



Abstracts

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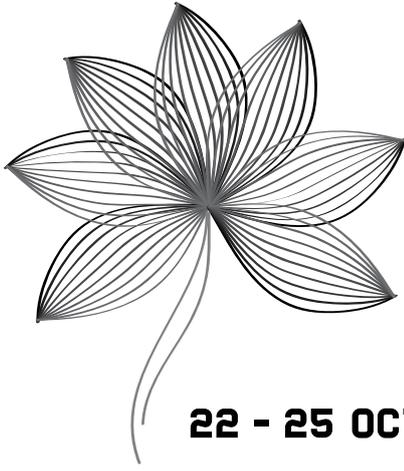


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TUESDAY 22 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
0930 – 1700	Pre Conference Workshop	Assessing and managing lower limb tendinopathy	Jill Cook Craig Purdam	Arcadia Hall 2	1
1715 – 1815	Refshaug Lecture	Tendinitis to tendinopathy: The past, present and future of an ongoing challenge in sports medicine	Craig Purdam	Ballroom B	2

1 Assessing and managing lower limb tendinopathy

PRE CONFERENCE WORKSHOP

J. Cook^{1*} ▪ C. Purdam^{2*} ▪ ¹Monash University ▪ ²Australian Institute of Sport

This full day course will examine all aspects of tendon injury from the underlying pathology to the management of these conditions. At the completion of the workshop the participant will understand why tendon injuries are difficult to treat, what to tell the client with a tendon injury, how to assess and treat lower limb tendons and will be well placed to educate other health professionals about tendinopathy. Although directed more towards tendinopathy of the lower limb, this course will give the clinician the skills to treat all tendon injuries and will include both theory and practical teaching.

Teaching Process: The course will involve power point presentations, practical sessions and open discussion.

Learning Outcomes: After the course, participants will:

- Understand and be able to explain the current understanding of the anatomy, pathology and physiology of tendinopathy.
- Have the capacity to assess a client presenting with tendon pain.
- Understand the principles of treatment for tendinopathy and apply them to all tendons.
- Recognise difficult tendons and refer them as appropriate to other providers.

2 Tendinitis to tendinopathy: The past, present and future of an ongoing challenge in sports medicine

REFSHAUGE LECTURE

Australian Sports Medicine Federation Fellows Supported Speaker

C. Purdam^{1*} ▪ ¹Australian Institute of Sport



Tendon pain and pathology have long been recognised as a mal-adaptive response to an increase in training load within sport in some, but not all athletes. This presentation explores the evolution, and our current understanding of the pathology and management practices of this sometimes difficult condition and reflects on some of the key contributions over the last 40 years. Looking forward, gaps in our knowledge of the tissue and related sciences provide real opportunities for new technologies, some of which have the potential to increase this understanding in a non-invasive manner in humans. Further, advances in pain science and genetics have the potential to change our approach to tendinopathy well into the future. Whilst this promises much for the future in terms of optimising recovery, our expectations may need to be tempered by some fundamental considerations.

WEDNESDAY 23 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
0800 – 0900	Workshop	Publishing your work	Greg Kolt Evert Verhagen Gordon Waddington Kim Bennell	Ballroom B	3
0800 – 0900	Workshop	Assessment of hip involvement in complex lumbo-pelvic-hip clinical presentations	Trish Wisbey-Roth	Arcadia Hall 1	4
0800 – 0900	Workshop	Management of patellar tendinopathy	Jill Cook	Arcadia Hall 2	5
0800 – 0900	Workshop	Foot and ankle taping for a purpose	Chris Bishop Kent Sweeting	Lagoon Hall A	6
0800 – 0900	Workshop	Shoe fitting	Mark Doherty Jason Mansfield Claire Thomas Johanna McConnell	Lagoon Hall B	7
0930 – 1030	Keynote	Neuromuscular plasticity to training: Spinal and supraspinal adaptations	Per Aagaard	Ballroom B	8
1100 – 1230	Free papers: Lower limb			Ballroom B	
		Athletic footwear does not alter in-shoe hindfoot kinematics during overground running	Chris Bishop		9
		Dynamic function of the plantar intrinsic foot muscles during walking and running	Luke Kelly		10
		Fatigue impact on non-contact ACL injury risk associated with multi-directional jumping and landing in female athletes: A systematic review	Catherine McMaster		11
		The effect of unstable rocker-soled recreational footwear on knee joint load in knee osteoarthritis	Elizabeth Madden		12
		The effect of athletic shoe midsole heel height on lower extremity kinematics and neuromuscular activation during overground walking	Kade Paterson		13
		An exploration of the biomechanical effects of footwear and orthoses on joints proximal to the foot during running	Chris Bishop		14
		Dynamic midfoot and ankle mechanisms of vertical jump performance of children while barefoot and wearing sports shoes	Caleb Wegener		15
1100 – 1230	Free papers: Upper limb			Arcadia Hall 1	
		A novel exercise for retraining the rotator cuff muscles of the shoulder	Tania Pizzari		16
		Ultrasound evaluation of asymptomatic senior and under-23 elite rowers' forearms with reference to Intersection Syndrome	Michael Drew		17
		Management of pain associated with acute sports injuries – is acupuncture a way to go?	Aleksandra Macznik		18
		Effect of acupuncture and instruction on post-exercise recovery: A balanced-placebo controlled trial	Paola Urroz		19
		12 month results of a randomised controlled trial comparing specific physiotherapy against advice for people with subacute low back disorders	Alexander Chan		20
		Facilitating the upward rotators of the scapular. A simple exercise	Tania Pizzari		21
		The effect of exercise based management for multidirectional instability of the glenohumeral joint: A systematic review	Sarah Warby		22

WEDNESDAY 23 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
1100 – 1230	Free papers: Physical activity and communities			Arcadia Hall 2	
		Relationship between motor skills, physical fitness and activity in children from Poland	Elzbieta Ciesla		23
		Sport and Recreation Spatial: Development of a national geographical information system for the sport and recreation sector	Rochelle Eime		24
		Fitness and health of vocational school youth in Poland	Halina Krol		25
		Cheering in the stand and playing on the field: The association between sports spectatorship and physical activity	Beth McLeod		26
		More to exercise than 'physical' health: The experiences of sedentary Māori men before and after exercise	Isaac Warbrick		27
		Promoting physical activity in disadvantaged South Australian communities through alternative community sport opportunities	Edoardo Rosso		28
		An internet-based intervention for promoting and maintaining physical activity in Thai university-aged females	Sonthaya Sriramatr		29
1100 – 1230	Symposium	Controversies in sports cardiology: Protecting the heart of the athlete		Lagoon Hall A	
		The athletes heart – innocent adaptations or harbingers of pathology?	Mathew Wilson		30
		FIFA 11 steps for preventing sudden cardiac death	Jiri Dvorak		
		Ultra-endurance exercise – too much of a good thing?	Mathew Wilson		31
1330 – 1500	Invited	Maximising joint health: Preventing and managing knee osteoarthritis in the athlete	Kim Bennell	Ballroom B	32
	Invited	Osgood Schlatter Disease – an ultrasound grading system with practical application	Matthieu Sailly		33
1330 – 1500	Free papers: Clinical exercise physiology			Arcadia Hall 1	
		The effect of high-impact exercise on hip and spine bone density in community-dwelling middle-aged and older men: A 9-month dose-response randomised controlled trial	Kate Bolam		34
		Endurance exercise but not high-intensity interval training improves abdominal fat distribution in overweight adults	Shelley Keating		35
		The effect of a 4-week student-led exercise program on the physical function of prostate cancer survivors	Kate Bolam		36
		Exercise training improves vascular health but not metabolic control in adolescents with type 2 diabetes	Louise Naylor		37
		12-weeks supervised exercise training is a feasible and efficacious treatment for reducing depression in youth with major depressive disorder	Robin Callister		38
1330 – 1500	Free papers: Sports biomechanics and skill acquisition			Arcadia Hall 2	
		Does a structured neuromuscular training program reduce the incidence of lower limb injuries in NZDF army recruits?	Narelle Hall		39
		Body loads and collisions in professional Australian Rugby League players	Cloe Cummins		40
		Artificial turf – surface properties and player-surface interaction	Paul Fleming		41
		Validating the SenseWear Armband during resistance training: Is there a difference between upper and lower body exercises?	Kate Pumpa		42
		Does the use of strider bikes improve stability in three to five year old children?	Andrew Shim		43
		Initial outcomes of a small group Physio/OT designed motor skills program (Bounce Back 4 Kids) for developmentally challenged primary school children: A case series	Trish Wisbey-Roth		44
		Investigation of front crawl stroke phases within force-time profiles in elite and sub-elite male sprint swimmers	Gina Sacilotto		45
		Measures of proprioception predict success in elite athletes	Gordon Waddington		46

WEDNESDAY 23 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
1330 – 1500	Symposium	Heat and altitude: Challenges and opportunities for the athlete		Lagoon Hall A	
		Competing and training in the heat	Sebastien Racinais		47
		Training at altitude: Current knowledge and future directions	Yorck Olaf Schumacher		48
		Training and competing in challenging environments: A practical perspective	Ian Gillam		49
1330 – 1500	Free papers: Injury prevention			Lagoon Hall B	
		Psychometric properties of the functional screening test: A review of current literature	Marian Baxter		50
		Reactive stepping behaviour in response to forward loss of balance predicts future falls in community-dwelling older adults	Christopher Carty		51
		An assessment of the 2008 Zurich consensus statement on concussion in sport using the Appraisal of Guidelines for Research and Evaluation II (AGREE II)	Caroline Finch		52
		A systematic evaluation of field-based screening tools for anterior cruciate ligament injury risk	Aaron Fox		53
		Injuries of athletes in training for 2010 Pan Pacific Masters Games: Types and locations	Ian Heazlewood		54
		Risk management in the Australian fitness industry: The results of the first national survey	Caroline Finch Kevin Norton		55
		Australian hospital admission and emergency department-reported snow sports injuries: A summary of the past decade	Emma Siesmaa		56
		Challenges when implementing a sports injury prevention training program into real-world community sport	Dara Twomey		57
1530 – 1700	Free papers: Lower limb clinical			Ballroom B	
		Evaluation of foot posture using the Microsoft Kinect	Benjamin Mentiplay		58
		Preventing ankle sprains with a smartphone: Implementation effectiveness of an evidence based app	Evert Verhagen		59
		Using a smartphone in the clinical setting: The Tiltmeter App and the weightbearing lunge test	Cylie Williams		60
		Anterior Cruciate Ligament injured copers and noncopers: The surgical dilemma revisited	Yonatan Kaplan		61
		Contributing factors in children who present with calcaneal apophysitis	Alicia James		62
		Effectiveness of customised foot orthoses for the treatment of Achilles tendinopathy: Preliminary findings of a randomised controlled trial	Shannon Munteanu		63
		Diagnostic accuracy of clinical tests for ankle syndesmosis injury	Amy Sman		64
		Exercise to reduce tendon pain: A comparison of isometric and isotonic muscle contractions and effects on pain, cortical inhibition and muscle strength	Ebonie Rio		65
		Compromised structure within the asymptomatic tendon in unilateral Achilles tendinopathy patients	Sean Docking		66

WEDNESDAY 23 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
1530 – 1700	Free papers: Exercise science 1			Arcadia Hall 1	
		Systemic adaptations to exercise training in skin microcirculation in humans	Ceri Atkinson		67
		High intensity interval training at overspeed in a lower body positive pressure treadmill improves performance in trained runners	Boris Gojanovic		68
		Dose response relationship between exercise intensity and C Reactive Protein in sedentary individuals	Fiddy Davis		69
		Cutaneous microvascular adaptation to repeated passive core heating in humans	Howard Carter		70
		Exercise-induced elevated rectal temperature: Sex differences and humidity effects	Hugh Morton		71
		The effect of “power naps” on aerobic capacity in sleep-deprived subjects	Monique Pointon		72
		The acute impact of exercise during water immersion on cerebral perfusion	Christopher Pugh		73
		Self-reported tolerance influences cerebral blood flow during exercise	Gavin Tempest		74
1530 – 1700	Free papers: Physical activity – Children and adolescents			Arcadia Hall 2	
		Effectiveness of a program for adolescent girls linking physical education with community sport and recreation	Meghan Casey		75
		Longitudinal changes in the structure of moderate and vigorous physical activity across adolescence for females	Rochelle Eime		76
		The relationship between BMI and physical fitness of physically active girls at the age of 6–7 years old	Elzbieta Ciesla		77
		Can coaches act as physical activity promoters for girls in organised youth sport?	Justin Guagliano		78
		Two-year outcomes from the NEAT Girls obesity prevention cluster randomized controlled trial	David Lubans		79
		An evaluation of a school community-linked sport and recreation program for adolescent girls	Amanda Telford		80
1530 – 1700	Symposium	Current management of concussion in a sporting setting	Neville Blomeley Brendan de Morton	Lagoon Hall A	81
1530 – 1700	Free papers: Nutrition			Lagoon Hall B	
		Dose response of nitrate supplementation on 2,000m rowing ergometer performance	Matthew Hoon		82
		Whey peptide HW3 supplementation suppress body fat accumulation by maintained basal metabolism	Noriko Ichinoseki-Sekine		83
		The effects of a polymorphism in the CD36 gene on metabolic response to a short-term endurance training program: A pilot study	Avindra Jayewardene		84
		A novel method for menstrual cycle phase and oral contraceptive cycle verification	Mia Schaumberg		85
		The effects of oral contraception on post-exercise interleukin-6 and hepcidin	Marc Sim		86
		Dietary nitrate supplementation improves time to fatigue in maximal cycling performance	Melanie Blackhall		87

3 Publishing your work

WORKSHOP

G. Kolt^{1*} ■ E. Verhagen^{2*} ■ G. Waddington^{3*} ■ K. Bennell^{4*} ■ ¹University of Western Sydney ■ ²Vrije Universiteit, The Netherlands ■ ³University of Canberra ■ ⁴University of Melbourne

The importance of publishing and disseminating research and clinical practice work for wider use is well known. This dissemination is an important and integral part of the research process, as it provides wider audiences with the benefit of the work undertaken, and allows for broad critique. Dissemination through peer-reviewed journals can take many forms including original research reports, reviews of literature (many of which will grade the evidence available for particular research questions), the presentation of case studies that will be of clinical importance and interest, reports of clinical trial protocols, or, on occasion, informed opinion pieces and editorials. Selecting the best outlet for your work (depending on its nature) can be tricky, and needs to be well considered in relation to the optimal audience and reach. The increasing number of journals in the sport and exercise medicine and science areas provides greater choice in selecting appropriate avenues for dissemination. Despite an increasing number of journals that publish work in the sports medicine and sports science disciplines, journals face a growing number of submissions for consideration. This often results in journal editors having to make difficult decisions about which papers they consider most worthy for publication, and the best fit for their journal. As such, a consequent number of good papers find it difficult to get published. The aim of this panel discussion is to allow participants to gain an understanding about the process of getting their work accepted for publication, and to provide some insight into the importance of the peer review process in evaluating work for publication.

4 Assessment of hip involvement in complex lumbo-pelvic-hip clinical presentations

WORKSHOP

T. Wisbey-Roth^{1,2,3*} ■ ¹Specialist Sports Physiotherapist (FACP) ■ ²Bounce Back Classes P/L ■ ³Invited Lecturer Australian Catholic University

Lumbo pelvic and hip pain is a relatively common clinical presentation which can be multifactorial and complex in nature. This workshop will use the specific example of a clinical presentation of Lumbo pelvic hip pain to discuss effective functional screening tests and passive assessment strategies for the differential diagnosis of hip involvement. The workshop will include participant discussion on assessment and planning treatment intervention to optimise optimal dynamic function of the hip.

5 Management of patellar tendinopathy

WORKSHOP

J. Cook^{1*} ■ ¹Monash University

Patellar tendinopathy is a condition of young jumping athletes, mostly men. The management is often compromised by ongoing athletic activity and this places constraints on the exercise-based management. The difficulties of managing this condition in both the rehabilitating and the competing athlete will be discussed.

6 Foot and ankle taping for a purpose

WORKSHOP

C. Bishop^{1*} ■ K. Sweeting^{2*} ■ ¹School of Health Sciences, University of South Australia ■ ²Performance Podiatry and Physiotherapy, QLD

This workshop will provide attendees with a structured and systematic approach to the taping of common foot and ankle pathologies. The focus of the workshop will involve appreciating the complex anatomy of the region of interest and determining the responsible muscle and soft tissue function of the impaired rotations and/or translations of a joint which caused the injury. The concept of rigid taping will then be employed to investigate how we can rectify the cause of common clinical presentations in each region of the foot, which, through an understanding of tapings various mechanisms of action, may help predict which treatments individuals are likely to respond to.

7 Shoe fitting

WORKSHOP

Asics Supported Session



M. Doherty^{1*} ■ J. Mansfield^{1*} ■ C. Thomas^{1*} ■ J. McConnell^{1*} ■ ¹Asics Oceania Pty Ltd

Footwear can play an important role in any practitioners treatment plan.

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KEYNOTE

P. Aagaard^{1*} ▪ ¹Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark

Physical exercise, and in particular resistance training induces adaptive changes in the morphology and architecture of human skeletal muscle while also leading to adaptive changes in nervous system function. In turn, these changes contribute to the marked increase in maximal contractile muscle force and power that can be seen with resistance (strength) training in both young and old adults, including athletes, patients and frail individuals. The adaptive change in neuromuscular function has been evaluated by use of muscle electromyography (EMG) measurements, which have included single motor unit recording and measurements of evoked spinal reflex responses (Hoffman reflex, V-wave) and transcranial brain stimulation (TMS, CMS). Training induced alterations in H-reflex and V-wave amplitude obtained during maximal muscle contraction may be used to quantify increase in efferent output from spinal motor neurons (MNs) and to examine the corresponding changes in the excitability and/or presynaptic/postsynaptic inhibition of spinal MNs. In addition, training induced changes in V-wave amplitude may indicate changes in supraspinal (cortical) drive to the pool of spinal MNs. More detailed information about training-induced changes in cortical drive can be achieved by means of transcranial magnetic stimulation of the motor cortex (TMS) or higher brain stem (cervicomedullary magnetic stimulation: CMS).

Based on surface EMG recording, evidence of increased neuromuscular activity during maximal voluntary contraction efforts has been consistently demonstrated following 6–16 wks of resistance training, both in athletes, elderly as well as in orthopedic (hip replacement) and neurological (MS, stroke) patients. In result, marked gains are observed in maximal muscle strength and rapid force capacity (rate of force development: RFD). Elevated MN firing frequency have been observed during maximal muscle contraction following periods of resistance training, contributing to the training induced gain in RFD. In addition, based on TMS experiments evidence of training-induced increases in the excitability of descending corticospinal pathways also exists, although not consistently demonstrated in all studies. Further supporting the aspect of cortical adaptation with resistance training, changes in blood oxygenation level dependent (BOLD) functional magnetic resonance imaging (fMRI) activation area have been detected in the primary motor cortex (M1) following resistance training along with changes in white matter microstructure in the corticospinal tract. In conclusion, a high degree of adaptive plasticity in neuromuscular function in response to resistance training appears to exist, which comprise training induced changes in both spinal and supraspinal neuro-circuitry function, respectively. In turn, these changes translate into significant improvements in mechanical muscle function and functional capacity that are of vital importance for athletes, patients and elderly individuals alike.

C. Bishop^{1*} ▪ J. Arnold¹ ▪ ¹University of South Australia

Background: Heel counters are added to most athletic shoes under the premise that they control excessive hindfoot motion. However, it is often questioned whether this premise has any scientific evidence. Although previous studies have described hindfoot kinematics during running, they have often used external shoe markers to infer in-shoe foot motion which is not a valid technique. The aim of this study was to compare hindfoot kinematics during running both barefoot and in typical running shoes. We hypothesised that running shoes would not alter hindfoot eversion motion but would reduce the rate at which it occurs (angular velocity).

Methodology: Eighteen adults participated in this study (mean age 21.2±2.0 years, height 1.73±0.08 m, body mass 70.8±8.3 kg). Each participant completed five running trials both barefoot and wearing shoes (Asics Gel-Pulse 3). Kinematic data were acquired with a 12 camera VICON MXF-20 motion capture system (Vicon Motion Systems Ltd., Oxford UK) at 100Hz. Variables of interest were the hindfoot eversion angle at initial contact and peak loading (15% stance), as well as the ROM and peak angular velocity during loading response (0–15% stance). Differences between conditions were compared using paired t-tests. Effect sizes (Cohen's *d*) were also computed.

Results: During running, footwear did not significantly reduce eversion of the hindfoot at initial contact (-7.59±5.69° vs. -6.15±5.59°, *p* =>.05, ES=0.26) or peak loading (-13.91±4.63° vs. -13.24±6.15°, *p* =>.05, ES=0.12), nor did it decrease the amount of eversion during loading response (6.88±2.63° vs. 7.21±1.99°, *p* =>.05, ES=0.14). No difference in eversion angular velocity was identified between barefoot and shod running (-175.46±100.52°/s vs. -151.73±70.73°/s, *p* =>.05, ES=0.27).

Conclusion: In this study, footwear did not change hindfoot eversion at initial contact or peak loading, nor significantly reduce the amount of eversion or the peak eversion velocity occurring during loading. These results suggest hindfoot kinematics were not altered by the shoe used in this study. We found no evidence that design features in the heel (i.e. heel counter) provide motion control benefits (i.e. decrease hindfoot eversion) to the foot during stance phase of running. It is possible that the purported feature of running shoe heel counters of 'motion control' with reference to the hindfoot require re-evaluation.

L. Kelly^{1*} ▪ G. Lichtwark¹ ▪ A. Cresswell¹ ▪ ¹School of Human Movement Studies, The University of Queensland

Introduction: During the stance phase of gait the longitudinal arch (LA) of the foot deforms and recoils in a spring-like manner. It is thought that the elastic plantar aponeurosis is the primary structure responsible for this spring-like foot function. However, given that the plantar intrinsic foot muscles have muscle-tendon units (MTU) that span the length of the LA they could potentially contribute to actively stiffen the LA during the stance phase of gait. Therefore, we sought to test the hypothesis that the plantar intrinsic foot muscles actively lengthen and shorten during the stance phase of gait and that recruitment of these muscles is regulated in response to the magnitude of the ground reaction force and MTU deformation.

Methods: 8 healthy male participants volunteered to participate in the study which involved walking (4.5 and 6km/h) and running (8,10 and 12km/h) on a force instrumented treadmill, while intra-muscular electromyography (EMGi) signals were recorded from the right foot abductor hallucis (AH), flexor digitorum brevis (FDB) and quadratus plantae (QP). A 3D motion capture system recorded foot and ankle motion according to a multi-segment foot model. MTU length of the AH, FDB and QP were determined based on a geometrical model according to the kinematics. Ground reaction forces (GRF) were recorded from the treadmill. A repeated-measures ANOVA was used to test for differences in EMGi, MTU length and GRF with increasing gait velocity. Results: Muscles were activated from the end of swing phase until toe off with the peak EMGi value occurring in mid-stance. Mean stance and swing phase EMGi root mean square amplitude increased with gait velocity (all $P \leq 0.05$). MTU length increased for all muscles during the first half of stance phase, followed by rapid recoil occurring prior to propulsion. Peak MTU lengths increased with increasing gait velocity for all muscles (all $P \leq 0.05$), corresponding to increases in both EMGi and GRF ($P \leq 0.05$).

Discussion: We have provided the first in-vivo evidence that the plantar intrinsic foot MTU's are actively lengthening and shortening during the stance phase of gait and thus are capable of contributing to the stiffness of the LA. We have also shown evidence of late swing phase and stance activation of these muscles, which may be an important mechanism to stiffen the LA in preparation for high deformation forces associated with running.

11

Fatigue impact on non-contact ACL injury risk associated with multi-directional jumping and landing in female athletes: A systematic review

C. McMaster^{1*} ■ ¹Catherine McMaster

Introduction: This paper reviews current research regarding the impact of fatigue and multi-directional landings on non-contact anterior cruciate ligament (NC-ACL) injury risk in female athletes. It focuses on knee and hip biomechanical outcomes associated with NC-ACL injury, covering all three planes of movement. Fatigue is considered to be an NC-ACL injury risk factor because an athlete appears to be at greatest risk towards the end of half time, end of the game and end of the season. Focusing on multi-directional landings moves research closer to sports like 'high risk' scenarios. Methods: The criterion for article selection includes a fatigue protocol, and at least one biomechanical outcome from the first multi-directional landing. Studies are evaluated for quality using a modified Downs and Black checklist. Analysis between studies focuses on identified hip and knee NC-ACL biomechanical risk factors. Effect size and Forest plots are used to compare study results.

Results: The keyword search yielded 105 articles on SCOPUS and 12 on Web Of Science. Eight articles were selected for this review after checking against the criteria for inclusion. All studies include a priori power calculation ensuring meaningful results. A total of 132 female participants are evaluated. Five studies include elite female soccer players. One study includes elite athletes from soccer, volleyball and basketball. Two studies include participants described as physically active. Resulting from studies selected, this review includes the examination and comparison of multi-directional landings influenced by fatigue and decision-making, unilateral fatigue and fatigue with single and double-legged landings. The efficacy of different fatigue protocols used, and the varying levels of injury risk that they produce is compared and discussed. The timeline of fatigue impact is revealed at 50% and 100% fatigue, and 20 minutes and 40 minutes into recovery.

Discussion: One common finding across all studies is the more extended landing posture of both hip and knee after fatigue. NC-ACL injury risk is increased by the combinations of fatigue and decision-making and by fatigue and single-legged landings on the non-dominant leg. Interestingly the fatigue timeline reveals NC-ACL injury risk occurs earlier than previously understood (50% fatigue) and lasts longer as pre-fatigue levels were not fully restored after 40 minutes. Risk is not increased by isolated hip and ankle fatigue. The greatest risk occurs while performing single-legged landings on the non-dominant leg while executing unanticipated tasks; a typical scenario repeated many times during the course of a game involving running and cutting.

