.5 \pm 3.4$  vs  $1.5 \pm 0.9$ ,  $P < 0.05$ ) decreased. The baroreflex sensitivity in HF increased ( $13.4 \pm 10.1$  vs  $26.0 \pm 20.9$  ms·mmHg<sup>-1</sup>,  $P < 0.05$ ).  $\dot{V}O_2\max$  increased ( $34.7 \pm 6.6$  vs  $37.2 \pm 5.9$  mL·min<sup>-1</sup>·kg<sup>-1</sup>,  $P < 0.01$ ).

**Conclusions:** Playing touch rugby with 1-hour 30 sessions weekly during 3 months modified the cardiovascular autonomic control of healthy sedentary subjects. A decrease in the sympathetic tone combined with both an increase in the vagal tone and a decrease in systolic blood pressure at rest were observed. Therefore, such training seems beneficial to cardiac health.

### Hip Strength in Healthy People: A Novel Approach to Detecting Side-to-Side Deficits

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**Objective:** To determine comparative side-to-side data of hip abduction/abduction strength in healthy people.

**Study Design:** Cohort study.

**Subjects:** Two hundred twenty-two adolescent males and adults under 40 years with no recent lower limb injury or back pain.

**Observation Technique:** Applying established techniques using hand-held dynamometry hip strength was tested in 3 hip abduction positions (Abd, Clam, and GDom) and 1 hip adduction position.

**Outcome Measures:** Each position was tested twice in a randomised order for 2 cycles. The maximum score for each test was used for comparative analysis.

**Results:** One hundred thirty-one adolescent males (mean age 15.5 years) and 91 adults were tested. The adult cohort comprised 52 men and 39 women of mean age 24.4 years. For each test the results were analysed by comparing the stronger and weaker hip, regardless of the magnitude of the difference. Large side-to-side differences were detected. The mean scores differed in the GDom position by 15% (SD 10), Abd 14% (SD 10), Adduction 11% (SD 8), and Clam 10% (SD 8%). The 3 variable positions of hip abduction resulted in large differences. For example, representative data from the female group left-sided testing showed a mean abduction strength in the Clam position of 211N (SD 59.4), Abd 134N (SD 50.4), and GDom 100N (35.4). These 3 mean scores were significantly different ( $P < 0.05$ ). The results from the adult men and adolescents were similar.

**Conclusions:** Large hip strength asymmetry in normal noninjured people has not been reported previously. Accepting 15% as an arbitrary upper limit for “normal” side-to-side hip strength variability, 30% of participants in this study exceeded this threshold. This study demonstrates objectively that in a “normal” population there is side-to-side weakness of abduction with significant asymmetry. Of these test positions, GDom produced the weakest and most asymmetrical results, with Clam being twice as strong and more symmetrical. Hip strength asymmetry in active individuals and hip abduction weakness has been tenuously linked to imbalance, poor landing technique, abnormal gait, and as a possible predictor of injury. Objective measures will enhance our understanding and contribute to improved preparticipation screening, prevention, and injury management.

### Selected Hormonal Changes in Ultra-Marathon Runners and in Winter Swimmers

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**Objective:** To determine the reaction of the human body in 2 extreme performance conditions: ultra-marathon running and swimming in ice cold water.

**Study Design:** Venous blood was sampled under resting conditions prior to and after finishing either a 100-km run and/or distance between 100 m and 1000 m in very cold water (5.8°C).

**Subjects:** Twenty-eight endurance runners and 78 winter swimmers volunteered for the study.

**Intervention:** All runners successfully finished 1 of 3 100-km running competitions organized in 2012 and 2013. Running time ranged between 7:19 to 11:56 hours. All swimmers successfully finished a swimming distance of 100, 250, 500, 750, and/or 1000 meters. Swimming time ranged between 3:10 to 21:30 minutes.

**Outcome Measures:** Blood samples were analyzed for selected hormones, immunological markers, and markers of muscle and kidney injury. Student's *t* test was used for statistical evaluation of the values obtained prior to and after the performance. Cortisol, prolactin, testosterone, immunoreactive insulin, human growth hormone, TT3, TT4, and leptin levels were studied.

**Results:** There were significant shifts in all of the selected hormones, which indicated a very expressive response of the athlete's body to an extremely hard load. However, the response in runners and winter swimmers was different, in accordance with the specific conditions of each discipline.

**Conclusions:** Hormonal changes during 2 types of extreme load evoke not only immune and tissue changes, but also very significant endocrine reactions. In many cases individual reaction exceeded the physiological

borderline, and only healthy, well-trained, and fit athletes can recover within a short period after the condition.

### Correlations Between Baseline Physiological Factors and Exercise-Induced Autonomic Changes

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**Objective:** Heart rate variability (HRV) quantification as indicator of exercise-induced changes in autonomic cardiac regulation show wide inter-person standard deviations, as well as inconsistencies in study results. In the current study it was theorised that baseline/preintervention systolic blood pressure (SBP), diastolic blood pressure (DBP), fitness ( $\dot{V}O_2\text{max}$ ), body mass index (BMI), as well as the preintervention status of the ANS (reflected by specific HRV indicators), correlate significantly with the exercise induced response of HRV indicators.

**Study Design:** A prospective cohort study.

**Subjects:** One hundred eighty-three volunteers (100 males and 83 females) between 18 and 22 years participated.

**Intervention:** A 12-week, medium- to high-intensity exercise intervention was completed by all volunteers.

**Outcome Measures:** Aspects of physiological status included were blood pressure, fitness, BMI, and baseline autonomic function. The independent variables were baseline SBP, DBP,  $\dot{V}O_2\text{max}$ , BMI, and supine HRV indicator values. The dependent variables were the changes in HRV indicator values calculated as postintervention HRV indicator value—pre-intervention HRV indicator values.

**Results:** No significant relationships ( $P < 0.05$ ) were found between the preintervention systolic or diastolic blood pressure and the exercise-induced changes in the supine HRV indicator values. In this group with normal BMI values (mean = 22.33, SD = 3.01), results indicated only 2 (LFnu and LF ms<sup>2</sup>) significant ( $P = 0.03$  and  $P = 0.034$ ), but weak correlations ( $r = -0.1894$  and  $r = -0.1965$ ) between the preintervention BMI and the exercise-induced responses of the HRV indicators. However, significant correlations were found between all preintervention indicators of ANS function and the response of the HRV indicator values to the exercise intervention.

**Conclusions:** Results indicated that there was no significant association between baseline blood pressure in this normotensive group and exercise-induced changes in HRV. Results also suggested that in young, healthy participants, baseline BMI (within normal ranges) and fitness is not strongly associated with the HRV response to exercise. However, the correlations between preintervention autonomic function and the response of all the HRV indicator values revealed baseline ANS function as perhaps the most significant determinant of the exercise-induced autonomic responses. Baseline autonomic function could thus be a significant confounder in the outcome of exercise studies.

### Autonomic Training Effects: The Difference Between 12 Weeks and 20 Weeks

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**Objective:** There are a wide variety of results published on the effect of training on the autonomic nervous system (ANS) as measured by noninvasive cardiovascular variability indicators. The aim of this study was to determine if 20 weeks of a highly standardized medium to high-intensity exercise intervention is superior to a 12-week medium- to high-intensity exercise intervention, in terms of fitness and cardiac autonomic changes measured in a healthy population. It was hypothesized that 20 weeks of exercise would yield higher and higher vagal cardiac control of heart rate than only 12 weeks.

**Study Design:** Prospective exercise intervention.

**Subjects:** One hundred fifty-four volunteers between the ages of 18 and 22 participated.

**Intervention:** This was a prospective 20-week, medium- to high-intensity exercise intervention.

**Outcome Measures:** Time domain, frequency domain, and Poincaré analysis were used for heart rate variability (HRV) quantification.  $\dot{V}O_2\text{max}$  was indirectly determined via the 2.4-km run test.

**Results:** The significant effect of basic training on  $\dot{V}O_2\text{max}$  between week 1 and week 12 (48.57, SD = 9.25 vs 53.36, SD = 7.21;  $P \leq 0.001$ ) did not continue during weeks 12 to 20 (53.36, SD = 7.21 vs 53.87, SD = 7.87;  $P = 0.44$ ). No changes were found after 12 weeks in the supine LF/HF (0.48 vs 0.41;  $P = 0.70$ ) or the standing LF/HF (4.02 vs 3.19;  $P = 0.40$ ) HRV indicator of autonomic balance. However, the power of the supine HRV indicators of vagal induced variability continued to increase after 12 weeks (RMSSD: 80.20 vs 94.15,  $P = 0.015$ ; pNN50: 56.60 vs 61.30,  $P = 0.083$ ; SD1: 57.00 vs 66.90,  $P = 0.013$ ; HF: 2448.50 vs 3016.05,  $P = 0.023$ ). The power of standing HRV indicators of vagal induced variability also continued to increase after 12 weeks (RMSSD: 33.90 vs 37.10,  $P = 0.021$ ; pNN50: 12.45 vs 12.85,  $P = 0.011$ ; SD1: 24.35 vs 26.60,  $P = 0.011$ ; HF: 447.50 vs 520.00,  $P = 0.011$ ).

**Conclusions:** The extension of a medium- to high-intensity exercise program, from 12 to 20 weeks, provides little benefit in terms of increased exercise capacity as measured by  $\dot{V}O_2\text{max}$ . However, cardiac conditioning continued during 12 to 20 weeks as indicated by decreased sympathetic and increased vagal cardiac control.

### The Validity and Reliability of Yo-Yo Intermittent Recovery Test 2 (YIRT2) to Estimate Maximal Oxygen Uptake ( $\dot{V}O_2\text{max}$ ) in Iranian Elite Female Futsal Players

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**Objective:** The purpose of the study was to determine the validity and reliability of the Yo-Yo Intermittent Recovery Test 2 (YIRT2) to estimate maximal oxygen uptake ( $\dot{V}O_2\text{max}$ ) in elite female futsal players.