12

The effect of unstable rocker-soled recreational footwear on knee joint load in knee osteoarthritis

E. Madden^{1*} ■ K. Bennell¹ ■ C. Kean¹ ■ T. Wrigley¹ ■ R. Hinman¹ ■ ¹Centre for Health, Exercise and Sports Medicine, The University of Melbourne

Introduction: Higher knee load is associated with greater disease severity and more rapid progression of knee osteoarthritis (OA). As there is no cure for OA, it is important that means of reducing knee load are identified. Wearing footwear increases joint load compared to walking barefoot but different shoes can increase or decrease knee load depending on their design features. Unstable rocker-sole shoes are popular within the general community and are marketed by manufacturers as a recreational footwear option that decreases joint stress and load. However, there is little evidence to substantiate such claims. This study evaluates the effects of unstable rocker-sole shoes on knee load during walking in people with knee OA.

Methods: Using a within-subject study design, 30 individuals (mean (SD) age 61 (7) years, 15 (50%) female) with radiographic and symptomatic knee OA underwent 3D gait analysis under three test conditions in random order: i) Skecher unstable rocker-sole shoes ii) non-rocker-sole recreational shoes, and iii) barefoot. The peak KAM and the KAM angular impulse were measured as primary indicators of knee load. Repeated measures analysis of variance was used to compare load parameters between test conditions.

Results: When wearing the rocker-sole shoes, peak KAM was significantly lower compared to the non-rocker-sole shoes ($p < 0.001$) (mean percentage (SD) change of -7.1 (9.2)%; range -28.3 to 9.6%) but was still significantly higher compared to barefoot walking ($p = 0.03$) (mean percentage change of 6.7 (12.5)%; range -16.7 to 42.8%). KAM impulse in the rocker-sole shoes was not significantly different to that of non-rocker-soled shoes ($p = 0.127$) while both were significantly higher compared to barefoot (both $p < 0.001$; percentage change of 12.0 (9.6)%; range -2.3 to 29.8% for rocker sole shoes; percentage change of 17.6 (17.7)%; range -1.6 to 86.1% for non-rocker-sole shoes).

Discussion: Limited research is available using the peak KAM and KAM impulse as primary indicators of knee load while investigating the effects of this recreational shoe design in people with knee OA. The Skechers unstable rocker-sole shoe significantly reduced the peak KAM during walking in individuals with knee OA, when compared to a non-rocker-sole recreational shoe. There was no difference in KAM impulse between shoe conditions. Both peak KAM and KAM impulse were significantly higher when wearing either shoe to barefoot, which is commonly seen with many types of shoes. Potentially this shoe style may be a viable option for reducing knee joint load and disease progression in this population.

The effect of athletic shoe midsole heel height on lower extremity kinematics and neuromuscular activation during overground walking

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Introduction: Recent debate surrounding the use of athletic footwear with elevated cushioned heels highlights the lack of knowledge regarding the effect of small changes in midsole heel height (MHH) on lower extremity biomechanical data. Consequently, the aim of this study was to examine the effect of walking in two identical shoes with different MHHs (10mm and 13mm), and compare these to walking in a racing flat (4mm).

Methods: The lower limb kinematics of 31 males was assessed during an acute bout of walking in two neutral shoes (ASICS Gel Nimbus 14 with 10mm and 13mm MHHs) and a racing flat (ASICS Piranha SP3; 4mm MHH), presented in random order. Differences in lower limb muscle activity and sagittal plane kinematics were examined using Friedman tests, and Wilcoxon signed rank tests were used to ascertain where differences occurred.

Results: There were significant increases in average contact phase medial gastrocnemius ($p=0.02$, $ES=0.43$) and tibialis anterior ($p=0.01$, $ES=0.44$) muscle activity in the 13mm compared to the 4mm shoe, and in tibialis anterior activity ($p=0.03$, $ES=0.40$) in the 10mm compared to 4mm shoe. No differences in muscle activity were found between the 10mm and 13mm shoes. When compared to the 10mm and 13mm shoes, the 4mm shoe significantly increased peak and average ankle dorsiflexion ($p<0.01$, $ES=0.84-0.87$), peak and average midfoot plantarflexion ($p<0.01$, $ES=0.72-0.79$), peak knee velocity ($p<0.01$, $ES=0.57$) and significantly decreased the time to peak knee flexion ($p<0.05$, $ES=0.45-0.48$) and hip extension ($p<0.01$, $ES=0.48-0.50$). Peak ankle plantarflexion was also significantly reduced in the 4mm compared to the 10mm and 13mm shoes ($p<0.01$, $ES=0.49-0.65$). The only differences between the 10mm and 13mm shoes were in peak (10mm=8.23°, 13mm=7.80°, $p=0.02$, $ES=0.42$) and average (10mm=1.39°, 13mm=1.32°, $p<0.01$, $ES=0.50$) ankle dorsiflexion.

Discussion: These results demonstrate a number of alterations in lower extremity muscle activity and kinematics during an acute bout of walking in shoes with three different MHHs, including two identical shoes with a MHH difference of only 3mm. Future research should examine the longer term effects of variations in MHHs and whether this impacts injury and performance.

An exploration of the biomechanical effects of footwear and orthoses on joints proximal to the foot during running

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Background: Musculoskeletal running injuries are common in elite and recreational athletes. Their clinical management, especially in those patients with pes planus foot types, commonly involves a combination of foot orthoses and supportive (dual density) shoes. Despite the evidence for the clinical effectiveness of foot orthoses (i.e. symptom reduction), there is minimal understanding of the mechanisms of their effect, and whether supportive shoes alone have similar effects to foot orthoses.

Methodology: In order to investigate the kinematic and kinetic effects of footwear and foot orthoses during running, twelve participants with pronated feet were recruited. Each participant ran five trials in neutral shoes (single density and defined as baseline), stability shoes (dual density) and neutral shoes with prefabricated and custom orthoses. Joint kinematics were measured using a 12 camera motion capture system (Vicon Motion Systems Ltd., Oxford UK) and ground reaction forces from two force platforms (9286b, Kistler, Switzerland). Joint moments were estimated using standard inverse dynamic techniques.

Results: Custom orthoses had a moderate effect on the peak ankle flexion moment, reducing it by 41% relative to baseline ($MD=0.092$ Nm/kg, p -value=0.03, $ES=0.51$). The stability shoe adducted the knee from initial contact, with the largest effect between conditions demonstrated at 50 % of stance ($MD=4.54^\circ$, p -value= <0.01 , $ES=0.59$). Prefabricated orthoses significantly reduced the hip flexion moment by 28% relative to baseline ($MD=0.133$ Nm/kg, p -value= <0.01 , $ES=0.76$). The stability shoes also produced more external rotation in the hip joint relative to all other conditions during stance, with the greatest difference identified at midstance ($MD=5.18^\circ$, p -value= <0.01 , $ES=0.60$).

Conclusion: This study demonstrates that foot orthoses and stability footwear both have moderate biomechanical effects on the joints proximal to the foot, indicating their potential to change both the kinematics and moments acting across these joints. Appropriate clinical utilisation of such devices therefore requires an in-depth appreciation of the consequential biomechanical effects of these devices, especially when prefabricated devices and stability footwear are readily available to the public.

Dynamic midfoot and ankle mechanisms of vertical jump performance of children while barefoot and wearing sports shoes

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Introduction: Children's shoes considerably alter midfoot and ankle function during propulsion. However the effect of shoes on children's performance and the mechanisms behind potential alterations to performance are poorly understood. The purpose of this study was to investigate the dynamic midfoot and ankle mechanisms of vertical jump performance of children while barefoot and wearing shoes.

Methods: Twenty children aged 8 and 12 years (mean age 10, SD 1.4) were recruited for the study and fitted with a conventional sports shoe (ASICS Gel Kanbarra 5). Footwear testing order was randomised for each participant. Children performed two standing counter movement vertical jumps with their right foot on a force plate (sampling rate 1000Hz) in each condition. The better jump in each condition was analysed. Three-dimensional midfoot and ankle motion and jump height were measured using a motion analysis system with a sampling rate of 200Hz. An inverse dynamics software package was used to calculate the three-dimensional kinetics. Data were analysed from 60% of the counter movement until toe-off (100%). Rearfoot and forefoot motion was attained by detachable markers through holes in the shoe. Paired sample t-tests were undertaken to assess significance between conditions. The relationship between jump height and dynamic variables was investigated using a series of Pearson product moment correlation coefficients.

Results: In comparison to barefoot (mean 33.4cm, SD 7.1), jump height was not significantly altered in the sports shoe (mean 32.1cm (SD 6.5); $P=0.052$). The highest vertical jump height was achieved by 15 children while barefoot and 5 children while wearing shoes. Shoes decreased peak midfoot angular velocity from -6.28 (SD 2.00) rad/s while barefoot to -3.37 (SD 1.48) rad/s ($p<0.0005$) in shoes and peak power generation from 4.67 (SD 2.33) W/kg while barefoot to 2.43 (SD 1.11) W/kg ($p=0.002$) in shoes. Midfoot peak angular velocity ($r=-0.631$; $p=0.003$) and peak power ($r=0.455$; $p=0.044$) were significantly associated with barefoot jump height. Ankle peak angular velocity ($r=-0.523$; $p=0.015$) and range of motion ($r=0.496$; $p=0.026$) were associated with shod jump height.

Discussion: Peak midfoot angular velocity describes 40% of the variance in barefoot jump height, while peak ankle angular velocity describes 27% of the variance in the shod jump height of children. Children's sports shoes shift the dynamic mechanisms of vertical jump performance proximally from the midfoot to the ankle and have implications for triceps surae muscle complex function and injury.

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A novel exercise for retraining the rotator cuff muscles of the shoulder

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Introduction: A modification to standard rotator cuff exercises that uses an elastic resistance band around the humeral head to create an anterior translational force is proposed to improve humeral head centralisation by facilitating co-contraction of the rotator cuff to resist the force. A balance between co-activation and muscle intensity of the rotator cuff is considered essential for optimal humeral head stability, correct axial alignment, concavity compression and normal shoulder function. The aim of this study was to determine if the modified internal and external rotation exercises increase activation of the rotator cuff when compared to standard rotation exercises.

Methods: Intramuscular electrodes were used to record the muscle activity of the infraspinatus, supraspinatus and subscapularis in the dominant shoulders of ten healthy individuals (mean age 22.8 years). Participants completed 8 repetitions of each of the exercises. Twelve sets of exercises were performed in random order: standard and modified internal rotation at 0, 45 and 90 degrees abduction and standard and modified external rotation at 0, 45 and 90 degrees of abduction.

Results: Subscapularis activated at a higher intensity during the modified exercises overall, however only external rotation at 0 degrees of abduction reached significance ($p=0.03$). No significant differences were found in supraspinatus and infraspinatus muscle activity between the standard and modified exercises ($p>0.05$).

Discussion: The modified exercises may elicit greater muscle activity in anterior cuff muscle in a normal population. This simple modification may promote increased dynamic stability when performing rotator cuff exercises. It has been shown previously using biomechanical and cadaveric modeling that during external rotation at 0 degrees of abduction, the subscapularis muscle is the most important stabiliser of the glenohumeral joint. Increasing the anterior translational force on the humeral head using the modified exercise in this position promotes greater subscapularis activity and co-activation of the rotator cuff. Considering the testing was performed in a normal population where passive constraints of the joint can also help to stabilise the humeral head, testing in a pathological group with increased glenohumeral laxity could elicit potentially greater differences between exercises. The current study provides preliminary validity for the use of these simple, modified exercises to elicit greater subscapularis muscle activity in the clinical setting.

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Ultrasound evaluation of asymptomatic senior and under-23 elite rowers' forearms with reference to Intersection Syndrome

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Introduction: The intersection is the region in the distal forearm where the muscles in the first dorsal compartment (EPB, APL) cross the tendons of the second dorsal compartment (ECRL, ECRB). Intersection syndrome (IS) is a debilitating and costly condition that can result in poor performance and inability to row. In some cases, it may lead to surgery. IS commonly presents pain and swelling around the IS region with crepitus on wrist movements. There is a dearth of literature into IS and this study's main purpose was to evaluate what ultrasound characteristics are normal in asymptomatic elite rowers.

Methods: 19 asymptomatic senior elite ($n=6$, male=4) and under-23 rowers ($n=13$, male=7) currently competing at National level or above underwent ultrasound (US) evaluation of their distal forearms by a trained sonographer with postgraduate qualifications. The exclusion criterion was any history of forearms symptoms. A comprehensive evaluation sheet was utilized based on current literature. This was then reviewed by senior clinicians in Rowing Australia's medical network to ensure its completeness. All ultrasound measurements were taken on a scheduled rest day. All participants were in full training at the time of imaging.

Results: No pathology was found in the first extensor compartments (APL, EPB). Peritendinous fluid was identified around the tendons of ECRL ($n=10$, 53%; male=7) and ECRB ($n=6$, 32%; male=4) with four participants having both (22%; male=3). One female participant (5%) had hypervascularity present on Doppler examination of her ECRB, co-existing with peritendinous fluid. One male participant had fluid identified between the first and second compartments co-existing with ECRL and ECRB peritendinous fluid and one female had fluid within the second compartment without involvement of any tendons. No tearing of the synovia of either compartment was identified. All tendons had free movement on wrist flexion and extension. The senior athletes were statistically more likely to have peritendinous fluid in both ECRL and ECRB ($p=0.04$). There was no statistical difference between the age groups for fluid in only one tendon (ECRL $p=0.07$; ECRB $p=0.24$).

Discussion: This is the first study looking at asymptomatic elite rowers' intersection region. The results of this study indicate that ultrasound identifiable pathology is common in the second extensor compartment (ECRL, ECRB) at the level of the intersection but absent in the first compartment. Clinicians should take care when diagnosing intersection syndrome based on the presence of peritendinous fluid on US. Future research should utilize age-matched controls.

18 Management of pain associated with acute sports injuries – is acupressure a way to go?

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Introduction: In excess of 10 million sport-related injuries are sustained globally each year, and an important component of the athlete's recovery is the management of their pain. However, many injuries occur on sports grounds that do not provide immediate access to qualified medical care resulting in increased morbidity for many athletes. Acupressure is an easily applied modality which has been effective in pain moderation in specific populations, but surprisingly not previously trialed in athletes. The aim of this study was to assess the effectiveness of acupressure for decreasing pain in athletes with an acute sports injury.

Methods: A three arm, single blinded RCT was conducted at a sports injury clinic during the 2012 winter sports season. Athletes, who sustained a sport injury immediately prior to presentation at the clinic and consented to the study, were randomized to one of three treatment groups: true acupressure (applied at Hegu (LI4) located on the dorsum of the hand between the 1st and 2nd metacarpal bones); placebo acupressure (at a non-acupressure point); and a non-treatment group (rest). All treatment and non-treatment periods were of 3 minutes duration, delivered by the same trained therapist, blinded to baseline pain scores. Athletes provided their pain levels using a 100mm visual analogue scale before and immediately after the treatment. Comparisons between groups were performed using ANOVA procedures and post-hoc analysis via the Westfall method. The a priori alpha level was set at $p < 0.05$. **Results:** Seventy nine acutely injured athletes (primarily ankle and shoulder) participated and completed the study. There were no baseline differences in pain between the three groups ($p = 0.91$), with the mean pain score of 49 ± 22 mm. There was a statistically significant decrease (9.1 mm) in pain following the intervention in the true acupressure group compared to non-treatment group ($p < 0.05$), and 11.3 mm difference between the true and placebo acupressure groups ($p < 0.001$). There was no difference between placebo and non-treatment groups ($p = 0.44$).

Discussion: The results of this study indicate that acupressure may be effective for the treatment of acute sport-injury associated pain when compared to placebo and non-treatment. Acupressure represents a non-invasive, non-pharmaceutical technique which may be easily administered by sports medics, coaches and other potential first responders. Future research should explore the influence of acupressure duration, frequency, choice and number of points, on the magnitude of pain relief in acute sports injuries.

19 Effect of acupuncture and instruction on post-exercise recovery: A balanced-placebo controlled trial

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Introduction: This study investigated the effect of acute (20min) acupuncture treatment administered immediately after a maximal exercise test on measures of recovery (i.e. heart rate and oxygen consumption).

Methods: A balanced-placebo 2x2 factorial design was employed. The first factor was acupuncture with participants allocated to receive traditional Chinese medicine (TCM) acupuncture or placebo acupuncture. The second factor was instruction (expectancy) with half of the participants correctly informed of their allocation and the other half incorrectly informed. A no-treatment control group was included as the fifth group to enable comparison of the total treatment response (acupuncture effect + placebo effect) to no intervention. Participant eligibility was limited to young adults (18–30yrs) that were recreationally active and acupuncture naïve. Participants performed a graded exercise test (GXT) to exhaustion on a cycle ergometer using a ramped protocol (15W/min). Following the GXT, participants transferred to a supine position on the plinth as quickly as possible. The participant was then randomized to one of the five groups. Heart rate and VO_2 were collected continuously throughout the test and for 60-min of supine recovery. An experienced acupuncturist delivered the acupuncture and placebo treatments. Real acupuncture points included *Neiguan* (PC6), *Zusanli* (ST36), *Lieque* (LU7), and *Tanzhang* (REN17). Placebo acupuncture was delivered using the Park sham needle placed 1–2 *cun* units away from the aforementioned real acupuncture points. Approximately 4 min was required to insert all acupuncture and placebo needles. Participants in the control condition received no intervention.

Results: Forty participants ($21 \pm 2y$, $24.6 \pm 3.6kg/m^2$) completed the study. Planned contrast analyses indicated a significant reduction in heart rate at 20min post exercise for the treatment groups combined compared with the control group, controlling for heart rate at fatigue (maximal heart rate). This trend was also evident from 30–60min, but failed to reach statistical significance ($p = 0.09$ to 0.13). There were no statistically significant effects when comparing real to placebo acupuncture, expectancy about treatment, or interactions. No effects were statistically significant for VO_2 .

Conclusions: The current pattern of results suggests that receiving some form of treatment facilitates heart rate recovery post maximal exercise. However, this appears to be a general effect that is independent of whether or not the participants received acupuncture or placebo and what they were told about their treatment.

20 12 month results of a randomised controlled trial comparing subgroup specific physiotherapy against advice for people with low back disorders

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Introduction: Low back disorders (LBD) affect athletes and non-athletes alike. Although multiple guidelines recommend the provision of advice for the treatment of acute-subacute LBD, few treatments have demonstrated clinically meaningful benefits. It has been proposed that clinical heterogeneity in randomised controlled trials (RCTs) may reduce the likelihood of demonstrating treatment effects. The Specific Treatment of Problems of the Spine (STOPS) trial attempted to minimise heterogeneity by evaluating the effectiveness of specific physiotherapy treatment compared to physiotherapy advice in people with LBD classified into one of five homogenous subgroups.

Methods: In a multi-centred randomised controlled trial, non-compensable participants with low back pain (≥ 6 weeks, ≤ 6 months) and/or referred leg pain were classified into one of five subgroups. They were then randomly allocated to receive either physiotherapy advice or specific physiotherapy treatment over 10 weeks at private practice clinics. The primary outcome measures included back pain and leg pain (0–10 numerical pain rating scale) and activity limitation (Oswestry Disability Index). Data were analysed using linear mixed models for continuous outcomes.

Results: Analysis of 300 participants (153 men, 147 women) showed a mean(SD) age of 44(12) years and a duration of back and leg symptoms of 15(10) and 11(10) weeks respectively. Linear mixed model analyses of primary outcomes showed that between group differences for Oswestry favoured specific physiotherapy at 10-weeks (4.7; 95% CI 2.0 to 7.5), 26-weeks (5.4; 95% CI 2.6 to 8.2) and 52-weeks (4.3; 95% CI 1.4 to 7.1). Similarly, back and leg pain were significantly lower in the specific physiotherapy group relative to the advice group at 10-weeks (Back: 1.3; 95% CI 0.8 to 1.8, Leg: 1.1; 95% CI 0.5 to 1.7) and 26-weeks (Back: 0.9; 95% CI 0.4 to 1.4, Leg: 1.0; 95% CI 0.4 to 1.6) time points.

Discussion: Subgroup specific physiotherapy leads to greater reduction in activity limitation across a 52-week follow-up period, and faster reduction in back and leg pain, relative to guideline-recommended advice. These differences are clinically important. This is the first specific physiotherapy RCT targeting pathoanatomical factors as a means of minimising the impact of sample heterogeneity in LBD. Provided physiotherapists in clinical practice adopt the described treatment integrity measures, clinical outcomes are likely to be superior compared to guideline recommended advice.

21 Facilitating the upward rotators of the scapular. A simple exercise

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Introduction: Scapula dyskinesia, characterised by drooping scapulae and reduced upward rotation, has been implicated in the presentation of a number of shoulder disorders. Traditionally, in shoulder rehabilitation programs, the shrug exercise has been prescribed to strengthen the upper trapezius muscle and facilitate upward rotation of the scapula. The aim of this research was to compare muscle activation levels during the standard shrug and the upward rotation shrug in a normal and pathological population.

Methods: Surface electrodes recorded EMG activity from upper trapezius, middle trapezius, lower trapezius and serratus anterior muscles in 23 normal participants and 14 participants with multi-directional shoulder instability. Participants completed 10 trials of the standard shrug exercise at 0° of shoulder abduction and the upward rotation shrug. The upward rotation shrug is performed with the arm at 30° of shoulder abduction in the coronal plane with an emphasis on the tip of the shoulder moving up towards the back of the ear. Muscle activity was expressed as a percentage of maximum voluntary isometric contraction.

Results: The four muscles tested performed at a higher intensity during the modified shrug than the standard shrug. Upper trapezius and lower trapezius activity was significantly greater ($p < 0.05$) in both populations. Though, for middle trapezius and serratus anterior muscles, the modified shrug was statistical significant only in the normal population, $p = 0.031$ and $p = < 0.001$ respectively.

Discussion: The upward rotation shrug is a more effective exercise for strengthening the upper and lower trapezius than the standard shrug in a normal and multi-directional instability population. Clinically, the upward rotation shrug can be used to address scapula dyskinesia involving drooping shoulders and reduced scapula upward rotation.

22 The effect of exercise based management for multidirectional instability of the glenohumeral joint: A systematic review

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Introduction: The most commonly recommended treatment for multidirectional instability (MDI) of the shoulder is exercise based management. The primary objective of this review was to evaluate the effectiveness of exercise based management in patients with MDI. Secondary aims were to investigate the structure of exercise protocols, the types of outcomes used, and any adverse effects associated with exercise.

Method: The Cochrane database of systematic reviews, MEDLINE, EMBASE, CINAHL, PEDro, Current Contents, AMED, AML, Ausport and the Clinical Trials Register were searched for published and unpublished studies from inception date to June 2012, using the key words and synonyms for "multidirectional instability", and "glenohumeral" and "exercise". Selection criteria included all study designs (except case reports and case series) that included participants with clinically diagnosed MDI utilizing exercise based management. Inclusion criteria were not limited by outcomes. The authors own risk of bias tool was used for quality assessment of studies. The GRADE approach was used to synthesise the evidence.

Results: Risk of bias was high in all seven included studies. Four studies investigated exercise compared to surgery, and three studies investigated the effects of exercise alone. GRADE assessment revealed very low quality evidence that surgery was favored over exercise for impairment outcomes only, and exercise was favored over surgery for patient focused outcomes. Before and after comparisons of exercise based management revealed very low quality evidence for improvements in outcomes.

Discussion: Downgrading of the evidence was primarily due to studies that had a high level of bias and issues with participant selection, outcome measures and reporting. Discrepancies in the diagnosis of MDI across studies resulted in participant heterogeneity. Outcome measures used across studies were either impairment based or not specific for measuring changes in an instability population. Poor reporting of exercise intervention details across studies meant that evaluation and comparison of their true effectiveness was extremely difficult. Despite the recommendation of exercise based management as the primary treatment for MDI, there is a lack of quality evidence to support one specific exercise protocol over another or to guide clinicians on the type of drills or dosages to use when treating MDI with exercise. There is a need for high quality intervention studies to be undertaken to validate the effect of exercise based management on functional and specific outcomes of patients with MDI.

23 Relationship between motor skills, physical fitness and activity in children from Poland

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Introduction: Scientific studies confirm numerous health benefits of motor activity in children and adolescents. They concern not only the physical and mental health dimension. It can be assumed that the above-average level of activity allows a child to master significantly faster a number of motor skills and creating a high level of physical fitness, which are in mutual close relationship with each other. It is also likely that the increased level of physical activity strengthens the relationship between the components of motor skills. Hence, the quality of the movement of a more efficient child compared to a peer with a low activity level is higher and the time spent on learning new motor tasks is shorter.

The aim of the study was to examine the relationship between motor skills, physical fitness and physical activity in children at 6–7-year-olds. Methods: Cross-sectional study was conducted in Poland in 2006. Representative sample was 14205 children of 6–7 years. The physical fitness of children was evaluated with EUROFIT test battery. The diagnosed skills included throws and catches of ball, jumps, kicks and run of a child when performing physical exercises. A questionnaire was used to collect information about children's additional physical activity. Relation between physical fitness and motor skills in two groups of children (attending and not attending additional activities) were calculated using Pearson correlations. An alpha level of 5% was adopted for all analysis.

Results: Approximately 19.73% of the children attend additional motor activities once or twice a week. Only 1.37% more than twice a week, while others (78.90%) do not participate in such activities. In both groups statistically significant correlations were observed between fitness and all motor tasks performed by children ($p \leq 0.01$). The strongest relations concern skills and abilities that require strength (sit-ups $r=0.474$, standing broad jump $r=0.484$) and flexibility ($r=0.410$). The weakest correlations were noted for fitness with the skills associated with the precision of movement of upper limbs (throws $r=0.168$, plate tapping $r=0.082$, grips $r=0.155$). Only in the tests of plate tapping, standing broad jump, sit-ups and one-leg jumps increase in correlation was observed in the groups of active children.

Discussion: Children's motor abilities are the most appropriate target for increasing physical activity in youth. Probably there is, however, a barrier of activity, below which their relationships are not exposed. Another important factor is also the level of biological development of a child.

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Sport and Recreation Spatial: Development of a national geographical information system for the sport and recreation sector

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Introduction: The Sport and Recreation Spatial project is a collaborative partnership between national and state sport, recreation, health, government and university organisations. It involves the development of a geographical information system (GIS) for presenting spatial data relevant to all levels of the sport and recreation sector.

Methods: The project was established to provide the sport and recreation sector with increased capacity for research, strategic planning, and development of participation programs and facilities. The integration of multiple large datasets provides a strong evidence base for the sport and recreation sector. The key research areas are: participation levels and trends; influences on participation; value of sport – the health benefits of participation; and places to play – the nexus between facilities and participation. The integrated, dynamic database system incorporates data about sport and recreation participation and facilities in conjunction with population demographic data. The initial tranche of participation data includes around 200,000 data records from the national Exercise, Recreation and Sport Survey (2001–2010) and over 1.8 million player, coach and umpire records from eight Victorian State Sporting Associations (2008–2012).