**Study Design:** For data collection, subjects participated in 3 test sessions. In the first session,  $\dot{V}O_2\text{max}$  using respiratory gas analysis (K4B2 devices manufactured COSMED Italy), body composition using body composition measurement machine (InBody 520 made in Korea), and anthropometric characteristics were measured at the National Olympic Academy. In the second session, 1 week after the first session, the first YIRT2 estimated  $\dot{V}O_2\text{max}$  test and was performed to determine the validity. In the third session, 1 week after the second session, YIRT2 second test was conducted to determine the reliability. Heart rates were recorded before and after the first and second YIRT2 tests and respiratory gas analysis during the test.

**Subjects:** Subjects were Iranian elite female futsal players ( $n = 21$ , mean age  $22.46 \pm 3.04$  yrs, height  $164.1 \pm 4.85$  cm, and body mass  $56.6 \pm 7.31$  kg).

**Intervention:** All subjects performed a graded exercise test on motorized treadmill to examine  $\dot{V}O_2\text{max}$  by breath-to-breath gas analyzing and the YIRT2 to estimate  $\dot{V}O_2\text{max}$ .

**Results:** The  $\dot{V}O_2\text{max}$  values measured by gas analyzer and estimated by YIRT2 correlated ( $r = 0.88$ ,  $r^2 = 0.77$ ,  $P = 0.001$ ), indicating that the YIRT2 is valid test to estimate  $\dot{V}O_2\text{max}$ . Test-retest results found the YIRT2 to be reliable ( $r = 0.98$ ,  $r^2 = 0.96$ ,  $P = 0.001$ ).

**Conclusions:** We conclude that YIRT2 was a valid and reliable test to estimate  $\dot{V}O_2\text{max}$  in elite female futsal players. The YIRT2 appears to measure aerobic fitness but may also be used as a field test of the ability to repeat high-intensity efforts. The heart rate, expressed as a percentage of individual maximal values obtained immediately after of the Yo-Yo IR2 test, has been observed to be inversely correlated to the performance of the Yo-Yo test. These findings suggest that the test can provide information about the capacity of an individual, if the test is of sufficient duration. That heart rate measurements can be utilized is supported by the observation that the heart rate, expressed as a percentage of maximal heart rate, during the Yo-Yo IR2 test was inversely related to work performed at a high intensity during a soccer game.

### Postural Control in Junior and Young Male Soccer Players

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**Objective:** We aimed to investigate the postural control parameters in junior and young male soccer players.

**Study Design:** Randomized clinical trial.

**Subjects:** Thirty-two male soccer players 13 to 19 years of age from a Turkish Super League soccer club participated in the study. The subjects played in the same soccer club in the last 4 years.

**Intervention:** Postural control parameters of randomly selected 32 participants were recorded in 2 different time periods: 4 years ago and present time.

**Outcome Measures:** Subjects were evaluated with eyes open, 60-second static double stance conditions. Postural control parameters were mediolateral center of pressure displacements (COPML), anteroposterior center of pressure displacements (COPAP), center of pressure area (COP Area), and center of pressure velocity (COP velocity). The subjects' present and previous outcome measures were compared in order to investigate the changes in 4-year time period.

**Results:** There were statistically significant differences between past and present time results ( $P < 0.01$ ).

**Conclusions:** In our observational study, our players had improvement in postural control in 4 years' time. In junior and young athletes, postural control may change with growth. According to developments in soccer, we may also think that postural control can be affected by sport-specific training, special warm-up programs, and balance and coordination exercises.

### Anthropometric and Physiological Profile of Iranian Elite Female Futsal Players

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**Objective:** The purpose of the present study was to determine the anthropometric and physiological profile of Iranian elite female futsal players.

**Study Design:** Subjects participated  $\dot{V}O_2$ max test session using respiratory gas analysis (K4B2 devices manufactured COSMED Italy), body composition using body composition measurement machine (InBody 520 made in Korea), and anthropometric characteristics were measured at the National Olympic Academy.

**Subjects:** Thirty-three players of Iranian national female futsal team have been recruited ( $n = 33$ , mean age  $22.46 \pm 3.04$  yrs).

**Intervention:** All subjects performed a graded exercise test on motorized treadmill to examine  $\dot{V}O_2$ max, lactate threshold and  $O_2$  pulse by breath to breath gas analyzer apparatus and the 30 s Wingate test to examine anaerobic power.

**Results:** Iranian elite female futsal players had mean height  $164.1 \pm 4.85$  cm, body mass  $56.6 \pm 7.31$  kg, %BF  $21.96 \pm 3.31$ ,  $\dot{V}O_2$ max  $45.91 \pm 6.37$  mL·kg<sup>-1</sup>·min<sup>-1</sup>, lactate threshold at %  $80.05 \pm 8.84$   $\dot{V}O_2$ max,  $O_2$  pulse  $13.42 \pm 1.84$  mL/bpm, and peak and average anaerobic powers  $13.63 \pm 1.81$  and  $7.54 \pm 0.64$  w/kg, respectively.

**Conclusions:** It was concluded that Iranian elite female futsal players had no better anthropometric profile than Brazilian and Turkish futsal players but they had a better anaerobic profile. Our finding may be used to identify talent in futsal and athletic training program design.

### High Levels of Plasma Markers of Myocardial Injury and Cytokines after Marathon

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**Objective:** To evaluate the alterations in cardiac troponin I, marker of myocardial injury, and cytokines, as TNF $\alpha$  and interleukins 6, 8, and 10, in marathon runners before and after a marathon and the correlation between the variables after the exercise.

**Study Design:** Prospective.

**Subjects:** Sixteen male runners, mean age  $36.38 \pm 9.15$  years, who performed the São Paulo International Marathon.

**Intervention:** Subjects were evaluated by a physician, including weight, height, electrocardiogram, and exercise test to determine peak oxygen capacity. Blood samples were collected.

**Outcome Measures:** The exercise test and basal measures occurred 1 month before the marathon. The blood samples were collected in 3 moments: 24 hours before, immediately after, and 72 hours after the marathon. Cardiac troponin I by chemiluminescence and cytokines were analyzed in the blood sample by ELISA.

**Results:** There was difference in all variables over time. The cytokine and troponin concentration increases significantly immediately after marathon and reduce to basal values 72 hours after marathon ( $P < 0.05$ ). We also observed significant correlations between TNF $\alpha$  and cardiac troponin before and immediately after the marathon. Before the marathon the correlation was moderate and positive (+0.539), but after the marathon the correlation was moderate and negative (−0.513). The other variables showed no correlation with troponin levels.

**Conclusion:** The marathon race induces higher levels of cardiac troponin I and cytokines; however, the blood concentrations of these molecules returns to basal levels following 72 hours after marathon.

**Acknowledgements:** Thanks to TEB, GerarMed, and Cosmed who made possible part of this work.

### Comparison of Autonomic Cardiorespiratory Control During Nocturnal Heart Rate Recordings Between Children and Adult Males

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**Objective:** Heart rate variability (HVR) has been broadly used to assess fitness state in sportive subjects. Nocturnal recording has been proposed as a relevant experimental condition to achieve HRV. This study aimed to explore the instantaneous heart rate variability (HRV) components during nocturnal recordings from childhood to adult age.

**Study Design:** Nocturnal recordings of beat-to-beat RR series.

**Subjects:** Nineteen children (11-17 years old) and 14 adults (27-56 years old) were involved in the study.

**Intervention:** After a visit to the laboratory for signing the informed consent, experimenters were shown how to perform heart rate recordings. Children came with their parents. Then, the subject's heart rate (HR) was recorded during the following full night at home. They came back in the following days to return the heart rate monitor.

**Outcome Measures:** The outcome measurements were beat-to-beat HR recordings during a full night at home. Time series were then extracted with the Polar Pro Trainer program. Ten minutes of quiet sleep period were chosen during the full night recording according to Brandenberger et al criteria's. Then, the Smoothed Pseudo Wigner-Ville Distribution (SPWVD) was used to compute the instantaneous components of HRV and breathing frequency (BF). When data distribution was normal, a  $t$  test was computed to compare these components, whereas when data distribution was not normal, a Mann-Whitney Rank Sum Test was used.

**Results:** When comparing children to adults, HR ( $66 \pm 9$  vs  $58 \pm 10$  beats·min<sup>-1</sup>;  $P = 0.02$ ), BF ( $0.271 \pm 0.038$  vs  $0.230 \pm 0.037$  beats·min<sup>-1</sup>;

$P = 0.004$ ), SDHR ( $4.5 \pm 2.2$  vs  $2.1 \pm 0.7$  beats  $\cdot$  min $^{-1}$ ;  $P < 0.001$ ), Log10 (HF-HRV) ( $3.26 \pm 0.57$  vs  $2.60 \pm 0.58$  ms $^2$ ;  $P = 0.004$ ), Log10 (HF-HRV)/RR ( $3.54 \pm 0.34$  vs  $2.46 \pm 0.60$  ms;  $P = 0.002$ ), HF-HRV/(LF-HRV+HF-HRV) ( $0.71 \pm 0.16$  vs  $0.49 \pm 0.22$ ;  $P = 0.002$ ) were higher, whereas LF/HF ratio ( $0.51 \pm 0.49$  vs  $1.80 \pm 2.44$ ;  $P = 0.006$ ) was lesser.

**Conclusions:** Nocturnal HR recordings during deep sleep phases and the subsequent time frequency RR processing allowed demonstration of a different autonomic cardiac control between children and adults. These differences must be taking into account in the noninvasive evaluation of cardiac fitness in healthy humans.