Results: A live presentation of the GIS interface will demonstrate the wide range of interactive user-specified options and queries and the resulting “on-the-fly” generation of maps and associated tables illustrating participation trends across time and geographical locations.

Discussion: This project is providing increased capacity for strategic planning and development of participation programs and facilities. Whilst we may know broad trends in participation across time, this project allows dynamic investigations across multiple datasets, of questions relating to specific geographical locations, which may pertain to population demographics, participation (player, coach and umpire) trends, and/or infrastructure development. National implementation of this system will provide social, health and economic benefits.

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Fitness and health of vocational school youth in Poland

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Introduction: Movement is a factor that significantly affects the human body through the use of various forms of physical activity and exercise. Physical fitness promotes health, well-being and helps young people learn practical profession. Often it is essential and necessary in a professional career requiring agility, heavy exercise or forced placement position.

Methods: The study was conducted in the school year 2007/2008 at vocational schools in Kielce, Poland. The study involved 2067 young people born in 1990. In 734 tested occurred disorders in health and development. After a thorough analysis of medical and school records eventually 210 people were qualified to study, both girls (33 persons) and boys (177), coming from the city (over 39%) and villages (nearly 61%).

The study used two equivalent research methods: a diagnostic survey and analysis of documents. In statistical analysis, nonparametric Chi-square test (χ^2) was used.

Results: Young people surveyed did not stand out with fitness skills. More than 74% of respondents defines their fitness level as “average” regardless of the direction of education. The result “above average” received only about 21% of the students educated in technical school, in a similar proportion of both the city and the countryside. A small percentage of respondents reported their physical fitness “below average”. In more than 44% of the respondents were disorders of the motor system (lateral curvature of the spine about 42%, excessive kyphosis 2.38%), predominant among young people from the rural environment. More than 16% revealed disorders in physical development (growth), having a strong correlation with the direction of education chosen by the subjects ($\chi^2=16,299 > \chi^2_{0,05;8}=15,507$; $r_c=0,26$). Approximately 40% of students due to existing health problems were enrolled in physical education classes in group B, B_k, C, which significantly affects the education in their chosen profession ($\chi^2=18,633 > \chi^2_{0,01;6}=16,812$; $r_c=0,28$).

Conclusions: Reduced physical fitness of the tested has a negative effect on their health. It causes significant disorders especially on the part of the motor system, thus significantly limiting the participation in activities and sports exams. In the future, to a large extent, it may limit opportunities in the labor market.

B. McLeod^{1*} ▪ R. Eime¹ ▪ J. Harvey¹ ▪ G. Tsolidis¹ ▪ ¹University of Ballarat

Introduction: The association between sports spectatorship (SS) and physical activity (PA) is not well understood, either for the general population or for international students in particular. International students are of particular interest because they are at increased risk of poor physical, mental and social health outcomes due to the additional stresses they face while studying abroad. This study investigated the relationship between SS and PA for international students living in Australia to help determine the value of SS and PA for this cohort.

Method: International students (n=317), from 53 countries, aged between 18 and 49 years (mean=24.4 years), completed a quantitative survey measuring SS and PA. The survey took approximately 30 minutes to complete and was available online or in a paper version. The mixed gender sample (females=51.4%) was recruited from 27 Victorian educational institutes. Most (52.4%) were completing the first year of an undergraduate degree.

Results: There was a significant positive correlation between SS and PA ($r=.208$, $p<.0001$), and students categorised as having a higher level of SS exhibited significantly higher levels of PA ($p=.003$). A comparison of the two types of sports spectatorship (active: event attendance; and passive: watching on television) showed no significant difference, in the level of PA, between students who watched sport only actively or only passively ($p=.052$) or between students who watched sport in both ways compared to only one way ($p=.113$).

Discussion: The results highlight the need for educational institutes and sporting bodies to place greater emphasis on SS opportunities because this, in turn, may enhance participation in sport and PA. The findings of this study demonstrate that increased SS opportunities may lead to an adoption of increased PA, and thus to an overall healthier lifestyle. These findings are particularly important for international students who experience poorer health outcomes while studying abroad. In conclusion, this study suggest by getting more people, particularly international students, involved in SS, may enhance PA, which in turn can assist in many positive health outcomes. However, given this study was cross sectional, further research is required to better understand this association, and in particular to confirm the direction of causation.

I. Warbrick^{1*} ▪ ¹Massey University

Introduction: Although Indigenous men are the focus of many health initiatives aimed at reducing lifestyle illness, little is known about the motivations, perceptions and preferences of these high-risk groups toward physical activity, the barriers which prevent them from being active, or the impact of interventions on subjective markers of wellbeing. Considering the impact of obesity and its related illnesses on Māori men in New Zealand, it is important to identify factors that could make physical activity and exercise more relevant and appealing to this particular group.

Methods: A cohort of 30 sedentary Māori men, between 28 and 50 years (BMI>25) were randomly assigned to one of two exercise programs. Before commencing the 12-week training program, participants met, in 3 separate focus groups, to discuss their thoughts, feelings, and preferences toward exercise and physical activity. Further discussions took place after the 12 week exercise intervention, to observe whether perspectives had changed post-participation and to also assess the intervention's impact on markers of subjective well-being.

Results: These discussions brought to light many key themes that were perceived as barriers to being regularly active including time commitments to work and family, lack of knowledge and guidance regarding exercise, lack of social support, and the fact that exercise methods commonly on offer failed to resonate with participants. The men also identified factors that would likely increase their participation and adherence to physical activity such as the importance of competition, the role of family support, and the necessity to have 'mates' involved in training sessions. Post-intervention discussions also revealed that participation in these interventions enhanced all aspects of well-being and lifestyle, from relationships with spouse and children, to workplace productivity and mood.

Discussion: Findings from these discussions could be valuable for those engaged in the development and implementation of interventions geared toward Māori men, other indigenous groups, and people in general who find it difficult to begin and/or adhere to a physically active lifestyle. Results suggest that the approach used, and the social environment established within an intervention is more important to participants than the method of exercise employed. The results of this study also suggest that using group discussions to allow participants input into interventions could prove valuable during the designing of initiatives, and provide a way to assess the effectiveness of such initiatives on the overall well-being of those who take part.

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Introduction: Participation in physical activity and sport can lead to an array of health benefits including psycho-social determinants of health like social engagement, strong social networks and self-esteem. However, many children from disadvantaged communities including culturally and linguistically diverse (CALD) and refugee are often excluded from traditional sport opportunities and associated health benefits. This project addresses this issue providing an alternative approach to sport participation and developing a set of relevant strategies and resources to empower communities to engage in health promotion through sport.

Methods: Through a participatory action research (PAR) approach, the project promoted physical activity and well being in disadvantaged CALD, refugee and low socio-economic status (SES) communities in South Australia through the provision of alternative community sport participation opportunities to children and youth who are at risk of social exclusion from traditional sport. The project established an ongoing consultation framework with community organisations, community leaders and key stakeholders in areas with high proportions of refugee, CALD and low SES households to scope needs for community-based alternatives to participation in traditional sport (e.g. clubs). It then offered a series of culturally appropriate, free and socially inclusive sport programs designed in partnership with communities and targeting children who do not normally participate in other forms of organised sport for reasons including psycho-social, cultural and economic. The sport programs were matched by a series of brief, low-cost, sport-related and fun health education workshops. Feedback was sought through interviews and questionnaire surveys with participants, community representatives, stakeholders and volunteers at different times throughout the project.

Results: The project resulted in regular, free football programs conducted at six sites in both metropolitan Adelaide and regional South Australia between February and November 2012, including primary school, secondary school and community-based sites. Programs were designed in strong partnership with communities, which informed their content, format, duration, location and appropriateness. They engaged approx. 280 male and female participants aged between 5 and 17 from a great variety of nationalities and birth places. More than half were refugees. Survey and interview data show strong satisfaction with the programs.

Discussion: The value of informal sport participation is often overlooked by government and sport organisations. Alternative community sport programs can effectively engage culturally diverse disadvantaged communities and provide a basic but valuable forum for broader promotion of physical activity and well being. Strong community consultation and partnership are key aspects of success.

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An internet-based intervention for promoting and maintaining physical activity in Thai university-aged females

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Introduction: Evidence shows that Thai female students are not likely to participate in leisure-time physical activity (LTPA). This study used social cognitive theory (SCT) and intervention mapping as theoretical frameworks in developing an Internet-based intervention designed. The main purpose of this study was to evaluate the efficacy of a SCT-based Internet intervention physical activity (PA) designed to promote and maintain leisure-time PA (LTPA) in university-aged female students in Thailand. The secondary purpose was to determine whether or not the SCT variables mediated changes in LTPA and physical fitness.

Methods: A 3-month randomized control trial intervention was conducted employing a Solomon four-group design. Female students (N=220) were randomly assigned to four groups: an intervention with either pretest or no pretest and no intervention with either pretest or no pretest. A website and e-mails were used to deliver the program for the intervention groups. The intervention ran for a period of 3 months with a follow-up 3 months later. Participants in the no intervention groups did not receive any treatments. Variables measured were weekly steps, leisure-time activity score (LTAS), the SCT variables of self-efficacy (SE), outcome expectations (OE), and self-regulation (S-R), resting heart rate (RHR) and VO_{2max} at pretest (only pretest groups), end of the intervention, and 3 months later as a follow-up. A true intention to treat analysis and statistical methods for the Solomon four-group design were used.

Results: There were no pretest sensitization effects. The intervention significantly increased steps, LTAS, SCT variables and reduced RHR at the end of the intervention. With the exception of RHR, the intervention effects on these variables also remained at the follow-up. The intervention had no effects on VO_{2max} at either the end of the intervention or the follow-up. The intervention effects on LTAS at the end of the intervention were partially mediated by SE and S-R. The intervention effects on steps at the end of the intervention were partially mediated by S-R.

Discussion: This study supported the suggestion that the pretest sensitisation effect was less relevant for experimental designs. The SCT-based Internet intervention program is effective in promoting and maintaining LTPA in university-aged female students in Thailand. Increases in LTPA did not lead to changes in cardiovascular fitness. Finally, SCT can be used as a model for promoting and maintaining LTPA among Thai female university students.

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The athletes heart – innocent adaptations or harbingers of pathology?

SYMPOSIUM

Aspetar Supported Session



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Regular exercise reduces the risk of cardiovascular disease and subsequent sudden cardiac death (SCD). However, a small, but notable proportion of athletes die suddenly due to a number of inherited and congenital disorders of the heart, which may predispose to malignant ventricular arrhythmias. Such tragedies are highly publicized, particularly when high-profile athletes are involved.

Due to the steady trickle of SCD's in young athletes, several major sport governing bodies, including the International Olympic Committee (IOC) and Fédération Internationale de Football Association (FIFA) have 'recommended' the implementation of systematic cardiac screening programmes – a trend increasingly being adopted by national and international sport governing bodies worldwide. Whilst the prevalence of inherited or congenital cardiac conditions are rare, modern cardiovascular diagnostic technology can identify potential SCD conditions with a high degree of accuracy and reliability, lending support to the establishment of pre-participation screening programmes to ascertain pathology.

Accurate interpretation of the athlete's ECG and echocardiogram is crucial, as the vast majority of athletes exhibit relatively mild cardiac structural and electrical modifications, which are considered to be within conventionally defined normal limits. These adaptations are often called the 'athlete's heart'. However, a small proportion of athletes develop pronounced changes, which overlap with phenotypic expressions of cardiac diseases implicated in exercise related sudden cardiac death. In such circumstances the differentiation between physiological adaptation and cardiac pathology is challenging, but an erroneous diagnosis has the potential for grave consequences.

This presentation aims to unravel the complex area of sports cardiology, whereby 1) it will present the impact of age, sex and ethnicity upon the features of the athletes heart and how they can be mistaken for cardiac pathology, 2) provide insight in how to distinguish between the athletes heart and inherited cardiac pathology, and finally 3) provide guidance on what to do in the event of a cardiac arrest in an elite athlete.

31 Ultra-endurance exercise – too much of a good thing?

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The cardiovascular benefits of regular physical exercise have been well-documented, with overwhelming evidence from epidemiological and intervention studies, suggesting that cardiovascular disease is largely a disease associated with physical inactivity. Exercise plays a beneficial role in the prevention and treatment of cardiovascular disease, with an inverse and robust relationship between physical activity and mortality risk. With such overwhelming evidence to support the promotion of physical activity within the community, the competitive retirement or even death of an athletic individual due to a cardiac pathological mechanism is a tragic and highly publicized event.

Over the past few decades, prolonged endurance events such as Ironman triathlons and ultra-endurance events such as the Marathon des Sables (150 miles of running) and the Race across America (3200 miles of cycling) have become popular. With the sudden rapid rise in the number of athletes taking part in these ultra-endurance events, it is apparent that a growing number of athletes are turning in impressive competitive results. However, recent data has documented an increased prevalence of supraventricular, complex ventricular and profound bradyarrhythmias in endurance-trained athletes, predominantly occurring in endurance trained veteran athletes. Several forms of idiopathic ventricular arrhythmia have been identified in athletes which, by definition, originate in hearts without structural abnormalities. The clinical significance of these arrhythmias remains to be fully elucidated. Furthermore, several other groups have used new imaging techniques, such as cardiac magnetic resonance imaging, and have found the presence of myocardial fibrosis (i.e., heart scarring) in the hearts of ultra-endurance athletes, who otherwise appear fit and well. This presentation will present the proposed evidence that supports the potential link between life-long intensive endurance competition and acquired cardiac pathology, in the attempt to answer the question, "Can one have too much of a good thing?"

32 Maximising joint health: Preventing and managing knee osteoarthritis in the athlete

INVITED

Asics Supported Speaker



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Athletes who sustain a knee joint injury, namely to the anterior cruciate ligament and/or meniscus, are at an increased risk of subsequent osteoarthritis (OA) – the so-called 'young people with old knees'. Surgical intervention does not appear to reduce this increased risk. There is no good evidence that moderate sporting activity in the presence of normal joints predisposes to OA. Whether high-level participation in sport, particularly impact type sports, is associated with OA is unclear as it is difficult to disentangle the confounding effect of joint injury. Attention to strategies that prevent joint injury in athletes, such as neuromuscular exercise, is therefore paramount to reduce the burden of OA. Optimal management is needed to minimize the onset and extent of joint symptoms in athletes following joint injury. Clinicians should counsel the athlete about their increased likelihood of future OA as this allows athletes to make informed decisions about return to sport as well as plan future management. Prevention and management of OA in athletes includes use of load-reducing strategies such as variable stiffness shoes, bracing, activity modification, muscle strengthening and weight control although these have not been tested in clinical trials in athletes. There are currently no pharmacologic agents with convincing structural disease-modifying efficacy for people with existing joint damage and most have been tested in mid- to late-term OA rather than early OA. There are no high quality clinical trials investigating the effects of platelet-rich plasma therapy in treatment of knee OA. Evidence for a possible structure-modifying effect of glucosamine, the most commonly used dietary supplement for OA, is still controversial.

33 Osgood Schlatter Disease – an ultrasound grading system with practical application

INVITED

Australian Institute of Sport and Club Warehouse Supported Speaker

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Introduction: The pathogenesis of the Osgood Schlatter's Disease (OSD) is still debated. The fragmentation of the ossification centre has been questioned as a definitive sign of OSD and has been seen as a normal development of the anterior tibial tubercle (ATT). Maturation staging of the ATT was developed using ultrasonography principally in asymptomatic subjects. This case series aims to assess the ATT with ultrasound in both symptomatic and asymptomatic athletes by using a four-stage classification of maturation while noting Doppler activity. It is unknown if changes are present in the presumed pathologic tendon insertion seen in OSD, nor the relation of Doppler positive changes to pain on clinical examination.

Methods: A prospective analysis was carried out on 20 consecutive symptomatic male athletes (13.9 years±1.3) and a comparison group of 35 asymptomatic male athletes (12.4 years±2.6). All underwent a comparative clinical assessment and ultrasound with colour Doppler scan on both knees. Subjective pain was recorded with a Visual Analogue Scale (VAS) during provocative manoeuvres: palpation, resisted contraction and single leg squat.

Results: The four-stage classification was a valid, uncomplicated, and effective way to assess the ATT maturation with ultrasound in both groups. Within the OSD subjects, VAS for palpation and resisted contraction of the athletes graded as stage 2 (51.1±22.0 and 60.0±21.2) were significantly higher than stage 3 (17.8±12.0 and 18.9±16.9) and stage 4 (15.0± 7.1 and 25.0± 7.1) (p<0.01). Positive Doppler US (within the distal end of the patellar tendon) was associated with higher pain on palpation (47±24.5 v 18±11.4, p<0.01) and resisted static contraction (59±20.2 v 27±12.5, p<0.001) compared to Doppler negative subjects. 90% of athletes showing Doppler activity were stage 2. Within the asymptomatic comparison group, no Doppler activity was found.

Discussion: More painful OSD is associated with presence of neo-vessels. This may be linked with a particular stage of ATT maturation and applied compressive forces. A Doppler ultrasound scan adds practical information to develop an individualised care plan for the patient which accounts for the maturation stage and presence of neovessels.

The effect of high-impact exercise on hip and spine bone density in community-dwelling middle-aged and older men: A 9-month dose-response randomised controlled trial

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Introduction: Exercise trials in pre- and post-menopausal women have shown impact-loading (IL) regimens to be effective at maintaining or improving bone mineral density (BMD). However, the optimum exercise prescription has not been established, nor has the effect of IL on the BMD of middle-aged and older men. The aim of this randomised controlled trial was to examine the effect of two different doses of IL exercise on the BMD of middle-aged and older men. **Methods:** Forty two community-dwelling men (mean age 59.9 years, range 50–74) were randomly assigned to a program of high dose IL (HI) (80 jumps each session), low dose IL (LO) (40 jumps each session) or a control (CO) group for 9 months. Clinic-based exercise sessions were conducted twice weekly under the supervision of an exercise physiologist. In addition, the exercise groups were prescribed a home program consisting of jumping exercises twice weekly on alternate days to the clinic sessions. BMD of the total hip, femoral neck (FN) and lumbar spine (LS) were measured by dual energy x-ray absorptiometry (DXA) at baseline and 9 months. Whole body lean mass and fat mass were also derived by DXA and serum total testosterone was analysed using a Cobas e 411 electrochemiluminescence immunoassay auto-analyser. Data were assessed for normality and analyses included correlation, ANOVA and ANCOVA using an intention-to-treat approach. Statistical significance was set at an alpha level of 0.05. **Results:** There was no significant difference ($p > 0.05$) among groups at baseline for age, body mass index, lean and fat mass, BMD, or testosterone. Mean exercise attendance for the HI and LO groups were 69% and 73%, respectively. Following 9 months of training, there were no significant differences among groups for either hip (total and FN) or LS BMD ($p > 0.05$). Group changes were $-0.3 \pm 1.7\%$ (mean \pm SD), $-0.2 \pm 1.6\%$ and $-1.2 \pm 1.7\%$ at the total hip, $0.3 \pm 3.0\%$, $-0.7 \pm 3.5\%$ and $-0.9 \pm 4.2\%$ for the FN, and $0.8 \pm 3.1\%$, $0.7 \pm 3.3\%$ and $-0.3 \pm 2.7\%$ at the LS for HI, LO and CO, respectively. In exercisers, body mass was associated with change in total hip BMD ($r = 0.454$, $p = 0.015$). **Discussion:** In contrast to trials in women, we found no significant effect of IL exercise on hip or lumbar spine BMD, although there was substantial variation within the exercise groups indicating responders and non-responders to the exercise regimen. There were no adverse events and the program was well tolerated by the men.

Endurance exercise but not high-intensity interval training improves abdominal fat distribution in overweight adults

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Introduction: Epidemiological data show that the majority of the adult population fails to meet recommended physical activity levels, which contributes to the obesity epidemic. A primary reason cited for this is a perceived lack of time. There is emerging evidence that high-intensity interval training (HIIT) is a time efficient strategy for eliciting improvements in work capacity and body fat levels in young healthy adults. However, although regular endurance type exercise training is known to improve abdominal fat partitioning, there is limited data on the effects of HIIT in previously inactive overweight cohorts. The purpose of this study was to examine the effect of 12 weeks of HIIT versus endurance-type training versus placebo on work capacity and fat distribution in overweight adults.

Methods: Thirty-eight inactive and overweight ($28.26 \pm 0.33 \text{ kg m}^{-2}$) adult (mean 42.82 years, range 27–55) volunteers were randomized to receive three sessions/week of HIIT or continuous moderate intensity exercise (CONT) or a placebo exercise intervention (PLA). Exercise sessions progressed to 45 min at 65% $\text{VO}_{2\text{peak}}$ in CONT and 6 x 1 min (2 min recovery) at 120% $\text{VO}_{2\text{peak}}$ in HIIT. Changes in work capacity (W_{peak}), assessed by graded exercise test on a cycle ergometer, and body composition measured by Dual-energy X-ray absorptiometry (DXA), were assessed before and after the intervention. Values are reported as means \pm SE.

Results: There was a significant group x time interaction for change in W_{peak} ($P < 0.001$) which increased significantly in CONT ($23.83 \pm 3.00\%$) and HIIT ($22.34 \pm 3.53\%$) but not PLA ($3.10 \pm 5.00\%$). Body weight did not significantly reduce in any group ($p = 0.89$). There was a significant main effect for total percentage body fat ($p = 0.049$) which reduced in CONT ($2.63 \pm 1.06\%$) but not HIIT ($0.30 \pm 0.60\%$, $p = 0.02$). There was a significant reduction in android fat percentage in CONT ($2.70 \pm 1.33\%$) but not HIIT (increase of $0.84 \pm 0.65\%$, $p = 0.01$ between CONT and HIIT). Both CONT and HIIT tended to reduce gynoid fat, but there was no difference between CONT and HIIT ($p = 0.35$).

Discussion: HIIT appears to result in comparable fitness benefits to endurance exercise training in overweight, previously inactive adults, despite a 53% reduction in training time. However, whilst regular endurance-type exercise improves abdominal fat distribution without weight loss, HIIT does not appear to provide comparable benefits under free living conditions. This outcome suggests that HIIT may be advocated for fitness benefits but not for beneficial fat partitioning.

The effect of a 4-week student-led exercise program on the physical function of prostate cancer survivors

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Introduction: Exercise trials have shown to be effective for improving the physical function of prostate cancer survivors. It is well established that prostate cancer survivors engage in lower levels of physical activity post-diagnosis than healthy men their age. Furthermore, lack of time to exercise is commonly reported as a main barrier to physical activity. Therefore, the aim of this exercise intervention was to examine the effect of a short duration (4-weeks), individualized exercise program on the physical function of prostate cancer survivors. **Methods:** 31 prostate cancer survivors (mean age 68.4 years, range 50–82) were recruited from South-East Queensland Prostate Cancer Support groups. The men were prescribed an individualised exercise program supervised by undergraduate and postgraduate clinical exercise physiology students once weekly (1-h) for 4 weeks. Men were also encouraged to increase their activity levels outside of the program to meet the physical activity guidelines. Exercises included upper and lower body resistance training, balance activities and education on the benefits of exercise. Outcome measures were performed by the same student at the same time of the day, using the same equipment one week directly before and after the exercise program and included muscle strength tests of the upper (1RM chest press) and lower body (1RM leg press) and a battery of physical performance measures (repeated chair stands, usual gait speed, 400-m walk and the extended timed up and go test). All tests were conducted in triplicate excluding the 1RM tests and 400-m walk, which were only performed once to minimise fatigue.

Results: Muscle strength (chest press, 12.7%, $P=0.005$; and leg press 12.0%, $P=0.001$) increased significantly after the training program. Significant improvements ($P<0.001$) occurred from baseline to post-intervention in the repeated chair stands (20.8%), 4-m usual gait speed (14.2%), 400-m walk (12.0%) and the extended timed up and go test (11.9%). Attendance and adherence to the exercise program were 100%. No adverse events were reported during the exercise intervention.

Discussion: This is the first study to report significant improvements in the physical function of prostate cancer survivors following an intervention of this duration. Our results showed that a targeted exercise program of strength and balance training significantly improved the muscle strength and physical function of prostate cancer survivors in as little as 4 exercise sessions led by student exercise physiologists. The exercise program was well tolerated and should be recommended to prostate cancer survivors as an important adjuvant therapy.

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Exercise training improves vascular health but not metabolic control in adolescents with type 2 diabetes

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Introduction: The rapid increase in childhood obesity has seen the recent emergence of type 2 diabetes (T2D) in teenagers. In Australia, the rate of diagnosis of T2D in youth increased nearly 10-fold in the past last decade and recent data suggesting that 20–25% of obese children and adolescents worldwide are diagnosed with T2D. Vascular disease is a leading cause of disability in patients with T2D, and we have recently reported that youth with T2D have poorer endothelial function than non-diabetic age and BMI matched youth. Exercise training can improve glycaemic control, endothelial function and body composition in obese adolescents, although it is unknown whether it is also an effective treatment strategy in T2D youth.

Methods: Eleven subjects with T2D (13–21 yrs) were recruited, and randomised into an exercise program, or into a control group for 12 weeks. The exercise program consisted of 3, 1 hour supervised circuit weight training sessions per week. Macrovascular function was assessed using ultrasonography (flow mediated dilation, FMD), insulin resistance (M) was assessed via the euglycaemic hyperinsulinaemic clamps and microvascular endothelial function measurements utilise a combined microdialysis, laser Doppler and local heating technique. Body composition was assessed using dual emission x-ray absorptiometry (DXA), and VO_{2peak} was used to assess cardiorespiratory fitness. All assessments were conducted at study entry, and again following the 12 week intervention period. Results are expressed as mean (SE).

Results: The average duration of diabetes of the participants was 38(6) months. Exercise training significantly improved macrovascular function from 10.5(1.1)% to 14.0(1.6)% and microvascular endothelial function, 13.7%(1.1) to 27.8%(1.4). There were no changes in M (4.7 (1.4) to 4.9 (1.5)), BMI (36.1 (3.6) to 36.0(3.8)) or cholesterol (2.3 (0.2) to 2.4 (0.3)) following exercise training. Cardiorespiratory fitness, total fat free and total fat mass did not alter significantly with training. No significant changes in any measure were observed in the control group.

Discussion: 12 weeks of supervised exercise training improved vascular health in adolescents with type 2 diabetes, independent of changes in insulin sensitivity, body composition or cholesterol.

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12-weeks supervised exercise training is a feasible and efficacious treatment for reducing depression in youth with major depressive disorder

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Introduction: Major Depressive Disorder (MDD) has high prevalence among adolescents and young adults. Evidence of any effective treatments is limited. Exercise as an effective treatment for adults has some support but studies in younger populations are lacking. Therefore the aim of this study was to investigate the feasibility and preliminary efficacy of brief motivational interviewing (MI) plus 12-weeks exercise training as a treatment for MDD in youth.

Methods: Youth (15–25 years) with MDD were recruited to participate in a prospective trial investigating exercise as treatment for MDD. Twenty-six participants were screened (telephone then clinical psychology diagnosis) and 13 (9 females) were eligible (MDD from SCID, no psychotic illness, not pregnant, no physical barriers to exercise, not suicidal, no major eating disorder) to participate. Participants completed assessments at baseline and after 12 weeks training, which included questionnaires: the Beck Depression Inventory (BDI-II); blood samples for analysis of inflammatory biomarkers; and fitness measures: VO_{2max} , YMCA bench press test, and a seated horizontal leg press endurance test. Prior to commencing the training program, participants engaged in a motivational interview with a psychologist to improve engagement with the program. The exercise program consisted of small group trainer-led supervised exercise (resistance and endurance) training 3 times a week (1h per session) for 12 weeks, and encouragement to do at least 30min of physical activity on other days. Paired t-tests were used to determine changes from baseline; Cohen's d to determine the magnitude of changes, and correlations used to explore relationships between changes in depression scores, training attendance and fitness levels.

Results: 12 participants (mean±SD, aged 20.7±1.7 y) completed 12-week assessments; one withdrew due to family issues. Attendance at training averaged 66±25% of sessions; 3 participants completed less than 40% of training sessions. At baseline all participants met the criteria for MDD; at 12 weeks only 2 still met the criteria; depression severity (BDI-II) decreased ($p<0.001$, $d=2.2$) from 32±9 to 12±10. Baseline aerobic fitness levels were higher than anticipated (41.4±8.7 mL.kg⁻¹.min⁻¹) and no changes were observed with training. YMCA bench press repetitions increased ($p<0.001$; $d=0.66$) from 20±11 to 27±11. Changes in depression symptom scores were significantly correlated ($p<0.05$) with attendance ($r=0.33$) and improvements in bench press endurance ($r=0.66$).

Discussion: Exercise training is a feasible and potentially effective intervention for MDD in youth. This study has informed a randomised controlled trial to more rigorously assess the effectiveness of exercise as treatment for MDD.

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Introduction: New Zealand Defence Force (NZDF) recruits are five times more likely than trained army personnel to sustain an injury. The majority of these injuries occur to the lower limbs. In a military environment injuries lead to significant costs in terms of time lost in working and training days, as well as increased attrition and decreased deployability. The aim of this research was to evaluate if a structured neuromuscular training program can reduce the incidence of lower limb injury and associated costs in army recruits.

Methods: A prospective double blind cluster randomized controlled trial was conducted at Waiouru Military Camp, New Zealand in 2012. 264 recruits from two Adult A Recruit Courses (AARC) who consented to research participation were allocated to one of 8 groups. Each group was randomly assigned to either the intervention group which involved a structured neuromuscular training program or the control group which undertook the usual recruit training program. The structured neuromuscular training program included exercises focusing on trunk and lower limb strength, flexibility, balance and coordination. Both training programs were undertaken 3 times per week, 18–20 minutes, for 6 weeks. Outcome measures included number of lower limb injuries, occasions of service and associated injury costs, the 2.4km regular fitness test (RFL) and the occupational endpoint achieved.

Results: 18% fewer lower limb injuries were recorded in the intervention groups. In addition 37% fewer health occasions of service were accessed in the intervention groups resulting in reduced health care costs when compared to the control groups. More recruits in the intervention groups successfully completed the recruit training course. Of 21 recruits who were backsquaded only 3 were in the intervention compared to 18 in the control groups. There was no significant difference in the RFL results between the groups.

Discussion: A neuromuscular training program administered early in recruit training appears to be beneficial in reducing the incidence of injury, health care service and associated costs when compared to usual training. Reduction in injuries may be attributed to improvements in stability, flexibility and strength. A reduction in recruit backsquad and recruit attrition in the neuromuscular training group is also beneficial for both the individual and the NZDF with greater numbers moving forward to further training and deployment. Findings from this research suggest that the introduction of a neuromuscular training program in army recruits may be beneficial in reducing lower limb injuries and subsequent associated monetary costs.

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Background: Rugby League is a contact sport, incorporating repeated bouts of high-intensity activity (sprinting and tackling) interspersed with low-intensity activity (standing and walking). Advances in notational analysis technology such as global positioning systems (GPS) have permitted comprehensive analysis of movement patterns, physiologic demands and recently, in contact sports, the quantification of body loads and impacts. This study investigated the physical demands of collision events by positional group in elite players during match play.

Methods: Elite Australian Rugby League players from the 2012 National Rugby League (NRL) competition were recruited. Players were divided into positional groups representing the hit-up forwards (HF) (props), wide-running forwards (WF) (second rower, lock), adjustables (ADJ) (hooker, halfback, five-eighth, fullback) and outside backs (OB) (center, winger). Players wore GPS units during each competition match, with 18 matches analyzed. Data included GPS files from HF (N=60), WF (N=87), ADJ (N=79) and OB (N=58). Match play video footage was linked to GPS data for analysis. Outcome measures of impacts (G force) sustained during attacking (hit-up) and defensive (tackle) play, physical contact and tries were assessed via accelerometer data categorised into six zones (Zone 1= lowest, Zone 6 =highest impact).

Results: A total of 42 NRL players were recruited (age 21 ± 2.8 yr, body mass 102.7 ± 19.2 kg, height 184.5 ± 6.2 cm). The total number of impacts recorded by HF, WF, ADJ and OB was 503.2 ± 192.5 , 357.9 ± 207.4 , 321.0 ± 318.9 and 132.0 ± 124.2 , respectively. ADJ and OB were involved in more try scoring events per game (1.9 ± 2.1 and 1.6 ± 1.6 , respectively) than HF (0.6 ± 0.5) and WF (1.3 ± 1.0). The mean number of tries scored per match was significantly higher for OB than HF ($p=.04$). The highest impact forces were in Zone 5 (8–9G) and Zone 6 (>9G). A mean of 1437.25 ± 827.1 impacts per game were recorded with 192.3 ± 167.3 (13.4%) in Zone 5 and 477.6 ± 403 (33.2%) in Zone 6. These high impact events were majorly attributed to HF, WF, the halfback and hooker.

Discussion: These preliminary findings show that 46.6% of impact events within a match are at high collision forces. The key defensive positions of hit up and wide running forwards, halfback and hooker contribute to the majority of high impact events throughout a game. Although these results may be unique to individual teams' defensive play strategies, they are indicative of the significant physiological demands of collisions in Rugby League. GPS analysis can provide further insight into the physical demands of elite competition.

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Introduction: There is in general a lack of good scientific data available on artificial turf (and natural) system engineering behaviour. The plethora of surface system test methods remains a long way short of replicating even simple human movement and loading patterns. In most player movement studies reported the surface system is poorly described or not controlled such that the data do not add to understanding how surface system response mechanism are mobilized to provide the measured reaction forces or the observed kinematic adjustments.

Methods: A recently completed PhD programme has investigated changes in human kinematic and kinetic response to controlled surface changes, i.e. high and low grip and high and low hardness. The surface properties were carefully controlled to meet specific target values and maintain these during the subject trials, utilizing a relatively standard 50mm long pile carpet with sand and rubber infill on a prefabricated shockpad. 16 subjects with more than ten years soccer experience at a high skill level completed different soccer related manoeuvres, including a run with a rapid stop and 180 degree turn, and a jump (header) and landing.

Results: The measured data showed that both the surface hardness and rotational traction resistance affected the human movement dynamics, though these effects were mainly identified from the stop and turn (S&T) maneuver. During the S&T the softer and higher traction surfaces gave increased frontal plane moments as well as increased ground reaction forces during mid-stance. In combination with decreased ground contact times it appeared that the players were able to decelerate / accelerate faster and generate a larger force on these soft and high traction surfaces. During peak push off it appeared that the players were able to generate a larger force on the hard surfaces, which also led to a significant increase in plantar flexion moment. Comparison made between the current standard surface mechanical tests and the subject data showed serious shortcomings in the standard rotational traction test method in particular, and the impact energy used to measure surface hardness.

Discussion: This data adds to emerging knowledge from several related projects building a clearer conceptual physical model of how the user movement affects the surface response and how this response in turn affects the loads and adjustments of the user.

This collective work is building steadily to help answer the many complex questions of player-surface interaction within sport surface science.

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Validating the SenseWear Armband during resistance training: Is there a difference between upper and lower body exercises?

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Introduction: Determining energy expenditure (EE) during exercise provides valuable information regarding the physiological demands of training and competition. The research team has recently determined the SenseWear Armband Mini (SWAM) to be a valid and reliable method of assessing EE during a resistance training session. The aim of this project was to isolate exercises within the session, and assess the validity comparison to the Cosmed K4b² portable (K4).

Methods: Ten males and 5 females completed 2 resistance training sessions after familiarisation and maximal testing. EE was simultaneously assessed by the SWAM and K4, which was used as the criterion measure. The resistance training sessions involved completing 9 exercises for 3 sets of 10 repetitions. The weight lifted was 70% of their estimated 1 RM with 90-second rest intervals. Validity was assessed using magnitude based statistics. Results: A mean percent change during squats (40, 90%CL -46 – -35), bench press (12, 90%CL -19 – -4), lunges (35, 90%CL -41 – -28), bent-over row (22, 90%CL -29 – -14), shoulder press (13, 90%CL -19 – -5), calf raise (12, 90%CL -18 – -5), bicep curls (7, 90%CL -15 – 2), triceps extensions (2, 90%CL -4 – 2) and abdominal crunch (6, 90%CL -8 – 2) was observed when comparing the SWAM to the K4, with a tendency for the SWAM to underestimate. Pearson correlations demonstrated there was an almost perfect correlation between the EE values recorded from the K4 and SWAM in the bench press ($r=0.91$), a very large correlation in the squats, shoulder press, calf raise and triceps extensions ($r=0.73$, $r=0.74$, $r=0.70$ and $r=0.83$ respectively), a large correlation in the bent-over row, biceps curl and abdominal crunch ($r=0.56$, $r=0.69$ and $r=0.69$ respectively), and a moderate correlation in the lunge ($r=0.41$). The typical error across the measures ranged from 22–35%.

Discussion: According to the percent mean changes, the SWAM underestimated the EE in the squats, lunges and row the most, and had the closest prediction in the bicep curls, triceps extensions and abdominal crunch. This has implications for resistance training sessions when athletes may focus on the lower body or upper body in isolation, therefore obtain inaccurate information regarding EE in that session. Research assessing the use of the SWAM in cycling has demonstrated a consistent underestimation of EE when compared to a criterion method. We hypothesize that the placement of the SWAM on the upper arm is not effective for accurately assessing EE in lower limb exercise.

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Does the use of strider bikes improve stability in three to five year old children?

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Introduction: The purpose of this study was to determine if a bicycle without pedals could improve Center of pressure scores of pre-school-aged children within a four week time period. Currently, the investigators are not aware of any past studies or investigations that address this issue.

Methods: A two group experimental/control repeated measures design was selected for this four week study. A sample of 20 healthy children, aged three to five years old were recruited at two selected daycare centers in rural South Dakota. Permissions were requested and received by both daycare sites to perform this study. One daycare center was selected for the control group while the other site became the experimental group. The investigators tested each subject in both groups on a Bertec Computerized Posturography Plate every week on the same day of each week for four consecutive weeks. The experimental group used Strider bicycles on a modified race course for a 20 minute duration, three times per week for four consecutive weeks. A repeated measures analysis of variance was used to determine if Center of Pressure scores improved significantly within and among the two groups during the four week duration.

Results: Significant differences in mean performance were detected between the experimental and control groups for Limit of Stability in the anterior plane ($p\text{-value}=0.12$), in the left sagittal (0.010), and in the right sagittal plane (<0.001). Borderline significance was detected between the group means for the posterior plane (0.057).

Discussion: There was evidence of significant associations between bikes without pedals and mean stability scores in three to five year old children within four weeks of training when observing Limit of Stability scores in all four planes versus the control group. These observations could possibly reduce or eliminate the use of training wheels as a progression towards pedal bicycles in young children.

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Initial outcomes of a small group Physio/OT designed motor skills program (Bounce Back 4 Kids) for developmentally challenged primary school children: A case series

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Introduction: 2013 Australian education analysis indicate 1 in 5 kindergarten aged children are developmentally vulnerable, failing to achieve acceptable levels of motor, academic and social interaction. A small group program (BB4kids) was developed with the combined skills of an Occupational Therapist (OT) and Physiotherapist (PT), to progress motor and social confidence skills in 5–12 year olds considered motor developmentally challenged.

Methods: At the date of abstract submission, 25 children had been referred to the BB4Kids program by participating OT or PT, by GP's, Child Psychologists, allied health professionals or concerned parents. After initial assessment utilising the Bot2[®] (brief) combined with quality of life questionnaires, those children scoring under the 40% percentile against age adjusted norms were recommended to participate in the BB4kids program. The program is a small group progressed motor control program where motor demands, socialisation and motor confidence is developed in complexity over an 8 week period. All participants were re-assessed at the completion of the program again using the Bot2 (brief) assessment tool. **Results:** An average improvement of 30 points in the Post BB4kids Bot 2 (brief) assessment was recorded. Some individuals achieved as high as 38–72 points improvement over a minimum of 3 months between pre and post Bot2 (brief) assessments. Individual case studies will be discussed. **Discussion:** Such significant improvements in motor proficiency demonstrate the exciting potential of small group programs such as BB4Kids to utilize structured, yet playful group activities to build fundamental skills in developmentally vulnerable children. BB4Kids utilising the OT approach of task analysis of fine motor skills, supported by Physiotherapy motor planning, and skill acquisition in structured and progressed playful activities may be an effective alternative or progression to individual therapy. Future educational and health cost benefits may be achieved with such child friendly small group interventions which also aim to mould social skills and confidence in developmentally vulnerable children.

45**Investigation of front crawl stroke phases within force-time profiles in elite and sub-elite male sprint swimmers**

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Introduction: The purpose of this study was to determine front crawl stroke phases within force-time profiles and perform a comparison on elite and sub-elite male sprint swimmers. Stroke phases were identified as entry and catch, pull, push and, exit and recovery. A secondary aim of this study was to determine if there was a significant difference between elite and sub-elite male swimmers and their time spent in each phase of the stroke.

Methods: Data from eight elite (21±2.73 years, 811±79 FINA points, 50.39±1.60 s) and six sub-elite (19.5±1.76 years, 601±2 FINA points, 55.73±2.11 s) male sprint front crawl swimmers were analysed. Force-time profiles were collected using the assisted towing method where the propulsion and active drag curves were calculated and evaluated. Stroke phases were also identified within each swimmer's stroke cycle by outlining the percentage of time spent in each phase. A two-tailed T-Test was conducted to determine if there was a significant difference between elite and sub-elite groups within the three phases spent in the water (entry and catch, pull and push).

Results: Similar peaks and troughs were identified in the propulsive force-time profiles within the elite sample. Although some swimmers in the sub-elite group generated similar propulsive curve shapes as in the elite group, majority of the sub-elite group demonstrated inconsistent curve patterns. Active drag curves were mostly observed to be comparable between all swimmers, regardless of elite or sub-elite status. Swimmers with the most inconsistent propulsive patterns tended to have the most atypically shaped active drag curves. The T-Test revealed there was no significant difference ($P=0.77$) between the elite percentages of time spent in the water when compared with the sub-elite group.

Discussion: The elite sample produced comparable curves, which would suggest that higher FINA ranking swimmers are able to perform more consistently and therefore more efficiently than the sub-elite. As no significant difference was found between either sample when identifying the percentage of time spent in the water, it could be suggested that the elite swimmers are more efficient throughout the entire underwater phase of the stroke. Therefore, it was demonstrated that elite male sprint front crawl swimmers have consistent stroking patterns when compared to sub-elite swimmers. Further research could now be undertaken into the integration of this form of biomechanical analysis in the assessment of front crawl technique.

46**Measures of proprioception predict success in elite athletes**

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Introduction: This study systematically examined the relationship between an athlete's proprioceptive ability, competition level achieved, and years of sport-specific training.

Methods: 100 athletes ranging from regional to international competition levels in aerobic gymnastics, swimming, sports dancing, badminton and soccer were assessed for proprioceptive acuity at the ankle, knee, spine, shoulder, and finger joints. An active movement extent discrimination test was conducted at each joint, to obtain a measure of the ability to discriminate between small differences in movements made to physical stops.

Results: Using multiple regression 30% of the variance in the sport competition level an athlete achieved could be accounted for, sequentially, ankle movement discrimination score, years of sport-specific training, and shoulder and spinal movement discrimination scores ($p<0.001$). Mean proprioceptive acuity score over the three predictor joints significantly correlated with sport competition level achieved ($r=0.5$, $p<0.001$). Although years of sport-specific training also correlated with an athlete's sport competition level achieved ($r=0.3$, $p=0.004$), proprioceptive acuity was not correlated with years of sport-specific training, whether proprioceptive acuity was averaged over joints or considered singly for each joint tested (all $r \leq 0.13$, $p \geq 0.217$).

Conclusion: Proprioceptive acuity is significantly associated with performance level achieved by elite athletes. However, the amount of improvement in proprioceptive acuity arising from training may be constrained by biologically-determined factors.

47**Competing and training in the heat****SYMPOSIUM***Aspetar Supported Session*

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Several international sporting events take place in the summer months and often in countries with hot environmental conditions. Based on epidemiological and laboratory data, heat has been considered to largely affect both the performance and health of the athlete. However, heat is not an external environmental issue and different athletes can respond differently depending on their sports, their training background or their health status the day of the competition. Acknowledging the specificity of the high-level athlete, the IOC has been calling for specific work on this population.

This presentation will address the effect of hot ambient conditions on the performance and health of the athletes depending on their sports. A special attention will be put on football as recent evidences have shown that hot ambient condition lead to a decrease in the total activity of the player but also to an increase in his sprinting speed.

The recovery of the players will also be addressed along with the effect of repeating an exercise in the heat. Indeed, competing in the heat requires forward planning. Evidence of the benefits of heat acclimatization will be provided along with recommendations to athletes, coaches and team doctors. Team doctor can use a simple heat-response test to determine the acclimatization of their different athletes and therefore their ability to cope with the heat in a competitive situation.

Lastly, recent researches have shown that heat-training camps can increase performance even in temperate environment. The benefits of training in the heat might occur faster than the benefits of altitude-training. New training strategies based on natural or artificial heat-exposure, with or without altitude exposure, will be proposed.

The presentation will be followed by a discussion to specifically address the concern of the audience in terms of their role and their sports.

48 Training at altitude: Current knowledge and future directions

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Training interventions under natural or artificial hypoxic conditions are nowadays integrative part of the preparation for high performance athletes in all endurance sports. The effect of altitude training on performance depends on the duration of exposure, the degree of hypoxia, altitude level and many other individual factors related to training and the distinct physiology of the individual athlete. Different types of hypoxic interventions exist, ranging from short time exposure to artificial hypoxia for several minutes to long term exposure to natural altitude over several weeks. Another distinction is made between the exposure during training or during recovery, implemented in various altitude training protocols such as "live high train low" (LHTL) or "live high train high" (LHTH). Meta-analysis of altitude training studies have shown worthwhile increases in sea level performance (power output) for elite athletes using optimized LHTL and LHTH protocols. The magnitude of the increases ranged between ~2 and 5%.

Until recently, the mechanisms for enhanced performance after altitude training were attributed to the hypoxia triggered increase in red cell mass only. There is convincing evidence that for every 100 hours of exposure at adequate altitudes, red cell mass will increase by 1%. Nevertheless, other mechanisms such as respiratory adaptations, metabolic adjustments and others certainly contribute to the beneficial effect of altitude training on performance.

Newer findings confirm a difference between the adaptation to artificial hypoxia (normobaric) and natural altitude (hypobaric), which is related to differences in the metabolism of nitric oxide in the respiratory system between the two types of exposure.

Another key issue of altitude training interventions is the best timing and exposure level of altitude in relation to the main competition. The difficulty in this context is the balance between the effects of training and the effects of altitude. Recent research suggests that an altitude between 2000 and 2500m is most beneficial for performance. More data is needed to determine the optimal timing of return to sea level before major competitions.

Research efforts in the future should focus on the best practical implementation of altitude training, the possible combination of hypoxic training methods, the potential benefit of hypoxic training for non-endurance athletes and the effect of hypoxia on other, non-hematological and non-respiratory organ systems involved in the performance of the athlete.

49 Training and competing in challenging environments: A practical perspective

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Introduction: Since the 1970's, an increasing number of ultra-marathon events have been organised for enthusiasts who enjoy the challenge of competing in extreme environmental conditions. The 235 km Badwater run through Death Valley, CA, or the 7-day 250 km "4-deserts run" series (Gobi, Atacama, Sahara and Antarctica) are some examples. Extensive preparation is required for these events.

Assessment, training and diet: To identify any risk factors when training or during competition, a comprehensive medical history and physical examination should be undertaken by a sports and exercise medicine physician. This should include blood tests, such as FBE, UNE and iron status, and may include a nutritional and hormonal assessment. Referral to a ESSA accredited sports physiologist and a nutritionist to provide an evaluation of the athlete's training, hydration and diet is essential. Advice on relevant nutritional supplements (eg iron, magnesium, vitamins C and E) to assist with acclimation, fatigue and recovery, including advice on heat and altitude training to maximise acclimation, should also be provided. A daily training log including monitoring of health, fatigue, training, sleep and muscle soreness should also be discussed.

The pre-race preparation: Following an evaluation of the race requirements, an implementation plan should be developed with the exercise physiologist and dietician on required nutritional, hydration and recovery practices for the event which need to be practiced in the weeks prior the event. Heat and altitude acclimation need to be continued. Clothing, equipment and any technical aspects should also be considered. Recovery strategies, such as refuelling and re-hydration especially in multi-stage events are crucial. Regeneration and sleep practices must also be practiced. A training taper and regeneration are the priorities in the week prior to the event, and strategies to avoid the risk of illness. Travel arrangements should be considered.

The event and the recovery: With the preparatory strategies in place, the athlete needs to ensure that they begin the event in a healthy, rested, hydrated and well-fuelled state. Fluid and fuel stops need to be well organised by the support crew who should also be monitoring the athlete for the presence any adverse signs. At the finish, rehydration, cooling (or passive re-warming) and refuelling are the immediate priority. Immediate attention to any injuries or pain is essential. In the post-race period athletes should also attempt to avoid close contact with athletes who exhibit signs of illness. Post-race supplementation with high dose vitamin C has been shown to reduce the risk of viral illness.

50 Psychometric properties of the functional screening test: A review of current literature

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Introduction: Injury prevention strategies are essential to influence the high prevalence of lower limb and low back overuse injuries within society, as well as reduce their substantial costs. The purpose of this review was to investigate whether prevention of overuse injuries can be successfully achieved with an appropriate screening protocol. To identify which screening method is appropriate, the reliability and validity of the screening test must be assessed.

Methods: The following databases were searched; Medline, AMED, Cochrane Library, PEDro, CINAHL. In addition, a hand search and reference list search were also conducted. 346 articles were found, after removal of double ups and those which did not meet the selection criteria, eleven were retained. Functional tests which had been satisfactorily investigated for their psychometric properties included: The Multi-hop test, Functional range of motion testing, Sacroiliac joint test, Gillet test, Hip extension test, Hindfoot alignment assessment, Single leg balance test and the Sport specific test.

Results: Several issues were identified which are of concern. Firstly, when investigating the reliability and validity of an individual test there needs to be some reference or comparison procedure. Unfortunately, there is a distinct lack of generally acceptable diagnostic criteria, and no gold standard of comparison tests for most of the clinical tests outlined. This makes assessments of validity particularly hard. Secondly, those tests which can be compared to a 'gold standard' test typically use radiographical measures. Radiography type assessments may have excellent reliability, but this does not mean that they are clinically valid tests as we still do not know whether they are providing an indicator of function and thus the risk of injury. Finally, clinical screening tests in general are based on the assumption that a biomechanical system which appears 'normal' leads to a low risk of injury: symmetry of function and absence of symptoms go hand in hand. There is some evidence to support this, yet it does not explain the high incidence of asymptomatic persons with asymmetries.

Discussion: The main finding from this narrative review is that the popularity of clinical tests far outweighs what is currently known regarding their psychometric properties and in particular their validation. This presents problems at every stage of the injury management system: if pre-treatment measures cannot be made accurately, the outcome of managements and optimal selection cannot be achieved or their outcomes assessed.

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Reactive stepping behaviour in response to forward loss of balance predicts future falls in community-dwelling older adults

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Introduction: A fall occurs when an individual experiences a loss of balance from which they are unable to recover. Assessment of balance recovery ability in older adults may therefore help to identify individuals at risk of falls. The primary purpose of the present study was to determine whether balance recovery ability following forward loss of balance could predict real-world falls in community-dwelling older adults.

Methods: Two hundred and one community-dwelling older adults, aged 65–90 years, underwent baseline testing of sensori-motor function and balance recovery biomechanics followed by 12-months prospective falls evaluation. Balance recovery ability was defined by whether participants required either single or multiple steps to recover from forward loss of balance from three lean magnitudes, as well as the maximum lean magnitude participants could recover from with a single step.

Results: Forty-four (22%) participants experienced one or more falls during the follow up period. Three out of the four balance recovery measures significantly predicted a future fall (Odd Ratios 1.13–1.26). Isometric knee extension strength and Physiological Profile Assessment of falls risk were also predictive of future falls (Odds Ratios 1.22 and 1.23 respectively), whereas age, sex, self-reported falls in the previous 12 months, postural sway and timed up and go were not predictive.

Discussion: Reactive stepping behaviour in response to forward loss of balance significantly predicted a future fall, whereas measures associated with postural sway did not. Knee extension strength was also confirmed as a significant falls predictor. These findings point to the possibility that exercise interventions designed to improve reactive stepping behaviour together with other known sensori-motor deficits such as lower extremity strength may protect against future falls.