### Acute Prednisone Intake During Brief Intense Exercise

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**Objective:** Systemic glucocorticoid administration (GC) is prohibited in-competition because of the potential ergogenic effects. Although short-term GC intake (5-7 days) has been shown to improve performance, no study has yet demonstrated any ergogenic effect of acute GC intake (drug taken 1-2 times). The purpose of this study was therefore to examine the ergogenic and metabolic effects of acute oral prednisone intake during repeated bouts of high-intensity exercise.

**Study Design:** Prospective, randomized, double blinded clinical trial.

**Subjects:** Nine healthy, physically active, male volunteers.

**Intervention:** Subjects followed 2 treatments (Pred: prednisone, twice 60mg, or Pla: placebo). At the second administration on the second day, they hopped on 1 leg for 30 seconds 3 times consecutively and then hopped until exhaustion, with 5 minutes of passive recovery.

**Outcome Measures:** Performance was assessed by the time of exhaustion during the last hopping bout. Blood and saliva samples were collected at rest and 3 minutes after each exercise bout to determine lactate, interleukin-6, interleukin-10, TNF-alpha, dehydroepiandrosterone (DHEA), and testosterone values. Enzyme-linked immunosorbent assays (ELISA) based on the sandwich principle were used for the blood analyses of IL-6, IL-10, and TNF-alpha. ELISA based on the principle of competitive binding were used for the saliva analyses of DHEA and testosterone. Assays were made in duplicate and coefficients of variation for all parameters were always <10%.

**Results:** Performance was not significantly changed after Pred versus Pla. Acute Pred intake lowered basal and exercise plasma interleukin-6, TNF-alpha, DHEA, and testosterone ( $P < 0.05$ ) and increased basal and exercise interleukin-10 ( $P < 0.05$ ), whereas no significant change was found in blood lactate between Pla and Pred during the experiment.

**Conclusions:** According to these data, acute glucocorticoid intake did not improve performance during repeated bouts of high-intensity exercise, despite the significant anti-inflammatory effect.

**Acknowledgments:** This project was carried out with the support of the World Anti-Doping Agency (WADA). The authors wish to express their gratitude to the subjects for their dedicated performance. In addition, we likewise thank the CHU of Kremlin-Bicêtre, the nurses, and Cathy Carmeni for their expert assistance.

### The Effects of Resistance Training With Blood Flow Restriction on Muscle Strength and Running Speed in Sprinters

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**Objective:** To determine the effectiveness of resistance training with blood flow restriction (BFR) on knee muscle strength and running speed in sprinters.

**Study Design:** Randomized controlled laboratory study.

**Subjects:** Twenty-one healthy college students.

**Intervention:** Subjects were randomly assigned to 3 treatment groups: (1) BFR group (Resistance training with BFR); (2) NBFR group (Resistance training only); and (3) Control group (No resistance training). The BFR group performed the resistance training protocol 3 times a week for 4 weeks. The BFR group underwent the same training protocol under restricted condition (thigh cuff inflated to 50% of detected complete blood occlusion pressure on both legs).

**Outcome Measures:** Before and after training, peak torque/body weight of knee flexion (KF) and Knee extension (KE) at 60 degrees, 180 degrees, and 300 degrees  $\cdot$  s $^{-1}$  of both legs were collected using an isokinetic dynamometer and the fastest 100-m sprint time was collected. A 2-way ANOVA (protocol  $\times$  time) with repeated measures on the second factor was used to analyze the data.

**Results:** There were significant protocol by time interactions for left KE at 300 degrees  $\cdot$  s $^{-1}$ . The difference in time was found to be statistically significant ( $P < 0.05$ ) in sprint time and average PT/BW in right KE at 180 degrees  $\cdot$  s $^{-1}$  and 300 degrees  $\cdot$  s $^{-1}$ , left KE at 180 degrees  $\cdot$  s $^{-1}$  and 300 degrees  $\cdot$  s $^{-1}$ , right KF at 60 degrees  $\cdot$  s $^{-1}$ , 180 degrees  $\cdot$  s $^{-1}$  and 300 degrees  $\cdot$  s $^{-1}$ , left KF at 60 degrees  $\cdot$  s $^{-1}$ , 180 degrees  $\cdot$  s $^{-1}$ , and 300 degrees  $\cdot$  s $^{-1}$ ; however, no difference in protocols was found. Following the BFR training, the sprint time was improved in the BFR group ( $-2.61\% \pm 2.60\%$ ) and NBFR group ( $-2.13\% \pm 2.45\%$ ).

**Conclusions:** The present study demonstrated that resistance training with/without BFR both appeared to enhance sprint performance and knee muscle strength; however, no difference in protocols was found.

### Effect of Oral Contraception on the Diurnal Pattern of Dehydroepiandrosterone

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**Objective:** Oral contraception (OC) induced significant hormonal alterations in hypothalamic-pituitary-adrenal function with alteration in saliva cortisol response, but its impact on the circadian rhythm of dehydroepiandrosterone (DHEA) has never been investigated. The objective was therefore to determine the effects of oral contraception on the diurnal patterns of DHEA.

**Study Design:** Causal comparative design.

**Subjects:** Twenty healthy, physically active, young female volunteers ( $19.9 \pm 1.1$  yrs) were allocated to an OC group ( $n = 10$ ) and a group without oral contraception (WOC,  $n = 10$ ) tested in the follicular and luteal phases.

**Intervention:** Saliva was used because it is convenient and noninvasive for DHEA analysis, with saliva steroid hormone concentrations reflecting the unbound biologically active fraction of serum hormones.

**Outcome Measures:** Saliva samples were collected from each volunteer as follows: at awakening and every 3 hours from 09:00 to 21:00 hours, 2 days, that is, in the middle of the follicular (day 8) and luteal (day 22) phases or pills 8-22 for the OC group. Immunoassay by ELISA (Enzyme-Linked ImmunoSorbent Assay) based on the principle of competitive binding was performed for DHEA analysis. All samples were analyzed according to a blind procedure and were decoded only after analyses were completed, with coefficients of variation always <10%.

**Results:** Overall, a classical diurnal decline in DHEA concentrations was observed with and without OC. After OC, DHEA concentrations were significantly decreased during the first part of the day (awakening till 12:00 h;  $P < 0.05$ ). No day effect was noted.

**Conclusions:** The results indicate that OC but not menstrual cycle affects the circadian pattern of saliva DHEA in healthy active female volunteers. Further

studies are necessary to determine whether this alteration in DHEA circadian pattern may have clinical consequences on the long term.

**Acknowledgments:** The authors wish to express their gratitude to the subjects for their dedicated performance.

### The Aerobic Fitness of Elite Youth Hockey Players

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**Objective:** To determine the aerobic fitness of elite youth hockey players.

**Study Design:** Retrospective database review.

**Subjects:** Two hundred thirty male, AAA ice hockey players between the ages of 13 and 17 years (age,  $14.4 \pm 1.2$  years; height,  $174.3 \pm 8.5$  cm; body mass,  $67.2 \pm 1.5$  kg; body fat,  $9.8\% \pm 3.5\%$ ) from various teams preparing to compete during the 2012–2013 season.

**Observation Technique:** Preseason off-ice testing results were retrieved and analyzed from a human performance database.

**Outcome Measures:** All subjects performed a graded exercise test while connected to either a Parvo Medics TrueOne 2400 or a CareFusion Oxycon Mobile metabolic cart to determine maximal oxygen consumption ( $\dot{V}O_{2max}$ ).

**Results:** Athletes aged 13 years had a lower absolute  $\dot{V}O_{2max}$  when compared with all other age groups ( $P < 0.001$ ). The 14-year-old players had a lower  $\dot{V}O_{2max}$  than the 15- and 16-year-olds ( $P < 0.05$ ). There was no difference in absolute  $\dot{V}O_{2max}$  between the 15- and 16-year-olds ( $P > 0.05$ ). At ventilatory threshold, the 13-year-old players had a lower  $\dot{V}O_2$  than athletes aged 15, 16, and 17 years ( $P < 0.05$ ), while the 14-year-old hockey players were not different from any age group ( $P > 0.05$ ). The 15-, 16-, and 17-year-old players had higher  $\dot{V}O_2$  scores at ventilatory threshold than the 13-year-old players ( $P < 0.05$ ), but did not differ from one another or the 14-year-old players ( $P > 0.05$ ).

**Conclusion:** The aerobic fitness levels of elite youth ice hockey players increases as players get older and mature physically and physiologically. However, aerobic fitness increases to a lesser extent at older ages. This information has the potential to influence off-season training and maximize the aerobic fitness of elite amateur hockey players.

**Acknowledgments:** Financial assistance was provided by the Pan Am Clinic Foundation.

### Anaerobic Fitness of Elite Youth Hockey Players Changes With Age

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**Objective:** The objective of this study was to determine the anaerobic fitness of elite youth hockey players.

**Study Design:** Retrospective database review.

**Subjects:** Two hundred fifty-three hockey players were recruited from Bantam (age, 13–15 years) and Midget (age, 15–17 years) AAA hockey teams (age,  $14.4 \pm 1.2$  years; height,  $174.3 \pm 8.5$  cm; body mass,  $67.2 \pm 11.3$  kg; body fat,  $9.8\% \pm 3.5\%$ ) to participate in this study.

**Observation Technique:** Preseason off-ice testing results were retrieved and analyzed from a human performance database.

**Outcome Measures:** All participants performed a 30-second Wingate test, with the resistance set at 7.5% of the athletes' body weight, on a Monark Ergonomic 894E cycle ergometer that was connected to Monark Wingate software to determine results.