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An assessment of the 2008 Zurich consensus statement on concussion in sport using the Appraisal of Guidelines for Research and Evaluation II (AGREE II)

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Introduction: The Appraisal of Guidelines for Research and Evaluation II (AGREE II) is a valid, reliable and internationally recognised tool that assesses the methodological rigour and transparency with which a practice guideline is developed. This study used the AGREE II instrument to assess the methodological rigour behind the 2008 Zurich consensus statement on concussion in sport. The aim was to identify the methodological strengths in the development of the consensus statement thereby informing the development of the next version of the consensus produced at the 4th International Conference on Concussion in Sport in Zurich in November, 2012.

Methods: Delegates at the 4th International Conference on Concussion in Sport, authors of the 2008 Zurich consensus statement on concussion in sport, and selected concussion researchers were invited to complete the 23-item AGREE II assessment using a 7-point scale (1=strongly disagree; 7=strongly agree). Scores were obtained for 6 quality domains: 1) scope and purpose; 2) stakeholder involvement; 3) rigour of development; 4) clarity of presentation; 5) applicability; and 6) editorial independence. Two final assessment items required appraisers to make overall judgments of the consensus statement.

Results: Thirteen delegates at the 2012 Zurich concussion conference, one author of the 2008 Zurich consensus statement on concussion in sport, and three researchers, completed the assessment. A total of 54% of participants said they would recommend the guidelines for use, while 38% said they would recommend the guidelines for use with some modifications. The median overall rating of the quality of the guidelines, based on a 7-point scale (1=lowest possible quality; 7=highest possible quality), was 5.5. The highest domain scores were obtained for Domain 1 (Scope and Purpose) and Domain 4 (Clarity of presentation), while the lowest score was obtained for Domain 5 (Applicability).

Discussion: The strengths of the 2008 Zurich consensus statement on concussion in sport lie in the specificity with which the objectives, health questions and population are described, as well as the clarity of the recommendations, options for management and key recommendations. The focus for improvement in the next version of the guidelines should be on describing the facilitators and barriers to the application of the guidelines, providing advice and/or tools on how to implement the recommendations, and considering the resource implications of applying the recommendations.

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Introduction: The development of appropriate screening tools to identify those at-risk of ACL injury would aid in facilitating targeted prevention strategies. Laboratory based measures currently identify individuals with predisposing risk factors for ACL injury, yet these are generally prohibitive to the wider community. Field-based screening tools for identifying ACL injury risk are emerging, however these are yet to be evaluated for use by clinicians or the wider community. Therefore, a systematic evaluation of field-based screening tools is required to determine their applicability of use in clinical or wider community settings.

Methods: Comprehensive searching of databases using relevant keywords was implemented. Studies were identified for inclusion via screening against specific inclusion/exclusion criteria. Studies were grouped according to the specific screening tool examined. Data were extracted for each screening tool surrounding the following criteria: ability of the tool to prospectively identify ACL injuries, tool validity, intra- and inter-rater reliability, additional equipment and training required, time taken to screen an athlete, and applicability of use across multiple sports.

Results: Of 790 citations, 20 studies were identified as potentially relevant and assessed for eligibility, of which 10 met all relevant criteria. Secondary literature searches pertaining to the screening tools identified resulted in the inclusion of six further studies. Therefore, a total of 16 studies were included in the review. Five screening tools (Landing Error Scoring System (LESS), Clinic-Based Prediction Tool, Observational Screening of Dynamic Knee Valgus, 2D-Cam Method and Tuck Jump Assessment) were identified, with data extracted for each tool from relevant studies.

Discussion: Limited information relating to the Observational Screening of Dynamic Knee Valgus and 2D-Cam Method screening tools was available, therefore these cannot be recommended as appropriate screening methods. No screening tool was reported as having the ability to prospectively identify ACL injuries. The Clinic-Based Prediction Tool may have the greatest predictive value in identifying ACL injury risk due to its ability to distinguish between athletes with 'high' and 'low' peak knee abduction moments with high sensitivity and specificity. This method, however, may not be applicable across a wide range of settings as extensive equipment is required to screen athletes. The LESS and Tuck Jump Assessment appear to be the most applicable tools for use in wider community settings due to the minimal equipment required and time taken to screen athletes. Further research is required to determine/improve the predictive ability of these tools in identifying athletes at-risk of future ACL injury.

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Introduction: Masters sport events are among the largest single sporting events in terms of participation in the world and as a consequence it is important to know the characteristics of the injuries present in this population and how they can be minimised. The 2010 Pan Pacific Masters Games recorded over 10,700 athletes, representing 26 nations, across 36 sports and thus presents an excellent opportunity for the collection of data regarding injuries in master's sport. Furthermore, this data may be compared to previous research on the 2009 World Masters Games. The aim was to assess the type and location of injuries sustained by athletes in training for the 2010 Pan Pacific Masters games.

Methods: 1569 athletes, (731 male and 837 female, age mean=49.13, SD±9.017, range=25–83) competing at the 2010 Pan Pacific Masters Games completed an online survey regarding injuries received during training within the three months prior to competition.

Results: In total 200 participants reported an injury and 95 were female and 105 were male. The most common sites for injury for pooled data were legs (74), knees (44), ankles (42) and shoulders (40). For males the most common sites were legs (45), knees (20), shoulders (18), ankles (16) and back (15). For females the most common sites were legs (29) ankles (26) knees (24) and shoulders (22). Most common combined types of injury were muscle/tendon strain (108), joint pain (58), inflammation (48), ligament sprain (47) and muscle pain (46). The most common types of injury for men were muscle/tendon strain (68), joint pain (34), ligament sprain (25), muscle pain (25) and inflammation (23). For women most common types of injury were muscle/tendon strain (40), inflammation (25), joint pain (24), ligament sprain (22) and muscle pain (21). Of note is the finding female participants reported 15 sprains and 7 fractures compared to male participants who reported 7 sprains and 2 fractures.

Discussion: Injuries reported at 2010 Pan Pacific Masters Games were similar to those reported by athletes participating in the football codes at the 2009 World Masters Games and thus may serve as a guide when implementing strategies aimed at injury prevention. As there are few differences between genders the gender specific injury prevention programs are not necessary. On the basis of these findings it is suggested a greater emphasis be directed to the importance of injury prevention strategies as enhancing joint stability through strength training and proprioceptive training.

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This paper will set out the findings of the first ever national survey of fitness professionals conducted under the auspices of the AFIRM Project. The Australian Fitness Industry Risk Management Project is a three-year Australian Research Council Linkage Project being conducted in partnership with Sports Medicine Australia and Fitness Australia that will answer two important questions:

- How does Australian regulation currently control risk management in the fitness industry and thereby prevent adverse health outcomes and injury, and the legal liability associated with those risks?
- What sustainable changes could be made to Australian regulation for more effective risk management in the health and fitness industry in order to prevent the risk of adverse health outcomes and injury, and the legal liability associated with those risks?

Using nominal group technique in focus groups in urban and regional centres in four States, the research team identified key issues and concerns of fitness professionals in a wide variety of categories. This research guided the development of the national survey, and in this paper we will set out the results of this groundbreaking research. The findings will be used to make recommendations for improvements in safety practices and improvements in policy and regulation.

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Introduction: Participation in snow sports, such as skiing and snowboarding, are popular recreational activities among Australians, particularly in the states of New South Wales and Victoria. These activities make a large economic contribution to Australian tourism, with approximately 2,000,000 visitor-days to the Australian ski fields annually. Similarly with international ski areas, participation in, as well as the nature of, snow sports in Australia carries an inherent injury risk, leading to a correspondingly high incidence of injury cases. Recent reports of Australian snow sports injury surveillance are lacking. This paper aims to provide an up to date summary of hospital admission and emergency department-reported injuries and injury trends relating to snow sports occurring over the past decade in Victoria, Australia.

Methods: Retrospective summary data from two datasets collected by the Victorian Injury Surveillance Unit (VISU) of hospital admissions (Victorian Admitted Episode Dataset [VAED]) and emergency department (ED) presentations (Victorian Emergency Minimum Dataset [VEMD]) were analysed over a 10-year period including 2002/03–2011/12. Hospital treated injury events relating to skiing, snowboarding and unspecified ice/snow sports were included. Data pertaining to injury type, body region injured, cause of injury and participant age and gender were analysed.

Results: Trends illustrated an increase in hospital treated snowboard injuries, with fluctuations in ED presentations and declines in admissions for ski injuries. More skiers (57%, n=1720) were admitted to hospital than snowboarders (37%, n=1117), however snowboarders (45%, n=1437) presented to ED more frequently than skiers (39%, n=1243). Hospital admission and ED data, respectively, showed that lower limb injuries were most common among skiers (44% & 16%), while upper limb injuries were common among snowboarders (35% & 20%). Approximately two thirds of all hospital treated injuries were sustained by males (65%), with falls being the most common cause (68% admissions, 72% ED). Younger participants were generally injured more frequently, however, some differences in age group and injury type existed across the two activities.

Discussion: Data indicates some trends in snow sports injury during the past decade, most likely reflecting participation rates and comparative snow conditions. The injuries common to each activity demonstrate the relative physical demands and differences in technique requirements, unique to each, and may also be a result of differences in terrain exposure. This evidence suggests that injury prevention measures be targeted to young male participants to decrease the impact of falls. Strategies could include use of personal protective equipment and/or education of correct landing/falling techniques.

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Introduction: A full understanding of the ecological context is critical in the implementation of an effective sports injury prevention intervention. There are many complexities and challenges associated with the delivery of a successful intervention in a community team-based setting. Although the development and efficacy of interventions are regularly reported, rarely are the lessons learnt during the delivery of the intervention published. Therefore, the purpose of this paper is to describe the key issues experienced in the delivery of a lower limb injury prevention training program in community-level Australian football.

Methods: A 26-week periodised training program, combining skill and perturbation-based activities, was delivered in the 'Preventing Australian Football Injuries through eXercise' (PAFIX) program in 40 community-level Australian football teams in two Australian states and across two seasons. It was delivered by undergraduate and graduate exercise and sports science students from the universities managing the PAFIX project. They provided regular feedback to the program managers and were encouraged to record issues experienced during the implementation of the program. In addition, the program manager in each state randomly attended training sessions to observe the program delivery and seek feedback from coaches and players.

Results: The implementation challenges experienced can be assigned to three broad categories; player, coach, and equipment/environmental factors. The ability to appropriately advance individual players through the program's progressions in a team-based setting was a constant challenge. This was influenced by players' punctuality, previous and existing injuries, absences and motivation. The support of the coach and senior leadership team and their understanding of the importance of injury prevention were also critical. The impact of wet, muddy conditions on the use of fundamental equipment, such as balance cushions, wobble boards and mini trampolines, was not anticipated. Solutions to the interface of the equipment with the various ground surfaces had to be addressed during the implementation of the program. Furthermore, some adaptations to the program were also required with cancellations of training sessions due to inclement weather.

Conclusions: Maintaining the fidelity of sports injury interventions relies on smooth delivery. Many of the issues presented could be experienced in the delivery of an intervention in any team sport. It is anticipated that increased awareness of these issues could be used to inform the development and delivery of similar interventions in the future.

The Athlete's Foot Supported Session

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Introduction: Prospective studies using the Foot Posture Index (FPI) in athletic and military populations have demonstrated that abnormal foot posture increases the risk of lower extremity injury. However, other research has shown that the FPI has reduced validity and inter-rater reliability. With recent studies demonstrating that the Microsoft Kinect can obtain some biomechanical data with similar accuracy to 3D motion analysis (3DMA) and scanning systems, the Kinect has the potential to evaluate static foot posture with more accuracy than subjective tools such as the FPI. Therefore, the aim of this study was to evaluate whether the Kinect is able to accurately and reliably evaluate static foot posture, compared to visual and 3DMA assessments of the FPI.

Methods: The static foot posture of 30 males was assessed over two sessions using three methods; a traditional visual assessment, a 3DMA system and the Kinect. Spearman's rho was used to assess the intra-rater reliability of the three methods and to evaluate the concurrent validity of each. Linear regression was used to examine the Kinect's ability to predict total visual FPI score.

Results: Four Kinect FPI items demonstrated moderate to good intra-rater reliability ($\rho=0.62$ to 0.78) whereas all visual FPI items demonstrated poor to moderate intra-rater reliability ($\rho=0.17$ to 0.63). Comparison to FPI items obtained using the 3DMA system revealed four Kinect FPI items possessed moderate to good validity ($\rho=0.51$ to 0.85) whereas all visual FPI items showed poor correlations with both the 3DMA and Kinect (absolute $\rho=0.01$ to 0.44). The Kinect items that demonstrated moderate to good reliability were able to predict 61% of the variance in the total visual FPI score.

Discussion: This study found that the majority of the FPI items derived using the Kinect were reliable and valid when compared to a 3DMA system. In contrast, poor reliability and validity was shown for the visual inspection of FPI. Kinect FPI items were also able to predict a moderate degree of variance in the total visual FPI score. The increased reliability and validity demonstrated by the Kinect may be credited to the instrument's continuous data which, when compared with the limited ordinal scale of the FPI, could allow for improved accuracy in foot posture evaluation. These results suggest that the inexpensive and portable Kinect system has the potential to accurately evaluate static foot posture in a clinical setting.

59 Preventing ankle sprains with a smartphone: Implementation effectiveness of an evidence based app

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Introduction: Ankle sprains continue to pose a significant burden to the individual athlete, as well as society as a whole. However, the uptake of effective preventive measures by the athletic population is lagging behind. In an attempt to bridge this implementation gap a freely available evidence based App for iOS and Android was developed. The purpose of this evaluation was to describe the implementation effectiveness of the App.

Methods: The App was evaluated within its practical context using the RE-AIM Framework. For the purpose of the current evaluation Maintenance was not described. The App contains a full translation of the neuromuscular training program described and evaluated for preventive effectiveness in a previous randomized controlled trial. The training program offers a set of exercises for the prevention of ankle sprain recurrences and has been linked to 50% reduction in recurrence risk. The App was launched in September 2011. The launch of the App was accompanied by a press release. In addition, advertisements and banners to guide potential users to the App were placed in printed media and relevant sports and sports medical websites. Data for the evaluation of the App was registered in May 2012, resulting in a follow-up of 7 months.

Results: The App only reached 7% of the intended target population. This can be regarded as a low percentage in light of the attention given to the App. Users rated the App with a score of 8.1 out of 10. In written reviews users appreciated the clarity and ease of use of the App. Of all users 38% did not actively use the App, whereas 33% used the App frequently (i.e. multiple times per week). As such, there is a large share of users that do not actively use the App. Many may have downloaded the App only out of interest, without the specific intent to actually use the embedded exercise program. Only 32% of all active users indicated to have followed the entire program, and 59% states to have followed part of the program.

Discussion: Reach and implementation of the App and program within the target population were low. Likely due to the broad and unfocused dissemination of the App. User feedback, however, was very positive. As such, it was concluded that App may provide a very useful tool for practice when delivered specifically to the target population, e.g. through coaches or therapists.

60 Using a smartphone in the clinical setting: The Tiltmeter App and the weightbearing lunge test

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Introduction: The weight bearing lunge test is often used within clinical practice to determine the range of available motion at the ankle. Many research studies using this method of measurement have used expensive digital inclinometers while clinician's use the less accurate but inexpensive gravity inclinometer. Recent use of smartphone technology to measure knee and spinal movement prompted this study to test the reliability of the free TiltMeter App on an iPhone and compare this to the digital inclinometer.

Methods: Healthy adult participants ($n=20$) were recruited from within the workplace. As a group, all participants performed a pre-conditioning stretch and were instructed on the positioning of the weight bearing lunge in first a straight leg position, then a bent knee position. As individuals and in a random order, each participant had multiple measures taken by either the novice (<2 years clinical experience) or the experienced (>15 years experience) rater in both the straight leg and bent knee weight bearing lunge position. Criterion validity was established between devices across all measures.

Results: There was a majority of females (16 female), with the participant's mean (SD) age of 40 (+12) years and a mean (SD) body mass index (kg/m^2) of $25.4 \text{ kg}/\text{m}^2+5.0 \text{ kg}/\text{m}^2$. There was no history of foot or ankle issues within the past 12 months or neurological disorders reported by the participants. The intra-rater reliability of both devices was good to excellent ($0.65-0.85$). The inter-rater reliability between the digital inclinometer and the tiltmeter with both the leg straight and knee bend positions were also calculated with excellent reliability ($0.8-0.96$). The equipment criterion validity was explored with a Bland Almand plot and the equipment ICC was 0.83 (CI: $-0.740-0.445$).

Discussion: With the majority of health care providers owning a smart phones and with the low cost of many apps, it is important to test how these can be confidently used within the clinical or research setting. This study determined clinicians and researchers could confidently use this low cost technology with comparable results to expensive testing equipment. The portability also increases its attractiveness for use. Care should be taken applying these results to the use of other smartphones with curved surfaces along with infection control precautions. While this technology has only been used with healthy participants, future investigations should be undertaken with the use of the equipment in the injured ankle or neurological conditions.

61 Anterior Cruciate Ligament injured copers and noncopers: The surgical dilemma revisited

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Background: Rupture of the Anterior Cruciate Ligament (ACL) results in increased tibiofemoral laxity and usually disturbs neuromuscular function, thereby ultimately resulting in knee instability and dysfunction. However, ACL rupture does not automatically result in functional impairment and instability, as confirmed by the ACL deficient (ACLD) coper, who can resume pre-morbid activity levels. Few studies have shown that ACL reconstruction (ACLR) actually restores dynamic knee stability or enables full return to pre-injury activity level in most individuals. The purpose of this meta-analysis was to review the dilemma regarding which ACL injured individuals need to undergo ACLR.

Methods: Electronic searches of Medline, EMBase, CINAHL and the Musculoskeletal Injuries Group's specialized register were performed up to June 2009 using medical subject headings and free-text words. Subject-specific search was based on the terms "ACL rehabilitation", "copers" "noncopers". **Results:** Three prospective, longitudinal trials have been undertaken following an ACL screening examination. Copers (non-operated) and noncopers (operated) have been followed over a few years post-injury. The results show that a similar percentage of subjects in both groups return to sporting activity. Regarding the differences between copers and noncopers, there exists investigative evidence that noncopers have deficits in quadriceps strength, vastus lateralis atrophy, quadriceps activation deficits, altered knee movement patterns, reduced knee flexion moment, higher quadriceps/hamstring co-contraction and a tendency to hold the tibia in a more posterior position.

Conclusion: No single measurement tool is sufficient in determining the functional status of the ACLD individual. Passive instability tests are a poor predictor of future rehabilitation outcome. A collaboration of tests to determine the functional status of the ACL deficient individual is recommended, specifically incorporating the KOS-Sport, Global Knee Function Rating, hop tests and Quadriceps Index. The ACL screening examination shows preliminary evidence for detecting potential copers, however a gold-standard method of detecting who will be successful is still lacking. ACL injured subjects should be informed of the possibility of good knee function following a non-operative rehabilitation program.

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Contributing factors in children who present with calcaneal apophysitis

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Introduction: Calcaneal apophysitis is a condition presenting in children between the ages of 8–15 years and is one of most common lower limb sporting presentations in older children. It is thought to be an inflammation and/or tractional condition at the apophysis of the heel however there is limited research confirming causative factors. The purpose of this study was to identify any association between activity levels, anthropometrics and quality of life impacts in children who present with pain associated with calcaneal apophysitis.

Methods: Children were eligible for participation if they had pain on medial and lateral compression of the calcaneal apophysis, no history of trauma or systemic illness.

Children between the ages of 8–15 (n=124) diagnosed with calcaneal apophysitis were assessed with the following:

- BMI (kg/m²)
- FPI-6
- Weight bearing lunge test (WBL)
- Oxford Foot and Ankle Questionnaire
- The Footwear Assessment Tool
- Activity levels measure by the Children's Leisure Activities Study Survey

Results: The baseline measures were collected from 124 symptomatic children (males=72, mean age 10.88 (+ 1.48) years). When compared to population norms, symptomatic children had a higher BMI ($p < 0.001$) and were taller ($p < 0.001$). Multiple regression analysis determined that these children were more likely to experience more pain throughout the day the older they were ($p = 0.05$) and the longer they had symptoms ($p = 0.02$). Pain was also associated with a decrease in interaction with peers and in social and school activities ($p < 0.001$). Increased participation levels in organized physical activity were associated with an increased ankle range of motion (straight leg WBL, $p = 0.004$, bent knee WBL $p = 0.01$) and the shoes most commonly worn (dual density athletic footwear $p = 0.006$). There was no association between any factors with inactivity.

Discussion: This study is the first to examine how this pain impacts their participation in the school environment and the progression of pain as they aged. Our results indicate an association between ankle dorsiflexion range and degree of participation in physical activity, suggesting that traction on the apophysis may be an important contributor to reduced activity associated with this condition. Our finding that physical activity levels were higher if the most commonly worn footwear was a dual density cushioned footwear may also indicate that impact forces mediate the association between calcaneal apophysitis and physical activity. Clinicians should consider both the biomechanical factors and the impact forces when considering their treatment pathway to ensure physical activity is maintained.

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Effectiveness of customised foot orthoses for the treatment of Achilles tendinopathy: Preliminary findings of a randomised controlled trial

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Introduction: Foot orthoses are commonly recommended for the management of mid-portion Achilles tendinopathy (AT), but the evidence relating to their effectiveness is equivocal. This study aimed to evaluate the effectiveness of customised foot orthoses for chronic AT in people who were also undergoing a calf muscle eccentric exercise program.

Methods: One hundred and forty community-dwelling men and women aged 18 to 55 years with AT (mean [SD] age=43.6 [7.9] years) were randomly allocated to either a control group (sham foot orthoses) or an experimental group (customised foot orthoses). Both groups were also prescribed a standard 12 week calf muscle eccentric exercise program. Participants were blinded to group allocation. The primary outcome measure was the Victorian Institute of Sport Assessment – Achilles (VISA-A) questionnaire. Secondary outcome measures included participant perception of treatment effect (dichotomised as effective or ineffective change in symptoms), level of physical activity (assessed using the 7-day Physical Activity Recall questionnaire), and health-related quality of life (assessed using the Short-Form-36 questionnaire – Version 2). Data were collected at baseline, then at 1, 3, and 6 months.

Results: There were clinically significant improvements in VISA-A questionnaire scores across time in both groups. However, there were no statistically significant differences between groups in scores of the VISA-A questionnaire at 1, 3, or 6 months (VISA-A at 3 months adjusted mean difference=2.1 points, 95% CI -4.1 to 8.2, $p = 0.506$). Furthermore, there were no significant differences between groups for the perception of treatment effect (risk ratio at 3 months=1.08, 95% CI=0.89 to 1.31), or health-related quality of life at any time point.

Discussion: Customised foot orthoses are no more effective than sham foot orthoses in reducing symptoms and improving function and activity in people with AT undergoing a calf muscle eccentric exercise program.

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Introduction: Ankle syndesmosis injury is clinically difficult to identify. Although clinical diagnostic tests form a critical part of the diagnostic triage for ankle syndesmosis injury, the usefulness of these tests has not been adequately researched. The aim was to investigate diagnostic accuracy of four common clinical diagnostic tests, and common features of clinical presentation to identify ankle syndesmosis injury.

Methods: Patients aged 16–60 years with an ankle sprain injury presenting to a participating clinic were invited to participate. A clinical history was taken and the four clinical diagnostic tests for ankle syndesmosis injury were performed prior to the acquisition of the MRI. The MRIs were performed within 2 weeks of injury and reported on by a blinded radiologist with extensive experience in musculoskeletal imaging. Diagnostic tests were evaluated using sensitivity, specificity values and likelihood ratios (LR), with 95% confidence intervals. A backwards stepwise Cox regression model was used to determine clinical value.

Results: Eighty-seven participants (69 male) aged 24.6±6.5 years (mean±SD) enrolled, of whom 38 had MRI-confirmed syndesmosis injury. The regression model, which correctly classified 69% of cases, showed that an injury was almost four times more likely to be an ankle syndesmosis injury in the presence of positive ankle syndesmosis ligament tenderness (OR 4.04, $p=0.048$) and a positive dorsiflexion/external rotation stress test (OR 3.9, $p=0.004$). As individual tests, the squeeze test had highest specificity (0.88, 95% CI 0.76 to 0.94) and the dorsiflexion/external rotation stress test had the highest combination of sensitivity (0.71, 95% CI 0.55 to 0.83) and specificity (0.63, 95% CI 0.49 to 0.75). Other factors, such as the inability to perform a single leg hop and the clinical presentation of inability to walk immediately after injury had the highest sensitivity (both 0.89, 95% CI 0.76 to 0.96). Pain out of proportion to the apparent injury had the best combination of sensitivity (0.65, 95% CI 0.49 to 0.78) and specificity (0.79, 95% CI 0.65 to 0.88).

Discussion: In this first study to compare diagnostic accuracy of clinical tests with MRI, we found no single test with sufficiently high values to accurately diagnose ankle syndesmosis injury. We recommend that clinicians use a combination of tests of high sensitivity to rule out or high specificity to diagnose (rule in) ankle syndesmosis injury. We recommend that future studies concentrate on prediction models that include combinations of factors such as clinical signs and symptoms and clinical diagnostic tests.

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Introduction: Patellar tendinopathy affects the ability to jump and land due to pain and associated corticospinal changes to motor patterning. There is a need for interventions that reduce pain immediately, enabling participation in sport yet do not negatively impact on muscle fatigue, which may affect performance. The purpose of this study was to compare an acute bout of either isometric or isotonic muscle contractions on patellar tendon pain and function and maximal voluntary isometric leg extension.

Methods: This was a cross over design study with baseline testing and two intervention arms. The baseline testing consisted of single leg decline squat (score out of ten), transcranial magnetic stimulation measures to assess corticospinal excitation and inhibition (modified stimulus response curve and short intra-cortical inhibition) and maximal compound wave (stimulation of the femoral nerve directly.) Surface EMG was used on the rectus femoris muscle. The intervention sessions consisted of the baseline testing protocol, followed by one of the intervention types then repeated the same measures. Four male athletes with patellar tendinopathy who participated in volleyball three times per week completed all three sessions one week apart with the order of intervention randomized by sealed envelope allocation. The isometric muscle contraction protocol consisted of 5 x 45 seconds at 70% of their maximal voluntary isometric contraction. The isotonic protocol consisted of 4 x 8 repetitions (3 second concentric phase and 4 second eccentric phase) at 100% of their 8 repetition maximum. The protocols were matched for time under load and both sessions allowed two minutes rest between sets. Data were analysed using SPSS using a univariate time-point analysis.

Results: All participants at baseline demonstrated high levels of inhibition ratio (36%±0.10) compared with normal data for the quadriceps muscle (reported 50–70%). At baseline single leg decline squat pain was mean 7.5/10, range 7–8. Both isometric and isotonic muscle contractions reduced patellar tendon pain immediately regardless of the order of intervention (mean 0.5/10 range 0–1, mean 0.75/10, range 1–3/10 respectively). However, isometric muscle contractions resulted in sustained pain relief for up to thirty minutes post intervention, whereas the isotonic intervention demonstrated only immediate pain reduction. Cortical inhibition was reduced following isometric contractions and isotonic contractions regardless of the order of intervention. Maximal voluntary isometric contraction was maintained or improved following isometric muscle contraction intervention, whereas this was reduced following the isotonic muscle contraction protocol.

Discussion: Isometric muscle contractions reduce tendon pain immediately and for at least 30 minutes post intervention and do not cause a reduction in maximal isometric voluntary contraction. The clinical implications are that isometric muscle contractions may be used to reduce pain prior to sport without resulting in muscle fatigue that may impact on performance. Whilst isotonic (heavy slow resistance) has been shown to be effective for tendon rehabilitation, this may not be appropriate immediately prior to activity due to the effects on muscle fatigue. Furthermore, it appears the pain reduction is short lasting (<30 minutes).

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Introduction: Tendinopathy is a prevalent and debilitating musculoskeletal injury affecting anyone from elite athletes to the older sedentary population. A high proportion of these patients present with, or develop, symptoms bilaterally. Cross-sectional studies in chronic Achilles tendinopathy patients have reported bilateral symptoms occurring in 35–40%, and induction of tendinopathy in one limb has shown to affect the unaffected contralateral tendon. The current study examined changes in tendon structure in patients suffering from unilateral Achilles tendinopathy using Ultrasound Tissue Characterisation (UTC) in both the symptomatic and asymptomatic tendon in comparison to individuals with no history of tendinopathy.

Method: Twenty-one participants with unilateral Achilles tendinopathy and no history of tendinopathy in the contralateral or any other tendon (ie patellar, hamstring etc) and six participants with no history of tendinopathy were recruited. Both Achilles tendons were scanned using UTC, which captures 600 transverse US images and renders a 3-D image of the tendon. Based on the stability of brightness within the tendon, UTC discriminates tendon structure into four echo-types. Tendon structure between the symptomatic, asymptomatic and control tendon was quantified from the calcaneal insertion to the musculotendinous junction and compared using a related-samples Wilcoxon signed rank test or Mann-Whitney U test where appropriate.

Results: Significant differences in tendon structure were observed in the proportion of normal tendon structure between all three groups, with the symptomatic tendon containing the least amount of normal tendon structure. The asymptomatic tendon contained significantly less normal tendon structure in comparison to the control group ($p=0.008$), suggesting the asymptomatic tendon is structurally compromised despite the absence of a hypoechoic area and symptoms.

Discussion: This study showed that bilateral structural changes were present in unilateral Achilles tendinopathy patients. Treatment protocols need to account for structural changes in the contralateral tendon to reduce a possible risk of developing bilateral symptoms.

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Introduction: Exercise training of the lower limbs mediates localised conduit and resistance artery adaptations in the active region and systemic adaptations in the upper limbs. These changes to the vasculature are largely mediated through elevations in shear stress. Whether microcirculatory vascular responses to lower limb training occur systemically, and whether shear stress contributes to such adaptations, is currently unknown.

Methods: Nine subjects completed an 8-week cycle ergometer training study, with unilateral cuff inflation around the forearm to unilaterally manipulate upper limb blood flow and shear stress during each exercise bout. To test skin microvascular function at 0, 4 and 8 weeks of exercise training, we measured laser-Doppler skin flux in response to localised disk heating at 33, 42 and 44°C. Cutaneous vascular conductance was derived from skin flux and blood pressure values.

Results: Acutely, the onset of cycling increased skin flux (12.1 ± 4.1 to 131.7 ± 35.0 PU) and temperature (31.7 ± 0.4 to $33.6\pm 0.9^\circ\text{C}$), whilst in the cuffed arm (60mmHg) skin flux (11.91 ± 2.22 to 52.92 PU) and temperature (31.5 ± 0.3 to $31.7\pm 0.8^\circ\text{C}$) responses were attenuated or absent (2-way ANOVA interaction-effect; both $P<0.001$). Chronically, after 8 weeks of cycling, skin flux responses during the plateau phase of heating at 42°C (3.19 ± 0.32 to 2.38 ± 0.41 PU/mmHg) and 44°C (3.65 ± 0.30 to 2.84 ± 0.44 PU/mmHg) were significantly lower in the uncuffed arm, but unchanged in the cuffed limb at (42°C : 3.10 ± 0.36 to 2.76 ± 0.30 PU/mmHg, 44°C : 3.70 ± 0.39 to 3.46 ± 0.30 PU/mmHg).

Discussion: Cycling exercise is associated with increased skin perfusion in the upper limbs, an effect which is ameliorated by placement of a pressure cuff. Cycle training decreased the skin vasodilator response to an identical local heating stimulus, suggesting enlargement of the capillary bed and associated increase in skin blood flow transit time. We speculate that this impact of leg exercise training in the upper limbs may enhance systemic heat loss following training. No changes in the contra-lateral cuffed arm were apparent, suggesting that repeated increases in shear stress may mediate some of this adaptation in the skin microcirculation as a result exercise training.

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Introduction: High Intensity Interval Training (HIIT) has been shown to improve various physiological parameters and running performance. A new type of treadmill allows to artificially reduce body weight (BW) by use of lower body positive pressure, while maintaining proper running motion (AlterG antigravity treadmill). It enables to reach maximal cardiovascular strain at higher running velocities, called overspeed running. This type of high intensity speed training can potentially elicit new positive training adaptation leading to better performance. This randomized controlled training intervention aims to investigate whether overspeed HIIT at 90% BW can improve performance.

Methods: 12 trained runners (35 ± 8 years) were randomized to 2 groups, regular treadmill (CON) and antigravity treadmill at 90% BW (AG). Training was composed of 4 weeks (8 sessions) at maximal aerobic speed ($v\text{VO}_{2\text{max}}$), with 4–5 intervals of a duration equal to 60% maximal time at $v\text{VO}_{2\text{max}}$ (T_{lim}), with an active recovery for half this duration ($30\% T_{\text{lim}}$) at $50\% v\text{VO}_{2\text{max}}$. Performance was measured on a 400m outdoor track (2 miles time trial) and by means of treadmill-based $\text{VO}_{2\text{max}}$ and running economy testing.

Results: Baseline $v\text{VO}_{2\text{max}}$ was higher in AG, as expected per protocol due to reduced BW (19.7 ± 0.8 vs 17.7 ± 1.6 km·h⁻¹). Both groups improved equally 2 miles time trial (-16.4 et -15.1 s for CON and AG, $p<0.01$ compared to baseline), and their anaerobic threshold velocity ($p<0.05$). Only AG improved significantly on $v\text{VO}_{2\text{max}}$ and T_{lim} . $\text{VO}_{2\text{max}}$ and running economy did not change in either group, only submaximal heart rate decreased in both groups ($p<0.01$). 1 CON runner dropped out because of newly occurring patellofemoral pain.

Discussion: HIIT improves running performance and submaximal heart rate, equally on both regular and antigravity treadmill at 90% BW. AG enables similar increases in performance, potentially with a difference in impact forces and overall musculoskeletal strain. Athletes reported better tolerability of the AG sessions and could complete more time at high speed than CON. HIIT sessions are very strenuous and whether the same benefits in performance could be obtained on AG at overspeed with a reduction in injury incidence remains to be investigated. However, important increases in T_{lim} and $v\dot{V}O_{2max}$ after AG HIIT seem to point to an adaptation to the antigravity treadmill by the runners, who are learning to better use the support provided by lower body positive pressure.

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Dose response relationship between exercise intensity and C Reactive Protein in sedentary individuals

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Background: The high sensitivity C Reactive Protein (hsCRP) which was once considered a risk marker associated with cardiovascular diseases is increasingly considered as an independent risk factor which has atherogenic potential.

Objectives: To determine whether a dose response relationship exists between exercise intensity and hsCRP in sedentary individuals.

Methods / Design: A four year randomized, active controlled, parallel group, outcome assessor blind, multiple arm trial.

Procedure: 98 sedentary (otherwise healthy) individuals with a baseline hsCRP of more than 1 mg/L and less than 15 mg/L were randomly allocated to one of the four groups (Control, and three exercise groups with escalating intensities of exercise). Three exercise groups were administered an exercise program at 50–60%, 60–70% and 70–80% based on heart rate reserve method, respectively for eight weeks. Concentration of hsCRP was measured at baseline and after eight weeks using immunoturbidimetry. The secondary outcome measures in this trial were peak oxygen uptake, waist circumference, fat percentage and body mass index.

Results: Participants had a mean (range) age of 23.3 (18–36) and a mean (range) body mass index of 26.6 (17.1–36.8). The hsCRP data was rank transformed as it did not follow normal distribution. The results indicated that there was no dose response relationship between exercise intensity and reduction in hsCRP ($F=1.603$, $p=0.19$). After removing six participants who had an increase in hsCRP of more than 30% from baseline after eight weeks, we found a significant reduction of 38% in participants who were in the 60–70% intensity and about 25% in participants with 50–60 and 70–80% intensity ($F=3.63$, $p<0.05$). The changes in hsCRP among exercise groups were independent of the changes observed in the secondary outcome measures.

Conclusion: There is no convincing evidence for a dose response relationship between exercise intensity and hsCRP, however short term aerobic training (eight weeks) at 60–70% intensity has a role in reducing subclinical inflammation. The threshold intensity for exercise to have a beneficial effect on the inflammatory front appears to be 60% based on heart rate reserve method.

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Cutaneous microvascular adaptation to repeated passive core heating in humans

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Introduction: Cycle exercise training leads to forearm microvascular adaptations which are partly mediated by repeated increases in cutaneous blood flow. In this study we examined the hypothesis that repeated exercise-independent increases in core temperature (T_c), and consequently cutaneous blood flow, induce microvascular adaptations which are independent of changes in skin temperature.

Methods: We recruited 9 healthy young volunteers (24.3 years, range 22–30) to participate for 8 weeks in thrice weekly bouts of 30 mins lower limb heating (40°C) in a custom-designed and enclosed bath. Throughout each leg heating session both forearms were placed in their own water baths, maintained at constant basal skin temperature (30°C). Additionally, a forearm cuff was placed on one arm during each leg heating bout and inflated (80mmHg) to unilaterally attenuate reflex-mediated blood flow responses during the T_c elevation. Finally, forearm microvascular function was assessed using a gradual heating protocol at baseline and again at weeks 4 and 8.

Results: Lower limb heating bouts induced increases in T_c (37.5 ± 0.1 vs $38.2\pm 0.1^\circ\text{C}$, $P<0.001$) and forearm skin perfusion (11.5 ± 3.1 vs 132.2 ± 41.0 perfusion units (PU), $P<0.001$), with skin responses significantly attenuated in the cuffed forearm (21.0 ± 4.0 vs 58.0 ± 17.4 PU, $P<0.01$). After 8 weeks of repeated exposure to leg heating, there was an upward and leftward shift in the relationship between changes in T_c during a bout of leg heating and the resultant change in cutaneous vascular flux. In contrast, skin perfusion responses to a local heating protocol decreased significantly in the uncuffed arm following 8 weeks arm at 40°C (114.1 ± 46.2 vs 73.3 ± 34.0 PU, $P<0.01$) and 41°C (145.3 ± 44.2 vs 112.2 ± 66.4 PU, $P<0.05$), but not in the cuffed arm which remained unchanged (40°C; 107.8 ± 28.0 vs 96.7 ± 32.7 and 41°C, 130.9 ± 26.3 vs 134.0 ± 65.0).

Discussion: This is the first study to isolate local and systemic impacts of repeated T_c elevation in humans, and to assess the role of skin blood flow and temperature in these adaptations. Our findings are consistent with a hypervolaemic impact of repeated increases in T_c that alter the relationship between T_c and skin blood flow in response to core heating. We also observed evidence for prolonged red cell transit time in response to localised heating, the most likely explanation for which is an increased microvascular capillarity that results from repeated episodic increases in microvascular perfusion. In combination, these distinct central and peripheral adaptations combine to enhance thermoregulatory capacity in humans.

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Exercise-induced elevated rectal temperature: Sex differences and humidity effects

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Introduction: Understanding the behavior of core body temperature in response to exercise is a key element in determining strategies to restrict exercise-induced core temperature rises to safe levels. The purposes of this study were to model the temperature/time relationship in a physiologically meaningful way, and to determine the extent and direction of sex and humidity differences in fitted model parameters.

Methods: Twenty-three fit and healthy volunteers (13 male, 10 female; aged 23±2 years) participated in the study, which was approved by the California State University, Fullerton Institutional Review Board. All undertook 90 minutes of exercise, walking at a speed equivalent to 35% of VO_{2max} on three occasions on a motorized treadmill in a chamber at a constant temperature of 35°C at relative humidities of 55, 70 and 85%. Rectal temperature was one of a number of response variables measured at 5 minute intervals during exercise. The time trend was modelled for each subject using an inverse exponential incorporating location, amplitude and time parameters; with indicator variables included to distinguish humidity differences. Curve fitting utilized SigmaPlot software (Jandel Scientific, San Rafael, CA). The resulting sets of parameter estimates were analysed using 2-way ANOVA (sex x humidity) with repeated measures.

Results: Good fits (R^2 in the range 0.950–0.998) were obtained for all but 3 of the 69 exercise sessions. Pre-exercise baseline rectal temperature did not differ between males and females ($p=0.603$). The amplitude of modelled temperature rise was significantly affected by sex ($p=0.0006$; female: +1.7, male: +4.9°C), by humidity ($p=0.0002$; 55%: +1.4, 70%: +2.7, & 85%: +6.7°C) and by their interaction ($p=0.0014$). The time constant of the exponential was similarly affected ($p=0.1062, 0.0062, \& 0.0503$ respectively). Of more interest is the time point of steepest temperature increase, which occurs (non-significantly) sooner after exercise start in females than in males ($p=0.2039$; female: 17.1, male: 25.8 minutes), and becomes significantly later as humidity increases ($p=0.0036$; 55%: 11.4, 70%: 17.3, & 85%: 38.4 minutes).

Discussion: When model parameters for males are compared to those for females as humidity increases, there are clear and coherent differences and trends; male-female parameter differences become exaggerated the higher the humidity. Taken together these characteristics suggest that in increasingly humid environments females appear to tolerate exercise-induced core temperature rises better than males: that is, they respond sooner, faster and to a lesser degree.

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The effect of “power naps” on aerobic capacity in sleep-deprived subjects

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Introduction: Athletes may often be subject to varying levels of sleep deprivation throughout scheduled training and competition. It is well-established that sleep loss results in impaired cognitive and motor functioning, including slowed reaction time which may negatively impact on exercise performance and training capacity. Although a considerable amount of research has investigated the effects of sleep loss, as well as the benefit of napping during the day on subsequent cognitive performance, the effects of a “power” nap, following a period of sleep deprivation on exercise performance has not been reported. Therefore, this study aimed to examine the effect of a power nap following a period of sleep deprivation on aerobic exercise capacity.

Methods: Eight recreational team-sport athletes (19–21yrs) completed an incremental treadmill test to exhaustion (TTE) immediately following a 30-min sleep (nap) or no sleep (control) after ~33hr sleep deprivation. An initial maximal oxygen uptake test was performed to determine associated workloads of the TTE which were subsequently set at 5 min stages of 60%, 70% and 80% of VO_{2max} , respectively, until volitional exhaustion.

Results: A repeated measures ANOVA indicated no significant differences between groups (nap vs. control) for HR, oxygen consumption, blood lactate or time to exhaustion ($p>0.05$). Further, no significant differences were evident between conditions for RPE, perceived pain, or ratings of sleepiness or anxiety ($p>0.05$).

Discussion: The results of this study indicate that aerobic performance is not altered by a short “power” nap in sleep deprived subjects. Although previous research has demonstrated the benefits of short naps on improving psychological variables including mood, feelings of sleepiness and reaction time, in contrast, the results of this study suggest that a short nap of 30 min following ~33h sleep deprivation does not provide any improvement in aerobic endurance performance or subjective ratings of sleepiness, arousal or perceived effort. Whilst a period of sleep deprivation may negatively impact on subsequent exercise performance, the results of this study demonstrate that a short 30 min “power” nap was not sufficient to induce any beneficial effect on aerobic exercise capacity or physiological and psychological function in sleep-deprived subjects.

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The acute impact of exercise during water immersion on cerebral perfusion

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Introduction: Recent studies from our laboratory have reported that water immersion induces an increase in cerebral artery shear stress and perfusion at rest. Exercise induces recurrent increases in shear stress in peripheral arteries, which have beneficial impacts on cardiovascular function and health. It is therefore plausible that water immersion may lead to greater cerebrovascular shear stress and perfusion during exercise than that observed during land-based activities. No previous research has compared the impact of acute bouts of water- and land-based exercise on cerebral artery function. We hypothesised that that an acute bout of exercise during water immersion would stimulate a greater increase in cerebral perfusion when compared with land-based exercise.

Methods: Fifteen normotensive participants were recruited to the study (age: 26±4yrs, BMI: 24.3±1.9kg/m²). Haemodynamic variables including mean arterial blood pressure, cardiac output and stroke volume were continuously assessed, along with blood flows in the middle and posterior cerebral arteries, during 20-min bouts of water and land-based exercise of matched intensity. Water-based exercise consisted of water immersion to the level of the right atrium. Data from the two exercise conditions were analysed using general linear modelling and all data are presented as mean (95% CI). Results: The water and land based exercise bouts were successfully matched for oxygen consumption [13.3ml.kg⁻¹.min⁻¹ (95% CI=12.2, 14.6) vs. 13.5ml.kg⁻¹.min⁻¹ (95% CI=12.1, 14.8); $P=0.89$] and heart rate [95bpm (95% CI=90, 101) vs. 96 bpm (95% CI=91, 102); $P=0.65$]. Water-based exercise induced a greater increase in mean arterial pressure [106mmHg (95% CI=100, 111) vs. 101mmHg (95% CI=95, 106) $P<0.001$], middle cerebral artery velocity [74cm/s (95% CI=66, 81) vs. 67cm/s (95% CI=60, 74) $P<0.001$] and posterior cerebral artery velocity [47cm/s (95% CI=40, 53) vs. 43cm/s (95% CI=37, 49) $P<0.001$] when compared with land based exercise.

Discussion: Our findings demonstrate, for the first time, that exercise during water immersion modifies haemodynamic variables and increases mean arterial pressure. This is associated with increased cerebral blood velocities, relative to land based exercise of a similar intensity. These novel data suggest that exercise undertaken in the water may decrease cerebrovascular risk. Future studies will focus on the chronic effect of exercise conducted in water on brain health and cognitive function.

74 Self-reported tolerance influences cerebral blood flow during exercise

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Introduction: Self-reported tolerance of exercise intensity is a dispositional trait with a biological basis. Tolerance influences how we perceive and regulate physiological responses in the brain during exercise. The objective of this study is to examine the influence of tolerance on activity of the frontal cortex (FC) using Near Infrared Spectroscopy (NIRS) during exercise standardised to metabolic processes (i.e. gas exchange thresholds).

Methods: Based on tolerance scores measured using the Preference for and Tolerance of the Intensity of Exercise Questionnaire (PRETIE-Q), participants were selected to a High (n=14) or Low (n=14) tolerance group. Participants completed an incremental exercise test to volitional exhaustion. Changes in cerebral oxygenation (O₂Hb), deoxygenation (HHb), blood volume (tHb) and haemoglobin difference (HbDiff=O₂Hb-HHb), were measured (micromolar; μ m) from the right and left FC (corresponding to Brodmann's Area 8) using NIRS. Averages were taken at ventilatory threshold (VT), respiratory compensation point (RCP) and exhaustion (END).

Results: A multivariate ANOVA revealed significant ($p < 0.05$) Group (High, Low) by Hemisphere (Right, Left) by Intensity (VT, RCP, END) interactions for O₂Hb, tHb and HbDiff. Above the VT, the Low group indicated greater changes within the Left (M \pm SD, RCP: O₂Hb 13.7 \pm 6.0, tHb 14.5 \pm 7.3, HbDiff 13.0 \pm 5.1; END: O₂Hb 14.2 \pm 6.5, tHb 16.7 \pm 7.9, HbDiff 11.6 \pm 5.9) compared to the Right hemisphere (RCP: O₂Hb 12.1 \pm 6.0, tHb 13.5 \pm 7.8, HbDiff 10.7 \pm 5.7; END: O₂Hb 12.5 \pm 6.9, tHb 15.9 \pm 7.7, HbDiff 9.1 \pm 7.3). The High group indicated the opposite, greater changes within the Right (RCP: O₂Hb 12.0 \pm 5.8, tHb 13.2 \pm 5.8, HbDiff 10.8 \pm 5.9; END: O₂Hb 14.4 \pm 7.7, tHb 18.5 \pm 7.5, HbDiff 10.4 \pm 8.5) compared to the Left hemisphere (RCP: O₂Hb 10.7 \pm 5.5, tHb 11.5 \pm 5.8, HbDiff 9.9 \pm 5.7; END: O₂Hb 12.9 \pm 8.0, tHb 16.5 \pm 8.2, HbDiff 9.2 \pm 8.7). From RCP to END, in the Low group, O₂Hb remained stable, tHb increased and HbDiff declined, whereas in the High group, O₂Hb and tHb increased and HbDiff declined.

Discussion: Tolerance influences activity and asymmetry of the FC at exercise intensities above VT. Tolerance (measured using the PRETIE-Q) could be used as a tool to further understand individual differences in how we regulate and respond to exercise.

75 Effectiveness of a program for adolescent girls linking physical education with community sport and recreation

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Introduction: Interventions that include both schools and communities are considered important for making positive changes to adolescent girls' physical activity (PA) levels and health-related quality of life (HRQoL). A school community-linked sport and recreation program for girls aged 12–15 was implemented in eight regional secondary schools in Victoria, Australia. The purpose of this study was to evaluate the effectiveness of the program.

Methods: The study was a group-randomized controlled trial. Communities with the requisite sports clubs and facilities were paired according to a range of criteria, one of each pair was randomly assigned to intervention and control arms, and schools were randomly selected from these communities; eight schools in each arm. Year 7–9 students in intervention schools received two six-session units – a sport unit (football or tennis) and a YMCA-based recreational unit – which were incorporated into the physical education curriculum, underpinned with student-centered teaching approaches and behavioral skill-development theory. These units were also conceptually and practically linked to PA opportunities for continued participation outside school in sports clubs and recreation facilities. Students were surveyed at baseline (start of the school year) and endpoint (one year later), regarding impact (e.g. competence, self-efficacy, behavioral self-management, access) and outcome (e.g. 24-hr physical activity recall questionnaire: PDPAR-24 and Pediatric Quality of Life Inventory 4.0 Generic Core Scales for Teens: PedsQLTM) measures. Repeated measures analysis of variance and linear mixed modelling techniques for covariate- and cluster-adjusted analysis were implemented with SPSS 18.0TM.

Results: Participants completing baseline and endpoint measures included 358 intervention (33.7% response rate at baseline, 61.3% retention) and 256 control (14.1% response rate at baseline, 84.0% retention). Significant differences between groups over time were observed only for PedsQL. All PedsQL scores (i.e. physical functioning, psychosocial functioning and total score, $p < 0.05$) decreased significantly in the control group, while there was no significant change over time for the intervention group. This difference was confirmed by analysis of endpoint PedsQL scores with adjustment for effects of baseline PedsQL scores, BMI and age. There was no evidence of clustering of responses within schools.

Discussion: Previous research has shown that HRQoL decreases during adolescence. In this study, such a decrease was observed in the control group, while the intervention group maintained its level of HRQoL. While this represented a beneficial outcome of the intervention, no specific benefit regarding PA was demonstrated, since, there were no significant changes in PA in either intervention or control groups.

76 Longitudinal changes in the structure of moderate and vigorous physical activity across adolescence for females

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Introduction: In an effort to curb rising levels of overweight and obesity, much attention has been given to understanding physical activity (PA) levels, in particular for adolescent females. Whilst general trends are often reported, it is important to understand the specific contexts of participation and how they may change over time. This study was aimed at investigating changes in the contexts of moderate and vigorous physical activity (MVPA) for adolescent females, from Year 7 to post-secondary school.

Methods: A 3-year longitudinal survey was conducted with females recruited in either Year 7 or Year 11. The questionnaire gathered demographic details, information about determinants of PA and PA outcome measures, including a Previous Day Physical Activity Recall (PDPAR) diary, from which self-reported total time spent in MVPA was calculated. An integrated cross-sectional and longitudinal analysis was conducted to investigate the duration and proportion of MVPA time occurring in the categories of sport, other (non-sport) PA and active transport, at six Year levels (7–9 and 11–13).

Results: Analysis was based on participants who completed the relevant questions (n=Year 7: 381; Year 11: 211). The mean 24-hour total duration of MVPA increased significantly from Year 7 (mean±95% confidence interval: 45.8±8.0 min) to Year 9 (65.5±8.5 min) but the difference between the mean duration in Year 7 and the mean duration in Year 13 (53.1±14.1 min) was not significant. There were, however, significant changes across time with respect to the form of MVPA undertaken. In Year 7, the mean proportion of MVPA time associated with sport (59.2±7.8 percent) was significantly greater than the mean proportion associated with other PA (35.7±7.8 percent), whereas for each of Years 12 and 13, the mean proportion of MVPA time associated with other PA (62.6±9.7 percent; 66.6±13.3 percent) was significantly greater than the mean proportion associated with sport (34.0±9.7 percent; 28.1±13.2 percent). The mean proportion of MVPA time undertaken in the form of active transport did not change significantly over time.

Discussion: It is pleasing to see that total time spent in MVPA by this sample of adolescent girls did not significantly decrease over time.