**Results:** The 13-year-old athletes achieved an absolute peak power output lower than the 14-, 15-, 16-, and 17-year-old age groups ( $P < 0.001$ ). The absolute peak power output for the 14-year-old athletes was lower than the 15-, 16-, and 17-year-old athletes ( $P < 0.001$ ). The 15-, 16-, and 17-year-old athletes' peak power output did not differ from one another ( $P > 0.05$ ). The 13-year-old athletes had a lower absolute average power output than all other

age groups ( $P < 0.001$ ). The 14-year-old age group had a lower average power output than the 15-, 16-, and 17-year-olds ( $P < 0.001$ ), while the 15-year-olds also had a lower average power output than the 16-year-olds ( $P < 0.05$ ).

**Conclusion:** Since elite youth ice hockey players demonstrated increased anaerobic fitness with increased age, off-season training programs should be designed to train the ensure anaerobic capacity is at a level specific to the age level of competition.

**Acknowledgments:** Financial assistance was provided by the Pan Am Clinic Foundation.

### Strength Changes in Youth Hockey Players

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**Objective:** To create a profile of anthropometric, muscular strength, muscular power, muscular endurance, and agility characteristics for elite amateur youth hockey players.

**Study Design:** Retrospective database review.

**Subjects:** Two hundred sixty male AAA ice hockey players. Age categories were grouped as 13 years old (yo) ( $n = 75$ ), 14 yo ( $n = 70$ ), 15 yo ( $n = 58$ ), and 16 yo ( $n = 57$ , includes 11 players 17 yo).

**Observation Technique:** Preseason off-ice testing results were retrieved and analyzed from a human performance database.

**Outcome Measures:** Outcome measures included height, weight, body fat percentage, grip strength, push-ups/bench press, supine rows, vertical jump, standing long jump, hip adductor and abductor strength, 5-10-5 shuttle, and the plank test. One-way ANOVAs and Tukeys post-hoc tests were performed to determine changes in the immediately successive age group ( $P < 0.05$ ).

**Results:** Statistically significant ( $P < 0.05$ ) increases in the following variables were demonstrated between successive age groups: weight (13, 14, 15, and 16 yo), height (13 and 14 yo), left and right grip strength (13, 14, 15, and 16 yo), bench press (15 and 16 yo), left and right hip abduction (14, 15, and 16 yo), and vertical and standing long jump (13, 14, and 15 yo). Total time for the 5-10-5 shuttle run test decreased from 13 to 14, and 14 to 15 yo. No changes were evident in body fat percentage, supine row or plank test scores between age groups.

**Conclusion:** Several off-ice performance variables change with age in elite amateur hockey players that should be recognized, followed and addressed during player development to minimize the risk of injury and maximize the potential for elite performance.

**Acknowledgments:** Financial assistance was provided by the Pan Am Clinic Foundation. The authors would also like to acknowledge Focus Fitness for their assistance with testing.

### The Prevalence of Anemia in Professional and Semiprofessional Soccer Players

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**Objective:** To determine the prevalence and classify anemia in professional and semiprofessional soccer players.

**Study Design:** Retrospective cross-sectional study.

**Subjects:** One hundred forty-seven professional (mean age,  $24.6 \pm 4.8$  y; BMI,  $22.9 \pm 1.4$ ; fat,  $8.3\% \pm 2.5\%$ ) and 25 semiprofessional (mean age,  $19.6 \pm 5.7$  y; BMI,  $23.5 \pm 1.5$ ; fat,  $10.2\% \pm 3.9\%$ ) soccer players who were members of 10 different teams were selected for this study.

**Intervention:** Anemia was defined as a hemoglobin level of less than 13.7 mg/dL (Beutler and Waalen, Blood, 2006). The pathogenic classification of the anemia was done according to international guidelines. Players who did not complete a full season or who were taking Iron, vitamin B12, of folate supplements were excluded from the study.

**Outcome Measures:** Hemoglobin, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC), Red Blood Cell Distribution Width (RDW), Serum Iron, Ferritin, Vitamin B12, Folate, LDH, and Bilirubin were evaluated at the beginning and at the end of a 6 weeks preparation period.

**Results:** Eight professional (5.4%) and 3 (12%) semiprofessional players were found with beta thalassemia trait (confirmed with HPLC). Also, at the beginning of the preparation period 6 cases (4.7%) of “sports anemia” were found among the professionals, giving a total 10.2% of anemia in this group. At the end of the preparation period the cases of anemia in professional players decreased to 6.7% as the cases of sports anemia decreased to 1.3%. On the contrary, among the semiprofessionals the incidence on anemia increased to 20% as 2 players (8%) developed iron deficiency anemia. This finding can be attributed to increased daily stress (work plus training) and insufficient nutrition among the semiprofessional players. Analysis of the results (Student’s *t* test) did not reveal any significant changes between Hemoglobin concentrations at the beginning and at the end of the preparation period, in both groups. Furthermore, independent samples *t* test did not reveal any significant difference on Hemoglobin concentrations between the 2 groups in both periods.

**Conclusions:** Our findings suggest that: (1) Semiprofessional players have a higher risk of developing iron deficiency and anemia. (2) The prevalence of anemia in professional, elite players is similar to that of young male adults of general population.

### Biomedical Control Cardiovascular Training Loads Produced at Different Times in College Water Polo Players

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**Objective:** To characterize the morpho-functional modifications cardiovascular product training loads of different orientation in Water Polo Players Sports University of the South.

**Study Design:** This research is the result of a descriptive, longitudinal, prospective study with cuts in the second and sixth week in college athletes Water Polo Sports South University based in the town of San Carlos Cojedes.

**Subjects:** The study population consisted of 14 players from the University Sport South based in San Carlos Cojedes state who were prepared to participate in a university event.

**Intervention:** These athletes prepared for 12 weeks in a temporary structure known as ATR planning, which is characterized as accumulation, processing, and implementation. The measurements were performed during the second week of the accumulation period and the fourth period of transformation, which range is considered a prudent time period for changes to occur and manifest in the structures and functions in the cardiovascular product of the guidance-assumed training loads.

**Outcome Measures:** The study analyzed and discussed the collected and processed information of the different changes observed in echocardiographic variables in the population under study, allowing inference of the relationship with the respective durations and intensities of training loads in each stage of the sports training.

**Results:** The variables that changed significantly from 1 measurement to the other were interventricular septum thickness, index h/r, stroke volume, stroke volume index, ejection fraction, and fractional shortening.

**Conclusions:** The various changes observed in the echocardiographic variables in the sample allow us to infer the relationship with the respective durations and intensities of training loads at each stage of sports training.

Saturday, June 21, 2014

Topic: *Exercise is Medicine*

### Validation of the Sense-Wear Armband in Measurement of the Energy Expenditure During Continuous Low- and Intermittent High-Intensity Exercise

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**Objective:** The aim of this study was to compare the Sense-Wear Armband (SWA) with indirect calorimetry to measure energy expenditure (EE) during continuous low-intensity (35%  $\dot{V}O_{2max}$ ) and intermittent high-intensity (70%  $\dot{V}O_{2max}$ ) exercise, as the intermittent exercise may improve the ability of the SWA to detect the total heat loss response to higher intensity exercise.

**Study Design:** Crossover study.

**Subjects:** Ten healthy subjects (7 males and 3 females with mean age 25 ± 2.41 years).

**Intervention:** Subjects in a random order exercised at a low intensity (35%  $\dot{V}O_{2max}$ ) continuously for 60 minutes and at a high intensity (70%  $\dot{V}O_{2max}$ ) intermittently (5 minutes of exercise alternated with 5 minutes of rest) for 60 minutes on 2 separate visits. Each visit lasted for 120 minutes.

**Outcome Measures:** Resting and recovery EE were measured during the first and last 30 minutes of each visit respectively, while subjects wearing the SWA with indirect calorimetry serving as the standard criterion method. Energy expenditure due to physical activity was estimated over a 60-minute period.

**Results:** The estimated EE by the SWA was not significantly different from indirect calorimetry values at rest (mean difference and SD,  $-4.5 \pm 7.9$  kcal/30 min), during the low-intensity exercise ( $-44.2 \pm 96.6$  kcal/h) and total ( $-55.1 \pm 109$  kcal/2h). However, there was a small overestimation during recovery. The SWA also overestimated EE during rest and recovery during the 70% intensity visit, but during the exercise period itself the SWA significantly underestimated EE (mean difference, 137.1 ± 64.1 kcal/h;  $P < 0.01$ ).

**Conclusion:** EE during intermittent high-intensity exercise cannot be accurately estimated with the SWA.

### Attributes Deemed Important for Chronic Disease Prevention

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**Objective:** To determine the “ideal” attributes of clinical programs for the prevention of chronic disease.

**Study Design:** Qualitative research.

**Subjects:** Twenty-two subjects volunteered for the study (12M, 10F, mean age 41, undergraduates = 9, certified fitness trainers = 3, adults with chronic disease = 4, healthy adults = 6).

**Observation Technique:** The authors led 5 groups (2 adults, 1 fitness expert, 2 students) through separate 90-minute sessions of a predetermined sequence of design thinking exercises (Luma Institute L. Innovating for People: Handbook for Human-Centered Design Methods. PA, USA: Luma Institute, LLC; 2012). First, participants were “introduced” to 3 chronic disease personas and asked to identify prevention program attributes they believed important for behavioral change in the personas. Responses were grouped into themes and compared to a list of 12 attributes developed by an expert panel prior to the start of the study. Eleven of the 12 attributes were very similar. The 5 study groups then ranked the 11 similar attributes into 3 levels and a final list was created, incorporating the results from all 5 groups.

**Outcome Measures:** A 3-level list of “ideal” attributes of a prevention program created from insights from all 5 groups.

**Results:** Each group’s attribute list was very similar to the expert panel list. The 12th attribute (developed by the expert panel), “adapting the model of

sports medicine to prevention”, was removed by all groups. Top tier attributes were individualization, exercise, diet, behavioral change, and communication/interaction. Second level attributes were accessibility, education, human interaction, and tracking/monitoring. Third level attributes were physical center, ambience, and credibility.

**Conclusions:** Chronic diseases are “diseases of lifestyle,” and so the “how” for lifestyle improvement must be addressed with the inclusion of behavioral change in prevention programs. Simply advising a patient of the “what” (diet, exercise) was not considered sufficient for behavioral change.

### Study of the Effect of Yoga Exercises on Sport Anxiety in Athlete Women

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**Objective:** Anxiety has increasingly affected many people within the last 2 decades and therefore researchers are trying to find noninvasive and nondrug methods for these disorders. In this respect, yoga practice, as an alternative medical system, seems to have attracted considerable attention. The purpose of this study was to compare the effects of yoga training on anxiety in athlete women.

**Study Design:** Quasi-experimental study with pre-posttest.

**Subjects:** Eighty subjects diagnosed with sport anxiety.

**Intervention:** Subjects were randomly assigned to 2 groups: (1) Experimental group with Hatha Yoga exercise; (2) Control group.

**Outcome Measures:** The present research is a 2-group semi-experimental controlled trial done in 2013, in which 80 athlete women were selected from national teams of different sports, 40 athlete women as the experimental group, and 40 athlete women as the control group; and Hatha Yoga exercise was performed for the experimental group for an hour twice a week during 2 months, after primary training by the yoga instructor. Data collection instruments included Beck Anxiety Questionnaire, which were evaluated before and 2 months after the intervention. Data were analyzed by SPSS statistical software using descriptive statistics (*t* test, Chi square, Fisher test, and paired *t* test).

**Results:** Analysis between the mean anxiety showed significant difference before and after the intervention in the experimental group ( $P < 0.001$ ), while this difference was not significant in the control group.

**Conclusions:** Performing the low-cost, simple, and enlivening Hatha yoga exercise is accompanied by improving living conditions of sport anxiety, and a positive step can be taken toward improvement and prevention of psychological problems as well as other chronic disorders through applying these practices for athletes.

### The Effects of Regular Unicycling Training on Postural Stability in Young Children

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**Objective:** Unicycling is a kind of sports activity that is developing in the same manner as biking, and plays an important role in physical, mental, and psychological development. The purpose of this study was to demonstrate the effects of 9-weeks regular unicycling training on postural stability in young children.

**Study Design:** Prospective, randomized.

**Subjects:** Twenty-eight young children volunteered and randomly assigned as training group (TG) and control group (CG).

**Intervention:** Children in TG were underwent the unicycling exercise training program 3 times a week for 9 weeks, but none of any physical training in CG.

**Outcome Measures:** The performance of postural stability was evaluated by Biodex Balance System (BBS) assessing the limits of stability (LOS) at level 2 and level 8. Overall LOS scores and scores in 8 directions (forward, backward, rightward, leftward, forward-right, forward-left, backward-right, and backward-

left) were calculated automatically on BBS. A 2-way ANOVA (group  $\times$  time) with repeated measures on the second factor was used to analyze the data.

**Results:** After 9-weeks unicycling training, children in TG have significant better LOS performance in the direction of rightward and forward-right at level 2, and in forward, backward, leftward, forward-right, and backward-right at level 8. In addition, the overall scores in TG were also increased from 32 % to 41 % at level 2 and 46 % to 56 % at level 8.

**Conclusions:** This study demonstrated that regular unicycling training program can improve the LOS postural stability performance in young children.

### The Correlation Between the Health-Related Fitness of Participants Measured at Home Opposed to Fitness Measured by Sport Scientists in a Laboratory

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**Objective:** In the health context, fitness is defined as a state of good health or physical condition primarily as a result of exercise and proper nutrition. Conventional methods of measuring exercise ability and fitness are expensive, time consuming and require specialized methods. There is a need for a noninvasive, fast method to assess health-related fitness and activity in athlete and nonathlete populations. The aim of this study was to establish the correlation between a health-related fitness index (HRF index) of participants measured at home and the HRF index measured under standardized laboratory conditions.

**Study Design:** This is a cross-sectional descriptive study.

**Subjects:** The participants consisted of 150 male and female volunteers between the ages of 18 and 55 years who were using no supplements or medication.

**Intervention:** The University of Pretoria’s HRF index protocol were first carried out by participants on their own at home, and then in the laboratory under the supervision of sport scientists.

**Outcome Measures:** The values obtained were statistically analyzed to establish the correlations.

**Results:** Results indicated highly significant and very strong positive correlations between the participant’s self-assessed fitness measurements and measurements by sports scientists.

**Conclusion:** This test protocol can be conducted at home by individuals, without supervision, to indicate exercise ability/fitness or to monitor the changes in physical fitness, thus limiting expenses and costs.

### From Sardinia, Italy, to the Top of the World: Trekking as Therapy. Modification of Physiological Parameters and Perception of Health Status in a Group of Patients With Severe Psychiatric Disorder

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**Objective:** The scientific literature has shown a strong correlation between physical activity and mental and physical health. The purpose of the study was to increase the physical activity of a group of people with severe psychiatric disorder, in order to improve the quality of life by optimizing physical health and reducing psychiatric and social disability.

**Study Design:** Longitudinal study.

**Subjects:** Ten subjects (9 males, 1 female) with severe psychiatric disorder, pharmacologically treated with antipsychotics, benzodiazepines, and mood stabilizers.

**Intervention:** Subjects were included in a group of psychoeducational therapy and initiated to a program to increase physical activity. Trekking was identified as physical activity suitable to their condition, as walking in nature was the first chance for the participants to go out from the isolated condition

in which the disease had confined them, to find “fellow travellers,” and join a community. The working program started in 2007, reached a first goal in 2009 with a trek to the base camp of Everest, and is still ongoing.

**Outcome Measures:** Maximal Oxygen Uptake and neuromuscular parameters such as Squat Jump and Counter Movement Jump height. Participants were also administered both SF-36 and IPAQ questionnaires.

**Results:** The results showed an average improvement of 20% in physiological parameters of all participants, and of 35% in the perception of health status. There was a reduction of pharmacological treatment in 8 subjects. In 2 subjects the activity has brought benefits, but nowadays they present the resurgence of the disease.

**Conclusions:** Individuals with severe psychiatric disorder may benefit in terms of physical and mental health if they undertake specific rehabilitation treatments aimed of increasing physical activity.

### Body Skeletal Muscle Mass in Child and Adolescent Participants in Organized Sports: Descriptive Epidemiological Study

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**Objective:** To examine body skeletal muscle mass in young athletes in relation to weight control practices in different sports disciplines at ages 10 to 17 years.

**Study Design:** Cross-sectional study.

**Subjects:** The study population comprised 10 389 young athletes (7425 boys and 2964 girls) aged 10-17 years from a representative mix of urban and rural areas and sports disciplines throughout Latvia. Tests were performed between 2008 and 2012. The athletes represented 27 sports divided into 3 groups according to the weight control practices: Group 1: weight class sports (eg, wrestling); Group 2: aesthetic sports (eg, aerobics); Group 3: nonweight-sensitive sports (eg, football).

**Observation Technique:** A multi-frequency 8-polar bioelectrical impedance leg-to-hand analyser (X-Scan pluss II, Korea) was used.

**Outcome Measures:** Weight (kg), total body fatness (kg, %), fat free mass (kg), and muscle mass (kg) were measured and muscle-to-fat ratio was calculated.

**Results:** Analysing the age groups separately, the mean muscle mass did not differ between the 3 weight control practice groupings of sports in boys. Muscle mass was significantly lower in girls participating in aesthetic sports compared with the 2 other groups of sports ( $P < 0.001$ ). Muscle mass increased with age, with 50<sup>th</sup> centile increasing from 33.3 kg at age 10 to 59.1 kg at age 17 in boys and from 29.0 kg at age 10 to 44.0 kg at age 17 in girls.

**Conclusions:** The muscle mass of the athletes was for each age group approximately double the mass reported from ordinary children and adolescents in a Caucasian population (McCarthy et al, 2013). Development of muscle mass in young athletes shows a different pattern compared to ordinary children.

### The FitTrack Index as an Indicator of Aerobic Fitness

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**Objective:** The FitTrack Index is a Web-based instrument developed in South Africa, and widely used by athletes to indicate fitness. A need exists for self-managed, noninvasive tests that effortlessly evaluate and categorize health-related fitness in different population groups. The aim of this study was to

compare the FitTrack Index with reliable measures of cardiorespiratory fitness and daily activity as indicated by  $\dot{V}O_2\text{max}$  measurements (maximal oxygen uptake) and pedometer activity measurement readings, respectively.

**Study Design:** A 12-week cross-sectional descriptive study was performed.

**Intervention:** The study measured the associations between a fitness index (FitTrack Index) and validated aerobic fitness and activity tests.

**Outcome Measures:**  $\dot{V}O_2\text{max}$  measures and pedometer readings.

**Results:** The baseline pedometer steps and distance correlated significantly ( $P < 0.05$ ), with the directly measured  $\dot{V}O_2\text{max}$  ( $P = 0.42$  and  $P = 0.48$ ), respectively, while distance showed a fairly strong correlation with the indirect measurement of  $\dot{V}O_2\text{max}$  ( $P = 0.29$ ,  $P = 0.002$ ). Only the pedometer distance was correlated with the indirectly measured  $\dot{V}O_2\text{max}$  after 12 weeks ( $P = 0.23$ ,  $P = 0.0046$ ). Even though correlations between indirectly measured  $\dot{V}O_2\text{max}$  and the FitTrack Index were only fair at baseline and after 12 weeks ( $P = 0.200$ ,  $P = 0.044$ ;  $P = 0.360$ ,  $P = 0.002$ ), respectively, the direct, laboratory tested  $\dot{V}O_2\text{max}$  indicated moderately to almost perfect associations with the FitTrack Index ( $P = 0.510$ ,  $P = 0.014$ ;  $P = 0.850$ ,  $P < 0.001$ ).