However, the context of participation did change significantly over time, with sport playing a larger role than other PA in early adolescence and this role reversing during late adolescence. The sport sector could benefit from understanding why this transfer occurs, and perhaps reverse this trend by offering more gender- and age-appropriate programs.

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The relationship between BMI and physical fitness of physically active girls at the age of 6–7 years old

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Introduction: Preschool years are critical to a child's development and mastery of fundamental movement skills. The reduced immunity to illness among preschool age children limits the physical activities. This leads to the lower level of physical fitness and the low efficiency during learning new motor tasks, even in the case of physically active children. The aim of the study was to analyze the association between physical fitness and body mass index (BMI) in the group of physically active girls of different health status.

Methods: The research study constituted an integral part of a nationwide diagnosis of school maturity of children which was conducted in 2006/2007. Data were collected among 2616 active girls at 6–7 years old. BMI was calculated from measured height and weight. Physical fitness was evaluated using EUROFIT test battery. The diagnosed skills included throws and catches of ball, jumps, kicks, run and overall coordination of a child when performing physical exercises. The parents were asked to provide information regarding the health status of children and their additional organized activities during a week. Descriptive statistics were calculated in all variables. Relation between physical fitness and motor skills in groups of girls of different health status were calculated using Pearson correlations. An alpha level of 5% was adopted for all analysis. Results: Correlation between coordination (total balance, arm speed movement), strength (trunk strength, arm functional strength, explosive leg power) were negative and varied between -0,003 and -0,201. The highest negative correlations were related to active girls without any health problems. There was general pattern of reduction the number of correlation depending on the health status. The worse status health, the less significant relationships arose between physical fitness and BMI. In the group of girls without any health problems, there were significant correlation between total balance (-0,054, $p \leq 0,05$), explosive leg power (-0,103, $p \leq 0,001$), trunk strength (-0,087, $p \leq 0,001$), running speed (0,08, $p \leq 0,001$), one-leg(right, left) and both legs jumps (respectively: 0,122, $p \leq 0,001$; 0,113, $p \leq 0,001$; 0,133, $p \leq 0,001$) and BMI. In group of active girls with health problems, relationship between explosive leg power was observed (-0,191, $p \leq 0,001$).

Discussion: Coordination and some aspects of strength demonstrated an inverse correlation with BMI of physically active girls at preschool age. The worse health status affects the decreasing the relationship between BMI and physical fitness. Children with health problems need the special support and care during physical activities.

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Can coaches act as physical activity promoters for girls in organised youth sport?

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Introduction: Participation in organised youth sports (OYS) has been recommended as an opportunity to increase young peoples' physical activity (PA) levels. This is particularly pertinent for girls in adolescence, when PA declines sharply. While coaches can potentially influence PA levels of athletes, little research has explored coaches' perceptions of themselves as PA promoters for their athletes.

Methods: Participants were 30 OYS coaches from basketball, soccer, or netball teams of girls aged 9–17 years in the Greater Sydney metropolitan area, Australia. Coaches were 19 males and 11 females aged 18–69 years (mean=42.2±13.2 years) and had an average of 13.3±11.8 years of coaching experience. Participants took part in a semi-structured interview that lasted approximately 30 minutes. Participants responded to questions regarding their perceived roles as coaches, their perceptions of themselves as role models for PA promotion, and their perceived ability to impact their athletes' PA levels. Interviews were audio-recorded and transcribed verbatim. Content analysis was conducted using an interpretational approach. Results: Participants described influential roles (i.e. teacher, mentor, and role model) when asked how they perceived their role as a coach. They also felt it was part of their role as a coach to promote a fun, friendly, and supportive team environment and provide sport-specific development (physical and tactical skills). Participants who perceived themselves as role models for PA promotion cited their current participation in organised sport and their participation in the training sessions of the team(s) they coach as reasons why they felt they were role models. Conversely, participants who did not feel they were role models for PA promotion cited retirement from sport, health/injury reasons, and old age as reasons. Many participants indicated that they could not push girls as hard as boys in terms of PA levels, as they feared girls would drop out of OYS if they were to incorporate too much PA into their training sessions. Participants reported that their potential, as coaches, to impact their athletes' long-term PA was limited, with many explaining that the athletes' parents were more influential in that respect.

Discussion: Coaches have the potential to promote PA for girls in OYS, however, findings from this study indicate that they may underestimate or may not fully realise the impact they can have on the girls they coach. Future research should focus on educating coaches to capitalise on the opportunity they have to promote girls' PA in OYS.

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Introduction: Obesity prevention among youth of low socio-economic position is a public health priority given the higher prevalence of youth obesity in this population sub-group. While there is evidence to support the beneficial effects of school-based child obesity prevention interventions, few studies have assessed maintenance or sustainability of impact after the initial post-test assessments. The aim of this paper was to report the 24-month impact of a school-based obesity prevention program among adolescent girls living in low-income communities.

Methods: The Nutrition and Enjoyable Activity for Teen (NEAT) Girls was evaluated using a cluster randomized controlled trial that involved 12 secondary schools located in low-income communities in New South Wales, Australia. Participants were 357 adolescent girls (13.2±0.5 years). The 12-month multi-component intervention was guided by Social Cognitive Theory and combined a range of strategies to promote lifestyle (e.g. walking to school) and lifetime physical activity (e.g., resistance training), improve dietary intake and reduce sedentary behaviors. Intervention components included enhanced school sport sessions, lunchtime physical activity sessions, nutrition workshops, interactive educational seminars, pedometers for self-monitoring, student handbooks, parent newsletters, and text messages to reinforce and encourage targeted health behaviors. The primary outcome was body mass index (BMI) and secondary outcomes were BMI z-score, percentage body fat (bioelectrical impedance analysis), physical activity (accelerometers), dietary intake and recreational screen-time (self-report). Data were collected in 2010–2012 and analyzed in 2012.

Results: After 24 months, the intervention effects on BMI (adjusted mean difference [95% CI]=−0.33 [−0.97 to 0.28]), p=0.35) and BMI z-score (−0.12 [−0.27 to 0.04], p=0.18) were not statistically significant. However, there was a significant group-by-time interaction for percentage body fat (−1.96% [−3.02 to −0.89, p=0.01). Intervention effects for physical activity, screen-time and dietary intake were not statistically significant.

Conclusion: The NEAT Girls intervention did not result in significant effects on the primary outcome. However, there were statistically significant improvements in body fatness that may have clinical importance. Reductions in screen-time were also observed over the study period which may have important implications for preventing unhealthy weight gain among adolescent girls living in low-income communities. Further study of youth who are 'at risk' of obesity should focus on strategies to improve retention and adherence in prevention programs.

Trial Registration: Australian New Zealand Clinical Trials Registry No:ACTRN1261000033004

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Introduction: Physical activity (PA) studies commonly evaluate the effectiveness of interventions, however more recently emphasis is on evaluating the context in which interventions are implemented. A group-randomized controlled trial of a school community-linked sport and recreation program for girls aged 12–15 (Year 7–9) was implemented in eight regional secondary schools in Victoria, Australia. The purpose of this study was to examine the reach of the program, along with barriers and facilitators to adoption and implementation of the program, using the RE-AIM framework.

Method: Intervention students received two six-session units – a sport unit and a YMCA recreational unit within physical education (PE) and these were linked to community-based programs. The intervention was underpinned by the socioecological model and student-centred curriculum approaches. Tools used to assess reach, adoption and implementation of the program included (a) Teacher lesson feedback forms on implementation in PE classes (e.g. proportion of lesson plan implemented); (b) Post-intervention focus group interviews with PE teachers, students, coaches and instructors regarding the perceptions and experiences of participants during the intervention; and (c) Field notes which recorded the implementation process and dissemination strategies of schools and project partners.

Results: Across seven intervention schools 1755 students received the program. Adoption: 7 of 10 schools invited agreed to participate in the program along with 4 tennis and 8 football clubs and 5 YMCAs. Implementation: Teachers reported (response rate 60%) that lessons were implemented as intended almost all (54%) or most (24%) of the time. Self-management journal activities were either not implemented (60%) or were set as homework (32%). Interviews revealed teachers reported being mostly satisfied with the professional development opportunities associated with the program including: the training, resource manual and opportunities to work with coaches and instructors during PE classes. Positive perceptions from students included increased awareness of PA opportunities outside of school, the development of new sport specific and PA skills and enjoyment of the program. Barriers to implementation included: student skill level, teacher lack of experience with game sense pedagogy as the curriculum approach, timetabling, and communication between schools and community providers; whilst students had mixed feelings about single sex PE and external coach/instructors delivering their classes.

Discussion: Understanding the reach, adoption and implementation is important, as the intervention program was in some cases not adopted and implemented to an adequate extent or as intended, affecting the likelihood of the program achieving the intended public health outcomes.

SYMPOSIUM

N. Blomeley^{1*} ▪ B. de Morton^{1*} ▪ ¹Sports Doctors Australia

Concussion is an important medical issue in contact and collision sports worldwide. Key new concepts that arose from the 2012 International Zurich Conference on Concussion included:

- A focus on improved recognition of concussion (e.g. video replays, etc);
- An emphasis on a conservative management approach particularly given the inherent unreliability of the sideline assessment and the fact that concussion is an evolving injury in the early minutes following head impact;
- Unanimous agreement of no return to play or training on the day of injury;
- The importance of balance and postural stability assessment;
- Modification of the management process with regard to exercise and symptom-limited activity;
- Highlighting the importance of sequelae such as depression and mental health issues and discussion about the potential risk of long term complications.

In following the guidelines, the diagnosis of concussion and subsequent return to play remains an individual decision by the team doctor guided by the principles set forth in this document, good clinical judgment and the information available to the team doctor at the time of the player's assessment. In considering the best practice management of concussion, the priority remains the welfare of the players both short and long term. The first part of the symposium looks at the pathophysiology of concussion followed by a discussion of current AFL guidelines for return to play. The use of SCAT 3 programme will be discussed. Following that a practical session using videos of actual impact events will allow discussion of the management of concussion in a sporting setting.

82 Dose response of nitrate supplementation on 2,000m rowing ergometer performance

M. Hoon^{1*} ▪ A. Jones² ▪ N. Johnson¹ ▪ J. Blackwell² ▪ E. Broad³ ▪ B. Lundy³ ▪ A. Rice³ ▪ L. Burke³

¹University of Sydney ▪ ²University of Exeter ▪ ³Australian Institute of Sport

Introduction: Beetroot juice is a naturally rich source of nitrate (NO₃⁻), a compound hypothesized to enhance endurance performance by improving exercise efficiency. This study investigated the effect of multiple doses of beetroot juice on 2,000 m ergometer rowing performance in well trained athletes.

Methods: Ten highly trained male rowers (17±3.4 h training per week) volunteered to participate in a counterbalanced, placebo controlled, cross-over study. Subjects were given either 0 mmol (PLACEBO), 4.2 mmol (SINGLE) or 8.4 mmol (DOUBLE) NO₃⁻ via a beetroot juice supplement 2 h before undertaking a 2,000 m test on a rowing ergometer. Blood samples were taken before supplement ingestion and immediately before the rowing test for later analysis of plasma [NO₃⁻] and [nitrite (NO₂⁻)].

Results: The SINGLE dose demonstrated a trivial effect compared to PLACEBO on 2,000 m time to completion. A possibly beneficial effect of DOUBLE was found compared to SINGLE (mean difference: -1.8 s±2.1 s) and PLACEBO (-1.6 s±1.6 s) respectively. Plasma [NO₂⁻] and [NO₃⁻] demonstrated a dose-response effect, with greater amounts of nitrate ingested leading to substantially higher concentrations (DOUBLE>SINGLE>PLACEBO). There was a moderate but insignificant positive correlation (r=0.573, p=0.065) between change in plasma [NO₂⁻] and improvement in performance.

Conclusion: When compared with placebo, a high (8.4 mmol NO₃⁻) but not moderate (4.2 mmol NO₃⁻) dose of beetroot juice 2 h before exercise improved 2,000m rowing performance in highly trained athletes.

83 Whey peptide HW3 supplementation suppress body fat accumulation by maintained basal metabolism

N. Ichinoseki-Sekine^{1*} ▪ R. Kakigi² ▪ T. Nakagata¹ ▪ S. Miura³ ▪ H. Naito¹

¹Graduate School of Health and Sports Science, Juntendo University ▪ ²School of Medicine, Juntendo University ▪ ³Megmilk Snow Brand Co., Ltd.

Introduction: Whey peptide HW3 mainly contains tripeptide which has superior digestion absorbency. The purpose of this study was to investigate the effect of whey peptide HW3 supplementation on basal metabolism and body composition.

Methods: This study consisted of animal and human experiment. All experimental procedures were approved by the ethics committee of Juntendo University, and given informed consent was obtained from all of human subjects. **Animal Experiment:** Male senescence accelerated mouse prone 6 (SAM-P6, n=26) were randomly divided into 3 groups by diet; control (CON), Whey protein (WPC) or Whey peptide HW3 (HW3). They were maintained under a 12:12 light-dark cycle (23±1°C, 55±5%) and access to water and diet ad libitum for 28 weeks (17~45 week of age). At the end of treatment period, tissues were dissected, weighed and analyzed by western blot technique.

Human Experiment: In this double-blind trial, we randomly assigned healthy adult male (24.8±2.4 years old, n=20) with placebo (whey protein, 10g/day) or whey peptide HW3 (10g/day) for 2 months. At the beginning and end of experiment, blood was taken and body composition was measured. Basal metabolism was also measured by using a human metabolic chamber.

Results: **Animal experiment:** Amount of food intakes did not differ among the experimental groups. Body weight in HW3 mice were significantly lower than the others at the end of experiment (CON: 47.6±7.0 g, WPC: 48.2±6.6 g, HW3: 38.3±6.5 g; p<0.05). Gonadal fat was also lower in HW3 (CON: 38.5±11.2 mg/g, WPC: 43.8±9.8 mg/g, HW3: 21.1±13.8 mg/g; p<0.05) whereas tibialis anterior and gastrocnemius muscle weights were larger than those of other groups (p<0.05). Phosphorylation of AMPK was increased (p<0.05) and ACC was decreased (p<0.05) in quadriceps of HW3, indicates that HW3 upregulates fatty acid oxidation. **Human experiment:** Two-month supplementation did not affect the blood properties in both groups. In placebo group, %body fat was increased (p<0.05) at the end of experiment whereas that in HW3 was unchanged. Basal metabolism did not show any difference between before and after supplementation in HW3 group, whereas it significantly decreased in placebo group (p<0.05).

Conclusion: Whey peptide HW3 supplementation might suppress body fat accumulation by maintained basal metabolism via upregulation of fatty acid oxidation.

84 The effects of a polymorphism in the CD36 gene on metabolic response to a short-term endurance training program: A pilot study

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¹Discipline of Exercise and Sports Science, University of Sydney ▪ ²Discipline of Molecular Bioscience, University of Sydney

Introduction: CD36 is a multi-functional transmembrane glycoprotein that facilitates fatty acid uptake into cardiac and skeletal muscle. This study investigated whether an alteration in the CD36 gene that encodes this protein would influence metabolic response to a short-term endurance training program.

Methodology: Screening involved the collection of resting physiological data, including HR_{resting}, BP, FFM, waist-to-hip ratio (WHR) & rate-pressure product (RPP), along with fasting plasma lipids (TC, HDL-C, LDL-C & triglycerides). Participants underwent an oral glucose tolerance test (OGTT), followed by a VO_{2peak} test and a graded submaximal FAT_{peak} test on a cycle ergometer to assess whole body substrate utilisation. Twenty individuals (23.0±3.0 yr; n_{male}=14; n_{female}=6) were screened and genotyped for the study using TaqMan[®] SNP Genotyping Assays on a Real-Time PCR system. Eleven participants completed the four-week endurance training program. Participants trained 3 days / week on a cycle ergometer. Training intensities started at 60% VO_{2peak} in weeks 1 & 2, 70% VO_{2peak} in week 3 & 75% VO_{2peak} in week 4. Post-testing assessment involved a repeat of the baseline tests, with the FAT_{peak} performed at the same absolute (ABS, W) intensities. Participants were representative of all three genotype groups (n_{CC}=1; n_{CT}=5; n_{TT}=5). Analysis was performed on participants in the CT and TT groups (23.3±2.4 yr; n_{male}=8; n_{female}=3) due to the limited CC homozygote group sample size.

Results: No significant correlations between genotype and metabolic response to the short-term endurance training program were found. However, a trend was evident in the fasting plasma triglyceride (FPT) response of the CT heterozygotes to the endurance training program, with an increase after the four-week intervention seen as opposed to the TT group (0.14 ± 0.22 vs. -0.19 ± 0.31 ; $p=0.088$). A number of baseline markers were of interest, with %FFM significantly greater in the CT genotype group when compared to the TT homozygotes (84.82 ± 4.85 vs. 77.89 ± 4.23 ; $p=0.043$), with no significant difference in body weight, BMI or WHR. TT homozygotes had significantly higher fasting plasma glucose (FPG) levels (4.76 ± 0.22 vs. 5.14 ± 0.29 ; $p=0.047$), although a trend towards CT heterozygotes having a greater area under the glucose curve (AUC) was evident at the baseline OGTT (298.89 ± 70.26 vs. 210.57 ± 74.58 ; $p=0.09$). There were no significant differences in mean VO_{2peak} or whole body substrate utilisation values between the groups.

Conclusions: Significant findings in baseline adiposity and FPG could suggest a possible link between SNP rs1527479 and chronic disease states such as cardiovascular disease and diabetes. Furthermore, potential trends in the triglyceride response to the training program and AUC data warrant further investigation of CD36 gene, and its influence on metabolic response to endurance training interventions.

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A novel method for menstrual cycle phase and oral contraceptive cycle verification

M. Schaumberg^{1*} ▪ D. Jenkins¹ ▪ X. Janse de Jonge² ▪ L. Emmerton³ ▪ T. Skinner¹

¹School of Human Movement Studies, University of Queensland ▪ ²School of Environmental and Life Science, University of Newcastle ▪ ³School of Pharmacy, Curtin University

Introduction: In applied sport science research control of potential influencers on performance outcomes is paramount. Due to the influence of oestrogen and progestogen on physiological parameters, exercise research in females should consider hormonal status as a potential influencing factor on performance outcomes. Exercise research focusing on females remains limited and the complexity of controlling for hormonal fluctuations of the menstrual cycle (MC) pose a challenge for research in the area. Furthermore, hormonal status in active females is highly individual, and commonly influenced by oral contraceptive (OC) use, anovulation (ANN) or amenorrhoea. Therefore commonly used methods such as day-counting for the control of menstrual phase have limitations.

Methods: A novel, three-step method for verification of MC/OC phase was developed to ensure stringent control of hormonal status in female-specific sport science research. Firstly, MC mapping for approximation of follicular and luteal phases, ovulation and cycle length is performed for three consecutive cycles. For OC, cycle mapping is used to identify hormone and non-hormone days. Secondly, to confirm the presence of ovulation during the MC and exclude the possibilities of ANN, a urinary ovulation test is carried out for seven consecutive days (8–14). Absence of ovulation and resulting low hormone levels is cause for participant exclusion in the instance where menstrual phases are compared or high hormone conditions are required. For OC, the same method is used to confirm cycle control identified by a lack of ovulation. Finally, a 6 mL venous blood sample is taken on the day of testing to verify MC/OC cycle phase via measurement of serum oestradiol and progestogen concentrations, and to ensure inter- and intra-participant standardisation of hormonal status. A minimum criterion of 16 nmol/L serum progestogen during the luteal phase is set for confirmation of ovulation, consistent with previous research.

Applications: Where hormonal status may influence outcomes of applied female-specific sports science research, strict verification of the MC/OC phase is necessary to ensure that intra- and inter-individual hormonal status remains constant. While previously used methods of hormonal verification may be more simple or less expensive, most have not considered the high prevalence of menstrual and ovulation disturbances in female athletes or measured serum hormone levels which are considered to be the gold standard verification of menstrual phase. The application of strict MC/OC verification will ensure greater consistency in hormone status to enhance the ability to detect differences in training, dietary or therapeutic interventions in female athletes.

86

The effects of oral contraception on post-exercise interleukin-6 and hepcidin

M. Sim^{1*} ▪ B. Dawson¹ ▪ G. Landers¹ ▪ D. Swinkels² ▪ H. Tjalsma² ▪ B. Yeap³ ▪ D. Trinder^{3,4} ▪ P. Peeling^{1,5} ▪

¹School of Sport Science, Exercise and Health, The University of Western Australia ▪ ²Department of Laboratory Medicine, Laboratory of Genetic, Endocrine and Metabolic Diseases, Radboud University Medical Centre, Nijmegen, The Netherlands ▪ ³School of Medicine and Pharmacology, The University of Western Australia, Fremantle Hospital, Western Australia ▪ ⁴Western Australian Institute for Medical Research, Nedlands ▪ ⁵Western Australian Institute of Sport

Purpose: Elevations in the master iron regulatory hormone hepcidin have been shown to reduce iron absorption at the gut and iron recycling by the macrophages. Specifically, the inflammatory cytokine interleukin-6 (IL-6) has been demonstrated to be one of the main regulators of hepcidin production (especially after exercise). Previously, hepcidin levels have been reported to peak 3 h post-exercise, possibly altering iron metabolism during this time. Such a response, in combination with poor dietary iron intake and/or menstrual blood loss, may explain the high incidence of iron deficiency amongst female athletes. However, recent animal studies have reported that estradiol supplementation may attenuate hepcidin production. Furthermore, progesterone has also been shown to have an inverse relationship with IL-6. To this end, since both hormones are commonly found in the female oral contraceptive pill (OCP), the effect of exogenous estradiol and progestogen supplementation on post-exercise IL-6 and hepcidin levels was investigated.

Methods: Ten active female current OCP users completed two 40 min treadmill running trials at 75% of their pre-determined peak oxygen uptake velocity (vVO_{2peak}). These trials were randomly performed in two specific phases of an OCP regulated menstrual cycle: a) Day 2–4, representing a hormone-free withdrawal period (D-0); b) Day 12–14, representing the end of the first week of active hormone therapy (D+7). Venous blood samples were drawn pre-, post- and 3 h post-exercise.

Results: In both trials, serum IL-6 was significantly elevated ($p < 0.05$) immediately post-exercise, while serum hepcidin was significantly elevated ($p < 0.05$) 3 h post-exercise, with no significant differences recorded between trials.

Conclusion: These findings suggest that exogenous estradiol and progestogen supplementation does not attenuate exercise induced IL-6 or hepcidin production during hormone-deplete (D-0) and hormone-replete phases (D+7) of an OCP regulated menstrual cycle. It appears that any exercise induced increases in IL-6 may override any suppressive effects of estrogen on hepcidin production. As such, future studies looking to investigate similar post-exercise responses may not need to 'control' for different phases of the menstrual cycle, provided participants are current OCP users.

M. Blackhall^{1*} ▪ E. Burke-Polden¹ ▪ J. Walls¹ ▪ ¹University of Tasmania

Introduction: Previous research has shown improved exercise economy via reduced oxygen (O₂) cost and increased performance during exercise with supplemental dietary nitrate intake. This supplementation has been shown to increase exercise time at VO_{2max} power in cyclists as well as improved cycling time trial performance. Nitrate intake is believed to exert its effect on oxygen cost and performance by increasing nitric oxide bioavailability. This investigation examined the effect of varied nitrate concentration, contained in beetroot juice, on sub-maximal and maximal performance during cycling exercise.

Methods: Eleven trained subjects [age 31.5 ± 9 years, VO_{2max} 61.8 ± 10.3 ml/kg/min] participated in the study, which had a randomised, double-blind, placebo controlled, crossover design. Subjects completed three regimes of testing and received nitrate doses of approximately 9.2 mmol/day, 3.8mmol/day or placebo in the form of beetroot stamina shots. Beetroot supplementation was consumed once per day for 3 days prior to the exercise testing. Each supplementation period was separated by a 10-day washout period. The performance test consisted of both a submaximal and maximal test carried out on an electronic cycle ergometer (WattBike). The submaximal test involved four intervals of five minutes duration at workloads of 70, 110, 150 and 200 watts for females and 90, 150, 200 and 250 watts for males. After a rest interval of 10 minutes subjects exercised at their pre-determined VO_{2max} power until volitional fatigue. Power output, oxygen consumption, carbon dioxide output, pulmonary ventilation, respiratory rate, heart rate and lactate were measured and recorded throughout the sessions.

Results: A 16.6 % increase in exercise time at maximal work levels following the 9.2mmol nitrate concentration supplementation compared with placebo supplementation ($p=0.0387$) was found. The results from the 3.8mmol nitrate supplementation were not statistically different from the placebo dose. No significant difference in oxygen cost was found at submaximal or maximal work levels and no significant difference in cardiovascular or respiratory measures was detected between each of the three regimes.

Discussion: In conclusion, whilst there was no significant difference in oxygen cost a significant improvement in performance was found following the higher dose of nitrate supplementation. The results from this study indicate a significant increase in maximal exercise performance with supplementation of 9.2mmol/ day nitrate whereas the 3.8mmol/ day dose was not found to bring about a significant improvement in performance. This indicates a threshold dosage may need to be administered for a performance benefit to be found.