**Conclusions:** These study results suggest that the Web-based FitTrack Index may be considered an appropriate tool to evaluate exercise capacity and cardiovascular fitness in healthy individuals following an aerobic training program.

### Association of Japanese-Specific Anxiety-Related Traits With a Polymorphism in the Serotonin Transporter Gene Under Pressure in Ballet Dancers

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**Objective:** The purpose was to examine interrelation among psychological variables when ballet dancers were placed under pressure and the association between their state-trait anxiety and polymorphism in the serotonin transporter gene.

**Study Design:** Open-label, nonrandomized, single group assignment, time series designed trial.

**Subjects:** Forty-four elite adolescent ballet dancers (Ama) and 19 pro-ballet dancers (Pro) including 4 males.

**Intervention:** We administered psychological questionnaires to participants on a normal exercise day and on a day of giving a public performance. They were classified into 3 groups according to their state/trait-anxiety scores, and group differences in mood were examined. The types of serotonin transporter gene were also investigated for 34 females.

**Outcome Measures:** For psychological assessment, the State-Trait Anxiety Inventory (STAI) and the Brunel Mood Scale (BRUMS) were applied, and for physiological assessment the types of serotonin transporter gene were used.

**Results:** The scores of trait anxiety within each group did not show any significant change in the whole period of this longitudinal study of Ama, and there were significant differences in the scores of Confusion or Tension of the BRUMS between high and low “state-anxiety” groups on a stressful practice day ( $P < 0.05$ ). In the term before the public performance, on all mood scales of the BRUMS there were significant differences among 3 “State-Anxiety” groups ( $P < 0.05$ ). The scores of trait anxiety within each group showed significant change in the whole period of this longitudinal study of Pro, but there were not significant differences on the scores of state anxiety without rehearsal day. A considerable number of the participants in the “high trait-anxiety” group might be associated with s/s genotypes, which were classified into s/s, s/l, and l/l groups.

**Conclusion:** The delay of the output in some kind of central processing might influence a performance and some associations between the polymorphism and the personality traits. However, the environment of practicing ballet every

day is related with perfectionism, which causes stress and performance traits of the kind of occupation to be seen in a professional.

**Acknowledgments:** This research was supported by a Grant-in-Aid for Scientific Research (No. 25350789) in Japan.

### Prevalence of Overweight and Obesity Among 8- to 12-Year-Old Iranian and Afghan Girls: Interrelationship With Physical Fitness

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**Objective:** Improving physical fitness is a public health priority in developed and developing countries to curb the substantial and growing prevalence of lifestyle-related diseases. Since physical activity is an important factor related to weight control, there is renewed interest in the relationship between physical activity and the body composition of adolescents, as well as in the importance of physical activity in maintaining good health and well-being. Obesity has increased substantially in developed and developing countries during the last few decades, and it is probable that this trend will continue. The present study was designed to compare some motor- and health-related fitness parameters between Iranian and Afghan girls.

**Study Design:** Cross-sectional.

**Subjects:** One hundred fifty Iranian girls and 150 Afghan girls aged 8 to 12 years randomly selected from the student population who live in Tehran suburb.

**Intervention:** All subjects underwent anthropometric measurements and motor- and health-related fitness tests.

**Results:** Afghan girls were better performers in modified pull-ups and handgrip strength and had greater predicted  $\dot{V}O_{2\max}$  than Iranian girls ( $P \leq 0.05$ ). However, there were not significant differences in flexibility, modified sit-ups, agility shuttle run, and 20-m sprint test between the 2 ethnicities. Compared to their counterparts, overweight and obese adolescents demonstrated inferior performance in most motor- and health-related fitness parameters ( $P \leq 0.05$ ).

**Conclusions:** We found that Iranian girls had inferior physical fitness compared to Afghan girls and being overweight and obese were associated with poor fitness performances. The findings provided evidence to support the establishment of tailored physical fitness intervention programs to manage and prevent obesity in Iranian adolescent girls.

### Functional Differences in Chronic Heart Failure Patients

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**Objective:** To determine differences in clinical characteristics and physical function in an ambulatory sample of chronic heart failure patients.

**Study Design:** Ambulatory cross-sectional study.

**Subjects:** Fifty-one patients (8 females and 43 males) diagnosed with chronic heart failure. The sample is representative of a contemporary cohort of patients with CHF followed in a specialized clinic of Southern Hospital in Brazil.

**Intervention:** Patients underwent evaluation of maximal inspiratory muscle pressure, handgrip strength, maximal oxygen uptake, flexibility, self-reported and directly measured physical activity, depression scale, quality of life, and clinical evaluations.

**Outcome Measures:** Cluster hierarchical analysis using the squared Euclidean distance dissimilarity measure and the Ward linkage method was applied to determine profiles. The sample was stratified into 2 groups. *T* test was used to compare variables of interest ( $P < 0.05$ ) and effect size (Cohen's *d*) was also computed.

**Results:** Differences were observed between groups in the maximal inspiratory muscle pressure ( $104.2 \pm 21.4$  vs  $53.4 \pm 20.7$  mmHg;  $P < 0.001$ ,  $d = 2.41$ ), handgrip strength ( $40.07 \pm 9.07$  vs  $32.07 \pm 10.1$  Kgf;  $P = 0.008$ ,  $d = 0.83$ ), and self-report physical activity ( $225.45 \pm 218.2$  vs  $113.04 \pm 89.6$ ;  $P = 0.028$ ,  $d = 0.67$ ). All other assessed variables did not show significant differences between the groups.

**Conclusions:** Contrary to what was expected, no differences were observed in clinical characteristics, which reflects a well-controlled and optimized medication sample in our outpatient clinic. The cluster with higher values of maximal inspiratory muscle pressure had also higher values of handgrip strength and self-reported physical activity. This fact suggests that care should be given in future interventions regarding functional parameters, as well as its influence with samples of similar patients.

### Topic: Orthopedics

### Combined Therapy of Intra-Articular Hyaluronic Acid Injection and Manual Therapy in Sportsmen Affected by Hip Osteoarthritis

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**Objective:** To compare the efficacy of a combination of intra-articular injections of Hyaluronic Acid (HA) under ultrasound guide together with Manual Therapy associated with Exercise Therapy with HA Injection only in the treatment of patients with hip osteoarthritis.

**Study Design:** Case control.

**Subjects:** In our study, we evaluated 59 patients, 19 female and 40 male, with average age 60.7 (max 84 and min 38) divided between sedentary individuals and those practicing sport at professional and nonprofessional levels all suffering from hip osteoarthritis.

**Intervention:** Thirty-three patients (10 sedentary, 4 professional, and 19 nonprofessional) were treated with HA injections combined with Manual Therapy and Exercise Therapy, and 26 (18 sedentary and 8 nonprofessional) with HA injections only. All patients were subjected to x-ray and MRI of the hip and, during the first examination in our surgery, a hip echography using the Migliore—Tormenta technique. The rehabilitation protocol consisted of a combination of Manual Therapy and Physical Exercises and started at the moment of the first injection. The program lasted 6 weeks and each patient was treated once or twice a week. The goal of the program was to increase mobility, strength, and control of the hip joint.

**Outcome Measures:** At the beginning of the study we evaluated active and passive hip range of motion (ROM) and the general joint functions through functional movements tests (Step Up, Trendelenburg Test, Deep Squat Test) and special tests (FABER Test, Ober Test, Thomas Test, Compression Test, Hip Prone Extension Test). After the initial evaluation we worked out an individual treatment protocol for each patient, focusing on the treatment of their own dysfunctions. Manual Therapy treatment consisted of a combination of soft tissue manipulation, myofascial stretching, and mobilization and/or manipulation techniques targeting movement limitations. Each Manual Therapy session lasted from 30 to 45 minutes. After the Manual Therapy treatment patients performed physical exercises consisting of joint mobility, followed by strength and neuromuscular control exercises. We used elastic resistance exercises, core training, balance training, and gait exercises. Patients were recommended to continue the entire exercise program at home between the physiotherapy sessions. At the end of the program we suggested that patients continue exercises at home in order to maintain the results, and to undergo a Manual Therapy session each month.

**Results:** Patients who had HA injections combined with Manual Therapy and Exercise Therapy showed a greater reduction in pain VAS (>68%) than patients that had only HA injections (<49%). Regarding the functional state of the hip joint, patients treated with the combination of HA injections and

rehabilitation showed a decrease of Lequesne index values (>58%) compared to patients who had only injections (35%).

**Conclusions:** Our findings show that the combination of intra-articular injections of HA under ultrasound guide together with Manual Therapy associated with Exercise Therapy seems to be a better solution than HA Injection only in the conservative treatment of patients with hip osteoarthritis.

### Medial Release and Lateral Imbrication for Intractable Anterior Knee Pain: Diagnostic Process, Technique, and Results

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**Objective:** To present the treatment of 3 knees in 2 patients (1 bilateral) in whom a novel treatment involving arthroscopic lateral imbrication and medial release of the patellar retinaculum was performed for intractable Patella Femoral Pain Syndrome (PFPS).

**Study Design:** Retrospective case series.

**Intervention:** Preoperatively both patients had intractable PFPS, in that they had previously failed all nonoperative management of their symptoms. Patients were offered the surgery following resolution of pain with bracing that lateralized the patella in a fashion that mimicked realignment surgery. An arthroscopic lateral imbrication and medial release of the patellar retinaculum was performed.

**Outcome Measures:** Resolution of pain, and in turn improvement in function, was the main subjective parameter used.

**Results:** Subjectively the 2 patients noticed very significant improvement in their level of pain with full return to work, sport, and activities of daily living. There were no complications noted in either patient.

**Conclusion:** Medial release and lateral imbrication of the patellar retinaculum is a surgical procedure that may be used for intractable PFPS. The use of this procedure has successfully been shown to reduce significantly the pain associated with PFPS in a subset of patients, identified through the use of bracing trials, as likely to respond.

### The Learning Curve in Hip Arthroscopy: A Systematic Review

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**Objective:** Hip arthroscopy is a technically demanding procedure and is almost universally described as having a difficult or “steep” learning curve. While a learning curve is an intuitive concept, reflecting an individual’s improvement in skill or competence over time, there is no universally accepted definition. The purpose of this systematic review was to (1) identify the various learning curves reported in the literature, (2) examine the evidence supporting these curves, and (3) determine whether this evidence supports an accepted number of cases needed to achieve proficiency.

**Data Sources:** EMBASE and MEDLINE were screened for any clinical studies reporting learning curves in hip arthroscopy. Two reviewers conducted a full-text review of eligible studies and a hand search of conference proceedings. Inclusion/exclusion criteria were applied and a quality assessment was completed for each included article. Descriptive statistics were compiled.

**Main Results:** We identified 6 studies with a total of 1063 patients. Studies grouped surgical cases into “early” versus “late” in a surgeon’s experience,

with 30 cases being the most common cut-off. The majority of these studies utilized descriptive statistics and used operative time and complication rates as measures of competence. Five out of 6 studies showed improvement in these measures between early and late, but only 1 proposed a bona fide curve.

**Conclusions:** This review shows that when 30 cases was used as the cut-off to differentiate between early and late cases in a surgeon’s experience, there were significant reductions in some reported outcomes, including operative time and complication rates. However, there was insufficient evidence to quantify the learning curve and validate that 30 is the point that the learning curve plateaus for these specific parameters. Consequently, this number should be interpreted with caution. Further studies are required to establish definitive boundaries for competence regarding various parameters for arthroscopic hip procedures.

### Surgical Management of Labral Tears during Femoroacetabular Impingement Surgery: A Systematic Review of the Literature

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**Objective:** This systematic review explored reported outcomes addressing FAI, specifically those comparing labral debridement to labral repair. In addition, the quality of the evidence was evaluated for the purposes of making treatment recommendations.

**Data Sources:** Three databases (MEDLINE, EMBASE, and PubMed) were searched for comparative studies involving labral repair and debridement during FAI surgery. Two reviewers conducted a title, abstract, and full-text review of eligible studies and the references of these studies. Inclusion and exclusion criteria were applied to the searched studies, data was extracted and a quality assessment was completed for included studies.

**Main Results:** We identified 6 eligible studies involving 490 patients. The most commonly reported outcome measure was the modified Harris Hip Score (50%). All studies reported that labral repair had greater postoperative improvements in functional scores (Modified Harris Hip, Non Arthritic Hip, Hip Outcome and Merle d’Aubigne Scores) compared to labral debridement. Five studies reported statistically significant improvements with labral repair. Modified Harris Hip Scores were pooled to demonstrate a clinically important difference in favor of labral repair by 7.41 points in 3 studies. The mean individual study quality can be considered fair. However, the overall quality of the body of evidence in this review is rated as low according to GRADE guidelines.

**Conclusions:** This review demonstrates a reporting of better clinical outcomes with labral repair compared to labral debridement in all studies with 5 of 6 studies reporting statistically significant improvements (of repair over debridement). However, given the lack of high quality evidence and associated limitations in study design, these results should be interpreted with caution. Consequently, definitive treatment recommendations are limited.

### Global Trends in Surgical Management of Femoroacetabular Impingement

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**Objective:** Femoroacetabular impingement (FAI) can result in joint damage and potentially lead to osteoarthritis. Interest in its diagnosis and surgical management has sparked significant research in the past decade. The purpose of this study is to assess the global pattern of surgical interventions addressing FAI, particularly global trends in diagnosis and management.

**Data Sources:** We performed a systematic search for surgical FAI studies published prior to June 2013. Study parameters included sample size, location, surgical intervention, diagnostic imaging, outcome measures used, gender distribution, and level of evidence. These parameters were compared between geographical regions and the number of trials and cumulative sample size of FAI surgical studies were analyzed.

**Main Results:** From a total of 104 studies reporting surgical FAI interventions, the majority of studies were completed in Europe (44 studies, 3745 patients), and North America (52 studies, 3629 patients). Asia (3 studies, 49 patients) and Oceania (6 studies, 394 patients) had smaller contributions. The majority of research performed in North America, Europe, and Oceania investigated arthroscopic management of FAI (55% of studies). By geographic region, the proportion of arthroscopic research was higher in North America, with 73% of enrolled patients undergoing hip arthroscopy compared to 57% in Europe. Methods of diagnosis were consistent across geographical regions, with radiographs being the mainstay of diagnosis in 84% of studies, followed by use of MRI in 64% of studies, and use of CT scan in 25% of studies. Gender ratios were also similar globally, with 61% of patients being male. Outcome measures varied by region, mHHS were the most commonly used measures in North America and Asia, HHS were predominant in Oceania, while NAHS and WOMAC were used in Europe.

**Conclusion:** Global contributions to surgical FAI studies have been led by North America and Europe. Globally, most patients enrolled in FAI surgical studies undergo arthroscopic surgery. Moreover, most of the evidence in surgical management of FAI consists of case series (ie, low quality). Global surgical trends in FAI show regional differences in research contributions, interventions and outcome measures used, while gender proportions, level of evidence and diagnostic imaging used were similar across regions.

### Temporal Effects of Intra-Articular HA and/or Corticosteroids on OA Synovial Fluid Boundary Lubricant Composition: A Case Series

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**Objective:** To measure the proteoglycan 4 (PRG4) and hyaluronan (HA) content in synovial fluid (SF) aspirated from the same osteoarthritic (OA) knee joints of patients receiving repeated courses of treatment with intra-articular (IA) corticosteroid and/or HA.

**Study Design:** Retrospective case-series.

**Subjects:** SF was aspirated from symptomatic knee OA patients prior to IA treatment. Patients were included in this study if 3 or more SF aspirations from the same knee were available for analysis. In total, 4 knees (3 patients) with 3 to 5 aspirations were available for analysis. Two patients (3 knees) had 1 HA and 2 corticosteroid injections over 6 to 9 months, and 1 patient had 1 HA and 4 corticosteroid injections over 34 months. The IA HA that was received was hylan G-F 20 and the corticosteroid received was Depo-Medrol.

**Observation Technique:** HA and PRG4 concentrations were measured using sandwich enzyme linked immunosorbent assays. HA molecular weight (MW) distribution was determined using agarose gel electrophoresis.

**Outcome Measures:** HA and PRG4 content of the OA SF was compared to average HA and PRG4 concentration and HA MW distribution in 29 normal cadaveric SF samples.

**Results:** No consistent trends in SF lubricant composition after IA HA or corticosteroid treatment were observed over time. PRG4 concentration in 3 of the 4 knees appeared to be lower than the normal range, but increased (1 knee), decreased (1 knee), and fluctuated (2 knees) over time. HA concentration in 2 knees appeared to be higher than the normal range, and decreased (1 knee) and fluctuated (3 knees) over time. Three of 4 knees appeared to have lower than normal high MW (3-6 MDa) HA content and higher than normal low MW (<0.5 MDa) HA content.

**Conclusions:** Repeated IA treatment did not appear to result in consistent changes in SF PRG4 or HA content. Other factors including joint loading,

activity level, and inflammation may also influence SF lubricant composition over time. This study suggests that boundary lubricant composition of SF in OA joints can change over time with repeated IA treatment, and that this response to IA corticosteroid or HA treatment appears to vary between individuals.

### The Effects of Combining Viscosupplementation and Knee Bracing on Pain Reduction and Increased Function in Patients With Medial Knee Osteoarthritis

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**Objective:** To evaluate the effects of combining knee bracing and viscosupplementation on pain reduction and functional level of subjects with grade 1, 2, and 3 knee osteoarthritis. The hypothesis is that the combination of a dynamic knee brace with viscosupplementation would be more effective in reducing pain and functional limitations of subjects with knee OA than each of the 2 interventions alone.

**Study Design:** Prospective, randomized controlled clinical trial with 3 treatment arms.

**Subjects:** Sixty subjects will be enrolled in the study from a population of patients presenting with medial knee OA.

**Interventions:** Subjects were randomly assigned to one of 3 treatment groups: (1) Dynamic custom fitted knee brace, (2) Hyaluronic acid (HA), or (3) Injection of HA and a dynamic knee brace.

**Outcome Measures:** All subjects will complete a disease specific Western Ontario and McMaster Universities Arthritis Index (WOMAC) questionnaire at enrolment into the study. The WOMAC questionnaire measures pain, function, and stiffness of the knee. At 3 and 6 months of follow-up (FU), a WOMAC and a Patient Global Impression of Change (PGIC) scale will also be completed. These outcome instruments have been shown to be valid, reliable, and responsive to change in population suffering from knee OA. For the WOMAC, higher scores indicate worse situation, and for the PGIC scale, a significant and favourable change is a score of 5 to 7.

**Results:** Preliminary results on 10 subjects are available. Group 1) Dynamic custom fitted knee brace showed a PGIC of 5.5. Group 2) hyaluronic acid showed a WOMAC of 65.36 at 0 months and 41.49 at 3 months with a PGIC of 5 (HA). Group 3) Injection of HA and a dynamic knee brace showed a WOMAC questionnaire of 59.72 at 0 months and 23 at 3 months with a PGIC of 6 for the combined treatment.

**Conclusions:** Knee OA is a common complaint in the sports community. It is important that sport medicine doctors find ways to treat the pain and reduce the functional limitations of their patients. This study aims at providing strategies for patients with knee OA to stay active while proposing few side effects and good short- to mid-term outcomes. According to our preliminary results the combination of a dynamic knee brace and viscosupplementation gives the best result on the WOMAC and PGIC.

### Banff Patellar Instability Instrument: Responsiveness to Change Up to 2 Years Post Patellar Stabilization Surgery

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**Objective:** The responsiveness to change of an instrument is one aspect of its validity. The objective of this study was to further validate the Banff Patellar Instability Instrument (BPII) by assessing its responsiveness to change following patellar stabilization surgery.

**Study Design:** Cross-sectional.

**Subjects:** Patients (n = 245) referred to an orthopaedic surgeon for evaluation of patellar instability. All patients were referred by sport medicine physicians and had failed nonoperative management.

**Intervention:** The diagnosis of patellar instability was confirmed in all patients by history, physical examination, and diagnostic imaging. Assessment using the BPII was performed at initial consultation (n = 245) as well as at 6 months (n = 79), 12 months (n = 68), and 24 months (n = 28) poststabilization.

**Outcome Measures:** Comparison of change in BPII scores was calculated using a 1-way analysis of variance (ANOVA) for each time point separately for imbrication and reconstruction procedures.

**Results:** The average initial BPII score for patients presenting with patellar instability who were treated without a patellar stabilizing procedure (n = 143) was 26.6 (SD, 15.2; range, 0.7-85.7). The average initial BPII score for patients who proceeded to a stabilization procedure (n = 102) was 25.3 (SD, 10.8; range, 0.5-51.5). For patients receiving an MPFL imbrication the average 6-month BPII was 65.6 (SD, 23.3). For patients receiving an MPFL reconstruction the average 6-month BPII was 53.7 (SD, 22.5). At 12 months poststabilization, the average BPII score of patients receiving an imbrication was 69.8 (SD, 21.3) compared with 60.6 (SD, 21.8) for patients receiving an MPFL reconstruction. At 24 months poststabilization, the average BPII score for patients receiving an imbrication was 70 (SD, 21.6) compared with 66.8 (SD, 19.9) for the reconstruction group. There was a statistically significant difference in BPII scores from the initial orthopaedic consult, to the 6-month, 12-month, and 24-month postoperative appointments for both the imbrication and reconstruction cohorts ( $P < 0.001$ ). The difference in scores between the 6-month and 12-month postoperative time-points was significant for both surgical cohorts ( $P < 0.005$ ). The difference between the 12 month and 24 month scores was not significant for either group.

**Conclusions:** This study furthers the validation of the BPII by demonstrating the responsiveness to change of this disease-specific quality of life instrument. Patients demonstrated a statistically significant improvement in BPII score after patella stabilization surgery.

### Effects of Whole-Body Vibration on Muscle Activity in ACL Deficient and Healthy Individuals

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**Objective:** To compare neural activation of the *vastus lateralis* muscle during whole-body vibration between anterior cruciate ligament (ACL) deficient and healthy individuals.

**Study Design:** Observational, cross-sectional study.

**Subjects:** Fifteen male patients (age:  $28 \pm 3$  years; stature:  $1.74 \pm 0.05$  m; mass:  $68.3 \pm 10.2$  kg) with unilateral isolated ACL rupture were recruited to participate in the study. Fifteen healthy male volunteers (age:  $28 \pm 3$  years; stature:  $1.78 \pm 0.07$  m; mass:  $73.6 \pm 12.1$  kg) with no disorder or history of knee injury served as the control group.

**Observation Technique:** Electromyography (EMG) signals from the *vastus lateralis* muscle were recorded by means of self-adhesive surface electrodes. The participants were exposed to vertical sinusoidal oscillations using a vibratory platform (Double Vibe; Bosco System Technologies, Rieti, Italy). Frequency of vibration was increased from 20 to 55 Hz, with increments of 5 Hz every 5 seconds, while each subject stood on the platform with bare feet at a 70-degree knee angle.

**Outcome Measures:** The average root mean square (RMS) of EMG signals was computed for each vibration frequency and normalized to the average RMS while maintaining the previously described body posture without vibration. A 3-way ANOVA was used to compare the normalized RMS between groups (ACL deficient and healthy participants) and limbs (involved and uninvolved for ACL deficient patients, dominant, and

nondominant for healthy participants) across different vibration frequencies (20 to 55 Hz).

**Results:** Average RMS of the *vastus lateralis* muscle was significantly greater in the ACL deficient limb than in the contralateral limb and in both limbs of healthy participants at vibration frequencies ranging from 25 to 35 Hz ( $P < 0.05$ ).

**Conclusions:** WBV at 25 to 35 Hz was accompanied by an increase in the neural activity of the *vastus lateralis* muscle of the ACL deficient limb with respect to muscle activity of the contralateral limb and healthy individuals. This might be due to a reduced inhibition of the stretch reflex excitability to the mechanical stimuli in the ACL deficient limb compared to the contralateral limb and both limbs of healthy participants.

### Hip Labral Tear: Description of Interventions and Outcomes

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**Objective:** (1) To provide a description of treatment, comorbidity, and sports participation in young athletes who were diagnosed as a labrum tear. (2) To examine effect of co-morbidity on labrum tear surgery in young athletes.

**Study Design:** Cross-sectional epidemiological study.

**Subjects:** Young athletes (age ranges between 8 and 20 years old) who visited sports medicine clinic at regional pediatric hospital.

**Observation Technique:** Computerized retrospective chart review was performed at the sports medicine clinic of an academic pediatric medical center between January 1, 2010, and December 31, 2013. Key words were "hip," "labrum," "physical therapy," "injection," and "surgery," and age ranges were set between 8 and 20 years old. Descriptive statistics was performed for Aim 1. Fisher's exact test was employed for Aim 2, and alpha level was set at 0.05 priori.

**Outcome Measures:** A type of treatment interventions (PT, IAI, and surgery), comorbidity, and sports participation were extracted and analyzed for Aim 1. A number of hip labrum tears with the most common comorbidity were compared based on a number of surgery cases for Aim 2.

**Results:** Among 78 young athletes who were diagnosed as labrum tear, 53 (67.9%) had PT, 56 (71.8%) received IAI, and 44 (56.4%) experienced both interventions. A total of 59 (75.6%) had a surgery. The most common comorbidity was femoral acetabulum impingement (FAI), which was observed in 47 individuals (52.2%). Of the 47 athletes with FAI, 85.1% needed surgery, while only 61.3% of athletes with labral tears, and no FAI needed surgery. Top 5 sports participated in were: dance (16.7%), soccer (13.3%), gymnastics (6.7%), lacrosse (6.7%), and track and field (6.7%). A significant number of surgery cases were recorded with athletes with labrum tear and FAI compared to labrum tear without FAI ( $P = 0.029$ ).

**Conclusions:** Young athletes with labrum tear often need interventions of PT, IAI (diagnostic and therapeutic values), and surgical procedures. For athletes with the comorbidity of FAI, the odds were greater than 2:1 for a surgical intervention versus those athletes without FAI. Conservative management was effective in 24.6% of cases. Commonly related sports were dance, soccer, gymnastics, lacrosse, and track and field. Future prospective studies are needed for further clarification.

### Arthroscopic Versus Open Repair for Traumatic Anterior Shoulder Instability: A Meta-analysis

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**Objective:** To determine whether arthroscopic labral repair leads to less recurrence and better functional outcomes than an open surgical repair in patients with shoulder instability between the ages of 16 to 40.

**Data Sources:** Our search through the databases (PubMed, Cochrane, EMBASE, CINAHL) between January 1950 and January 2013 for level of

evidence I or II studies (randomized controlled trials or prospective comparative studies) published in English peer-reviewed journals generated 430 entries. Inclusion criteria: Age 16-40, traumatic, primary or recurrent, symptomatic anterior instability, arthroscopic or open surgical repair with suture anchors. Exclusion criteria: Other repair techniques or revision surgery, infections prior to surgery, associated nerve injuries, concomitant rotator cuff repair or other surgeries, associated bony defects (glenoid or humeral head), multidirectional or posterior instability. Duplicate studies were removed, leaving 169 entries. Twelve were short-listed for full text screening (title/abstracts screened by 2 independent reviewers). Seven were excluded (1 German, 1 retrospective cohort, 1 mixed suture anchors/transglenoid, 1 anchorless/open, 1 suturetack/arthroscopy, 1 anchorless). Five studies were short-listed for quantitative analysis. Primary outcome was recurrence of shoulder instability (relative risk ratio, dichotomous outcome, 95% confidence intervals, fixed effects model/standardized mean difference). Secondary outcomes included

range of motion, strength, and patient rated functional outcome scores (Rowe score, WOSI, SF36, Constant, SST, DASH, ASES).

**Main Results:** Four randomized, 1 quasi-randomized controlled trials (265 patients) were included. Studies used different shoulder functional outcome scores with different scales, but were combined using SMD. No significant difference with respect to recurrence of instability ( $P = 0.45$ ; low heterogeneity  $I^2 = 5\%$ ), strength ( $P = 0.89$ ; low heterogeneity  $I^2 = 5\%$ ), or shoulder functional outcome scores ( $P = 0.36$ ; low heterogeneity  $I^2 = 0\%$ ). Risk of publication bias low (funnel plots); bias moderate (across/within studies – blinding and allocation concealment). Arthroscopy had better range of motion compared to open ( $P = 0.02$ ; high heterogeneity  $I^2 = 77\%$ ).

**Conclusions:** Both open and arthroscopic labral repair techniques can lead to successful outcomes with low risk of recurrence of instability and excellent function with better range of motion with arthroscopy.