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THURSDAY 24 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
0930 – 1030	Workshop	Assessment of hip involvement in complex lumbo-pelvic-hip clinical presentations	Trish Wisbey-Roth	Arcadia Hall 1	88
0930 – 1030	Workshop	Management of Achilles tendinopathy	Jill Cook	Arcadia Hall 2	89
0930 – 1030	Workshop	Exercise rehabilitation for hip and knee osteoarthritis	Kim Bennell	Lagoon Hall A	90
0930 – 1030	Workshop	Mix up your training with Asics	Mark Doherty Jason Mansfield Chris Bishop Kent Sweeting	Lagoon Hall B	91
1100 – 1230	Keynote	Pubic apophysitis – a previously undescribed clinical entity of groin pain in athletes	Matthieu Saily	Ballroom B	92
		The anatomical and histological considerations of pubic-related groin pain	Michael Drew		93
1330 – 1500	Invited	Recurrent hamstring injuries – an overview of considerations	Craig Purdam	Ballroom B	94
		Free papers: Back and hamstring			
		A novel field test of eccentric hamstring strength: A reliability and injury study	David Opar		95
		Predisposing risk factors for hamstring and quadriceps strain injury in male soccer and rugby league players	Phoebe Freeman		96
		Sacral nerve stimulation for the treatment of chronic intractable pelvic pain – a prospective study	Bruce Mitchell		97
		Hamstring muscle activation during the Nordic hamstring exercise and the impact of previous injury: An fMRI study	David Opar		98
1330 – 1500	Free papers: Exercise science 2			Arcadia Hall 1	
		Inter-relationship between lesion level, muscle hemodynamics and peak aerobic power in spinal cord injured athletes	Yagesh Bhambhani		99
		Variability of serum markers of erythropoiesis during a cycling stage race	Pitre Bourdon		100
		Effect of different next-to-skin garments on jumping and landing performance after cold exposure	Kevin Netto		101
		Patterning of affective responses during a graded exercise test in older adults	Belinda Norton		102
		Hyperventilation as a strategy for improved repeated sprint performance	Akihiro Sakamoto		103
		Are swimmers prone to deloading related dysfunction of gluteus medius and gluteus minimus?	Adam Senciw		104
		Impact of lean body mass on exercise training-induced ventricular adaptation: Evidence for genuine cardiac hypertrophy?	Angela Spence		105
1330 – 1500	Free papers: Physical activity			Arcadia Hall 2	
		Assessing physical activity and sedentary time after a 12-week intervention for male university staff: Initial findings	Emma George		106
		My best move: Physical activity for long term conditions	Priathashini Krishnasamy		107
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		Hip and knee arthroplasty surgery does not change physical activity	Paula Harding		109
		Smartphone apps for physical activity: A systematic review	Morwenna Kirwan		110
		Translating health promotion research into community practice: The ManUp physical activity and nutrition project	Gregory Kolt		111

THURSDAY 24 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
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	Invited	Effects of short-term disuse and retraining at young and old age: Neural and muscular factors	Charlotte Suetta		113
1530 – 1700	Free papers: Sports and health psychology			Arcadia Hall 1	
		The physical and decision making performance of team sport officials during a match simulation	Nathan Elsworth		114
		Gender differences in motivating participation and adherence in masters sport	Ian Heazlewood		115
		Exercise feelings are associated with adolescent's physical activity behaviour	Gaynor Parfitt		116
		Relationships between motivation and burnout in sub-elite rowers	Jacqueline Tran		117
		Monitoring athletes through self-report: Perceived benefits and outcomes	Anna Neumaier		118
		Development and validation of the Perceived Social Influences in Sport Scale-2 (PSISS-2): A cross cultural study	Richard Keegan		119
1530 – 1700	Free papers: Physical activity and older adults			Arcadia Hall 2	
		A qualitative exploration of social motivational influences in determining the physical activity of 30–60 year old adults	Richard Keegan		120
		Physical activity and optimism in young and mid-aged women	Toby Pavey		121
		Population attributable risk factors in women: Should we be investing more in the promotion of physical activity?	Wendy Brown		122
		Six weeks of unsupervised WiiFit game play improves balance and gait speed in independent older adults aged 65–84 years	Vaughan Nicholson		123
		Does vigorous intensity physical activity provide additional health benefits beyond those of moderate intensity in mid-aged women?	Toby Pavey		124
1530 – 1700	Symposium			Lagoon Hall A	
		Soccer medicine ahead of Brasil 2014, on the road to Qatar 2022 – Past, present and future soccer injuries and their prevention			
		Soccer injuries on the road to the World Cup Qatar 2022: Main obstacles and challenges	Cristiano Eirale		125
		The value of isokinetic testing and MRI for return to sport decision making in acute hamstring injuries	Johannes Tol		126
		The value of physical examination procedures in predicting return to play and re-injury in hamstring injury in professional football players	Rod Whiteley		127
1530 – 1700	Free papers: Injury and football codes			Lagoon Hall B	
		Tracking injuries via SMS in community Australian football	Christina Ekegren		128
		Preliminary evaluation of the FootyFirst implementation plan	Caroline Finch		129
		The relationship between player wellbeing and training loads in elite female AFL players	Dana Pimley		130
		Medical-attention injuries in community Australian football: A review of 30 years of surveillance data from treatment-sources	Christina Ekegren		131
		Injury epidemiology studies for AFC Asian Cup championship	Yahya Maharmeh		132
		Injury risk factors in elite Australian football	Paul Gastin		133
		Injuries can be prevented in contact flag football!	Yonatan Kaplan		134
		Position specific rugby injuries at university level as related to frequency, severity and site	Paola Wood		135

WORKSHOP

T. Wisbey-Roth^{1,2,3*} ▪ ¹Specialist Sports Physiotherapist (FACP) ▪ ²Bounce Back Classes P/L ▪ ³Invited Lecturer Australian Catholic University

Lumbo pelvic and hip pain is a relatively common clinical presentation which can be multifactorial and complex in nature. This workshop will use the specific example of a clinical presentation of Lumbo pelvic hip pain to discuss effective functional screening tests and passive assessment strategies for the differential diagnosis of hip involvement. The workshop will include participant discussion on assessment and planning treatment intervention to optimise optimal dynamic function of the hip.

WORKSHOP

J. Cook^{1*} ▪ ¹Monash University

This workshop will discuss the principles of treating Achilles tendinopathy, which are complex because of the variable presentation of people with this condition. Achilles tendinopathy can be at the mid-tendon or the insertion; it can be a reactive, degenerative or combination presentation; it can be in elite or sedentary people; and there may be substantial risk factors or not. The differences in presentation and the alterations in treatment to account for these factors will be presented both theoretically and practically.

WORKSHOP

Asics Supported Speaker



K. Bennell^{1*} ▪ ¹Centre for Health, Exercise and Sports Medicine, University of Melbourne

Exercise is the cornerstone of management for hip and knee osteoarthritis (OA) and is recommended by all clinical guidelines. The aim of this workshop is to outline the evidence based exercise approaches for use in people with established hip and knee OA. It will also cover assessment and measurement of outcomes, education, strategies to maximize exercise adherence and the role of increasing overall levels of physical activity in this patient group.

WORKSHOP

Asics Supported Session



M. Doherty^{1*} ▪ J. Mansfield^{1*} ▪ C. Bishop^{2*} ▪ K. Sweeting^{3*}

¹Asics Oceania Pty Ltd ▪ ²School of Health Sciences, University of South Australia ▪ ³Performance Podiatry and Physiotherapy, QLD

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KEYNOTE

Australian Institute of Sport and Club Warehouse Supported Speaker

M. Saily^{1*} ▪ R. Whiteley^{2,3,4} ▪ J. Read⁵

¹Centre Synergie Medical, Lausanne, Switzerland ▪ ²Aspetar Orthopaedic and Sports Medicine Hospital, Doha, Qatar

³University of Sydney ▪ ⁴University of New England ▪ ⁵Castlereagh Imaging, Westmead, Australia



Introduction: Sport-related pubalgia remains a diagnostic and management challenge in elite athletes. While scientific attention has focused on adults, an initial peak of incidence has been reported in adolescent athletes. Pubic symphysis maturation is a late and complex process. Some authors report developmental changes until the third decade. Cadaveric and imaging studies identify a secondary ossification centre located at the antero-medial corner of the pubis at the insertion of the common tendon of the Adductor longus and Gracilis. Very little is known about this apophysis, its maturation, or the existence and chronic implications of stress-related symptoms. This study aims to define pubic apophysitis as a clinically relevant entity in adolescent athletes.

Methods: A retrospective case series was carried out on 26 highly trained football players (16.0 years±1.8) who complained of adductor-related groin pain. All underwent a complete clinical examination by the same sports physician associated with radiological investigations (X-ray, MRI, ultrasound, CT-scan). CT scan was the most sensitive technique for depicting the pubic secondary centres of ossification. Thus pelvic CT scans from 31 asymptomatic male subjects [age range 9–30 years] were used as a comparison group to investigate normal ossification centre development and apophyseal plate closure.

Results: All symptomatic subjects showed a similar historical and clinical pattern: progressive groin pain following an increase in training load. Kicking, fast running, and quick turning triggered symptoms. Clinically, palpation at the pubic insertion of the common tendon (VAS 70/100) and adductor strength testing were painful. X-ray showed non-specific signs of pubic joint remodelling. MRI was used to exclude differential diagnoses and showed symphyseal stress-related signs (bony oedema, subchondral sclerosis). CT scans demonstrated a secondary ossification centre and open apophyseal plate. Within the asymptomatic group, all subjects with apophyseal plate closure were older than 21 years old. Some residual open apophyseal plates (3/31) were found after 25 years old.

Discussion: In general, apophysitis is a clinical diagnosis supported by radiological investigations. In our cases of pubic apophysitis, physical examination and CT scan together showed that the site of tenderness correlated with an immature pubic apophysis and related common origin of Adductor longus and Gracilis origin. This study confirmed that the maturation of the pubic apophysis is a late process bridging adolescence and adulthood. Football players in their early twenties should be seen as immature athletes and adductor-related symptoms should be taken carefully into consideration to avoid chronic symptoms due to complicating apophyseal avulsion and non-union.

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The anatomical and histological considerations of pubic-related groin pain

M. Drew^{1*} ▪ ¹Australian Institute of Sport

Longstanding groin injuries are a challenging area of sports medicine. Before we move forward in management we must first better understand the structures that form this region. This includes the gross anatomy and its function as well as the cells that underpin this function. The adductor longus has a fibrocartilage entheses proximally. However, this entheses is complex with a confluence of structures that interact including bone, entheses and tendon. This interaction is likely to be critical in future advances in diagnosis and treatment methods. This presentation will explore the anatomy and histology of this area and discuss its relevance to the clinician. Current literature will also be synthesised with emerging data in EMG, quantitative sensory testing and the effect pain has on these measures.

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Recurrent hamstring injuries – an overview of considerations

INVITED

Australian Sports Medicine Federation Fellows Supported Speaker

C. Purdam^{1*} ▪ ¹Australian Institute of Sport

Recurrent hamstring injuries are often frustrating to medical teams in many high intensity sports. This clinical paper aims to provide an outline of elements that may be considered in a systematic approach to the clinical diagnosis and subsequent management of these often multi-factorial presentations. Aside from the muscle strength considerations which are well supported in the literature, many of the less prevalent aspects are derived from small case studies, either published or in collaboration with other practitioners. It is hoped raising awareness of the more unusual aspects within a rubric of acknowledged factors, may prove to be of some value in managing the more challenging chronic hamstring patient.



95

A novel field test of eccentric hamstring strength: A reliability and injury study

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Introduction: Hamstring strain injuries (HSIs) and reinjuries are the most common injury in sport. Eccentric knee flexor weakness is a major modifiable risk factor, however there is a lack of accessible methodologies. The purpose of this study was 1) to determine if a novel device, designed to measure eccentric knee flexor strength, displays acceptable test-retest reliability; 2) to determine normative values for eccentric knee flexor strength derived from the experimental device in individuals without a history of HSI and; 3) to determine if the device could detect weakness in elite athletes with a previous history of unilateral HSI.

Methods: The device consists of padded ankle braces with load cells located directly underneath and a base furnished with foam padding. During the eccentric portion of the Nordic hamstring exercise (NHE) the lower leg pulls up against the braces with the force recorded by the load cells. Thirty active males (22.5±2.3 years; 1.81±0.06m; 80.5±8.5kg) without a history of HSI completed NHEs and had their strength measured on the device on two separate occasions. Intraclass correlation coefficients (ICC), typical error (TE) and typical error as a co-efficient of variation (%TE) were established. Normative strength data was determined using the most reliable measurement. An additional 20 elite athletes from Australian football, rugby union and track and field with a unilateral history of HSI within the last 12 months performed NHEs on the device to determine if eccentric weakness existed. Each group performed a single set of three NHEs on the experimental device to determine strength. Results: The device displayed high to moderate reliability (ICC=0.85 to 0.90; TE=21.7N to 27.5N; %TE=5.8 to 8.5). Normative eccentric strength for the left (344.7±61.1N) and right (361.2±65.1) limbs were determined in the uninjured group. The previously injured limbs were 15% weaker than contralateral uninjured limbs (mean difference=50.3N; 95% CI=25.7 to 74.9N; p=0.0002), 15% weaker than the normative left limb data (mean difference=50.0N; 95% CI=1.4 to 98.5N; p=0.0437) and 18% weaker than the normative right limb data (mean difference=66.5N; 95% CI=18.0 to 115.1N; p=0.0080).

Discussion: The experimental device offers a reliable method to determine eccentric knee flexor strength and strength asymmetry and was able to detect weakness in previously injured elite athletes similar to other previously validated methodologies.

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Predisposing risk factors for hamstring and quadriceps strain injury in male soccer and rugby league players

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Question: Are muscle strength, flexibility, body structure or static lower limb posture associated with increased risk of hamstring or quadriceps muscle strain injury in soccer or rugby league players?

Design: prospective cohort study.

Participants: Soccer (n=294) and rugby league (n=201) players ranging from amateur to professional performance.

Outcome Measures: Prior to commencement of the 2008 and 2009 playing seasons, players completed an injury history questionnaire and a battery of reliable physical assessments, including anthropometry, vertical jumps, anterior step up, incline single-leg squats, modified Thomas Test (MTT), active knee extension (AKE) for hamstring length, combined MTT/AKE and static postural photographs. Injury surveillance and exposure data were collected for the following playing season.

Results: During surveillance there were 19 players with hamstring and 23 with quadriceps strains. Those with a sitting height (trunk length measured whilst sitting on a 40cm box, minus the 40cm) greater than 141.4cm (OR=1.481; p=0.033) and a history of hamstring injury in the previous 12 months (OR=2.497; p=0.019) were independent predictors of hamstring strain, in both soccer and rugby league. Knee hyperextension (OR=3.893; p=0.040) and sustaining a quadriceps injury in the previous 12 months (OR=6.836; p=0.012) were independent predictors of quadriceps strain, regardless of sport.

Conclusion: In this multivariate analysis, muscle-specific previous injury and aspects of body structure were independent risk factors for sustaining hamstring and quadriceps injuries. These results provide a greater understanding of the factors influencing hamstring and quadriceps muscle strains and may contribute to future preventative or rehabilitative strategies.

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Sacral nerve stimulation for the treatment of chronic intractable pelvic pain – a prospective study

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Introduction: Sacral nerve stimulation (SNS) has been used effectively in the management of the urinary and bowel symptoms associated with some chronic pelvic pain disorders in the last 15 years. However, while the evidence is good, it remains somewhat limited both in terms of long-term efficacy studies and scope of the pelvic pain conditions investigated. Here, we present result of a single centre prospective clinical study in patients with diagnosed intractable pelvic nerve pain of varied etiology.

Methods and Materials: Over a 2 year period we assessed 23 consecutive patients who had a successful trial and were subsequently implanted with octrode percutaneous leads within the major area of pain in their pelvis using sacral hiatus approach. Questionnaires, along with patients' histories were used to assess outcomes of the treatment and included the following: pain intensity (VAS), analgesic use, depression (Zung depression index), disability (Oswestry index) and patient satisfaction with the treatment. A follow up rate of 100% was achieved with a follow up range of 6–24 months (average of 10.0±8.24 months).

Results: Of the 23 patients studied, only one patient reported a poor outcome to the implant and another patient had an explant due to hardware failure. Overall, a statistically significant reduction in pain levels with an average reduction of 3.5±0.91 (VAS) was observed at 6, 12, 18 and 24 months post-implant (p≤0.001). This equated to a 52% improvement of pain relief, with half of the patients also reporting a significant reduction in their analgesic use. Where data was available, post-operatively, anxiety was seen to decrease by 23%, depression by an average of 11.4±5.5%, and disability by 16 index points on the Oswestry scale.

Discussion: Sacral neuromodulation is an effective treatment for a variety of forms of pelvic (sacral) pain¹. In this study, all patients reported significant improvement of pain throughout the study and decrease their medication uptake. The trend towards improved disability was also noted. SNS should be considered as an alternative to traditional pharmacological pain management strategies where suitable.

Conclusion: SNS can produce effective pain relief in the majority of carefully selected patients suffering from chronic pelvic pain.

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Hamstring muscle activation during the Nordic hamstring exercise and the impact of previous injury: An fMRI study

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Introduction: Hamstring strain injuries (HSIs) display high rates of incidence and recurrence in running-based sports. The Nordic hamstring exercise (NHE) is effective in preventing injury and re-injury however its mechanism of action remains to be fully elucidated. We aimed to determine 1) the spatial patterns of hamstring muscle voluntary activation (VA) during the NHE, 2) whether, following a return to sport, previously injured hamstring muscles display deficits in VA compared to uninjured contralateral muscles during the NHE, and 3) whether previously injured hamstring muscles exhibit long-term alterations in muscle morphology.

Methods: 10 healthy males with a history of unilateral HSI (average time of 9.8±8.67 months post-injury; average age 21.6±1.9 years; stature 180.1±7.4 cm and mass 81.3±6.5 kg) were tested on two separate occasions eight days apart (±1 day) using an observational retrospective study design. Functional MRI (fMRI) was performed on participant's thighs before and after 6 sets of 10 repetitions of the NHE. For all hamstring muscles (biceps femoris long head, BF_{lh}; biceps femoris short head, BF_{sh}; semitendinosus, ST; semimembranosus, SM), transverse (T2) relaxation times were measured at rest and immediately after the NHE protocol and cross-sectional area (CSA) was measured at rest.

Results: For the uninjured limb, the percentage increase in T2 relaxation time for ST was significantly greater than for BF_{lh} (mean difference=18.9%, 95% CI=9.1 to 28.7%, p<0.0001), BF_{sh} (mean difference=16.2%, CI=0.1 to 32.3%, p=0.0489) and SM (mean difference=21.6%, 95% CI=11.9 to 31.4%, p<0.0001). Participants with a previous strain injury to BF_{lh} (n=7) displayed a significantly lower percentage increase in T2 relaxation time when compared to the uninjured contralateral BF_{lh} (mean difference=7.9%, 95% CI=0.7 to 15.1%, p=0.0321, d=0.53).

However, there was no significant difference in the mean CSA observed between muscles in the previously injured and uninjured limbs (BF_{lh}, p=0.7003; BF_{sh}, p=0.7583; ST, p=0.9648; SM, p=0.7919).

Discussion: This study is the first to use fMRI to explore VA during the NHE. Results demonstrated that during the NHE the ST of healthy limbs is selectively activated. Furthermore, previously injured BF_{lh} muscles display chronic deficits in VA when compared to uninjured contralateral BF_{lh} muscles. These findings can be used to improve conventional HSI prevention and rehabilitation practices and ultimately reduce the incidence and recurrence of this troublesome injury.

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Introduction: Spinal cord injury (SCI) results in significant impairment of the cardiovascular and neuromuscular responses to exercise. The reduction in peak aerobic power ($\dot{V}O_2$) is inversely related to the lesion level (LL) and has been attributed to decreases in central oxygen transport and peripheral oxygen extraction. Near infrared spectroscopy (NIRS) is a non-invasive optical technique that is used to evaluate muscle oxygenation (Mox) in situ during exercise. This study tested the hypotheses that: (1) $\dot{V}O_2$ would be significantly related to changes in Mox during incremental exercise, and (2) $\dot{V}O_2$ and Mox would be inversely related to LL.

Methods: Seventeen male athletes with SCI lesions ranging from C6 to L5 volunteered to complete one incremental wheelchair velocity test to voluntary fatigue. The test was performed in their individual racing wheelchair mounted on a frictionless roller system. Cardiorespiratory responses were monitored using a wireless breath by breath metabolic system (VMax ST, SensorMedics, CA). Mox was continuously recorded from the biceps brachii using a dual wave NIRS instrument (MicroRunnam, PA). Baseline NIRs measurements were recorded for two mins prior to, during the incremental exercise test and for four mins upon termination of exercise. Metabolic and NIRS data were averaged over 20 sec intervals. Delta Mox was calculated as the difference between the peak value during exercise and the average value for the last 20 secs prior to the onset of exercise. Pearson correlations were used to examine the inter-relationships between LL, $\dot{V}O_2$ and Mox.

Results: $\dot{V}O_2$ (35.2 ± 8.7 ml/kg/min) varied considerably among the athletes and was inversely related to LL ($r = -0.62$, $p < .05$). Mox decreased at the onset of exercise and levelled off at approximately 80% to 90% of $\dot{V}O_2$ in most athletes. During recovery, Mox increased rapidly and demonstrated a significant hyperemia above the baseline value. There was large variation in the Mox response during exercise with the athletes with lower LL demonstrating greater declines. Overall, Delta Mox was significantly related to LL ($r = 0.59$, $p < .05$) and $\dot{V}O_2$ ($r = 0.69$, $p < .01$).

Discussion: Delta Mox measured by NIRS is an index of the balance between oxygen delivery and removal at the level of the small blood vessels (arterioles, capillaries and venules). The current evidence suggests that the $\dot{V}O_2$ in SCI athletes is closely related with peripheral oxygen extraction. This could be due to a larger active muscle mass and enhanced muscle oxidative capacity at the lower lesion levels.

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Introduction: The Athlete Biological Passport for the fight against doping is currently based on longitudinal monitoring for abnormal changes in cellular blood parameters. Serum parameters related to altered erythropoiesis could be considered for inclusion in the passport. The aim of this study was to quantify the changes in such parameters in athletes during a period of intense exercise.

Methods: Twelve highly trained cyclists tapered for three days prior to completing six days of intense simulated cycling stage racing. Morning and evening blood samples were taken each day and analysed for total protein, albumin, soluble transferrin receptor and ferritin concentrations. Plasma volume was determined via total haemoglobin mass measured by the optimised carbon monoxide rebreathing method. Percent changes in means from baseline and percent standard errors of measurement (analytical error plus within athlete variation) on each measurement occasion were estimated with mixed linear modeling of log-transformed measures.

Results: The plasma volume showed a small decrease during the tapering period, followed by an increase during the race days. Means of all variables changed substantially in the days following the onset of racing, ranging from -13% (haemoglobin concentration) through +27% (ferritin). After the second day, errors of measurement were generally twice those at baseline.

Discussion: Nearly all the plasma variables assessed were significantly affected by heavy exercise either because of changes in plasma volume (total protein, albumin), acute phase/inflammatory reactions (ferritin) or both (soluble transferrin receptor). The same dependence on plasma volume is also relevant for haemoglobin which is already one of the key parameters in the blood passport. These effects therefore need to be taken into consideration before integrating a new plasma parameter into the Athlete Biological Passport model.

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Introduction: Exposure to low ambient temperatures has a profound effect of the human neuro-musculoskeletal system with reports of decreased strength, power and proprioception commonplace. These changes may have a significant effect on winter or cold climate sporting performance and injury. To combat these deleterious effects, athletes perform warm-ups, wear insulating clothing and more recently, use a next-to-skin garment.

Modern next-to-skin garments can have pure thermo-insulating properties or combine insulation with compression. Unlike performing a warm-up, there is no evidence to support the efficacy of any next-to-skin garment to improve muscle function after cold exposure. Thus the aim of this study was to compare the effect of two different lower body, next-to-skin garments on jumping and landing performance following exposure to the cold.

Methods: Following ethical approval and familiarization, 11 female and 13 male (mean age 22.3 yrs, range 21–24 yrs) active adults attended three separate laboratory testing sessions. At each session, a randomly assigned lower body garment was used (compression, thermal and control (shorts)). Each session involved a pre and post-cooling exercise testing protocol of countermovement jumps (CMJ) and drop landings from 1-m (DL) that was interspersed with a sedentary cooling period of 40-min at 0 °C in an environmental chamber. High speed motion analysis was performed to quantify jumping and landing kinematics while subjective ratings of thermal sensation were recorded throughout and immediately after the cooling period.

Results: Cooling significantly reduced thermal sensation ($p<0.001$) and CMJ height ($p<0.001$) in all participants and significantly increased hip flexion ($p<0.019$), reduced knee flexion ($p=0.043$) and limited knee valgus ($p=0.009$) during DL in males. The thermal garment significantly offset the level of reduction in jump height in males ($p<0.012$) while the both thermal and compression garments had the same effect in females ($p=0.012$). Knee valgus during DL was significantly greater ($p=0.014$) while wearing compression garments in male participants. Only female participants reported significantly higher thermal sensation scores while wearing either the thermal ($p<0.018$) or the compression ($p<0.013$) garment. Discussion: The results show efficacy for the use of thermal and compression garments to offset the negative effect of cold exposure on jump height and thermal sensation. However, the most effective garment tested was the thermal garment which also had the highest thermo-insulating properties. Considering the large price discrepancy between this garment and the compression garment, participants in sport where cold exposure is common, may want to base their choice of next-to-skin garment on these findings.

102 Patterning of affective responses during a graded exercise test in older adults

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Introduction: Research indicates that feelings of pleasure during activity are important for exercise adherence. Higher intensities of exercise are associated with reduced pleasure and increased displeasure during the activity. Patterning of affective responses during a graded exercise test (GXT) can be used to indicate the shift in affective response around ventilatory threshold. Past studies have shown this relationship in adult, adolescent and younger children populations, but none have explored the patterns in older adults. This study explored the patterning of affective responses during a GXT in adults aged 60–75 years.

Methods: Sufficiently active older adults ($n=8$, 61–74, 5 males) completed a GXT. At the end of each incremental step, participants reported affective valence and perceived exertion using the feeling scale and Borg ratings of perceived exertion scale respectively and heart rate was recorded. Ventilatory threshold (VT) was identified using the v-slope method.

Results: Across the GXT heart rate and reports of perceived exertion rose continuously whereas affective valence was stable from the onset of exercise until 2 minutes after VT, where it declined significantly ($F[6, 42]=34.5$, $P<0.001$).

Discussion: Results suggest it is suitable to prescribe exercise at intensities at or marginally above VT for suitably active older adults, to ensure positive affective responses and improvements in cardiorespiratory fitness. These results can not necessarily be transferred to a sedentary older population until this patterning has been confirmed.

103 Hyperventilation as a strategy for improved repeated sprint performance

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Introduction: Repeated high intensity sprints incur substantial anaerobic metabolic challenges and create an acidic muscle milieu that is unfavorable for subsequent performance. Hyperventilation acts as a compensatory mechanism for metabolic acidosis, resulting in respiratory alkalosis. This study tested the hypothesis that hyperventilation performed during recovery intervals would attenuate performance decrement in repeated short sprint pedaling.

Methods: Thirteen male university athletes performed ten sets of 10 s maximal pedaling on a cycle ergometer with a 60 s recovery between sets under control (spontaneous breathing) and hyperventilation conditions in a crossover, counter-balanced manner. Pedaling load (kp) was set at $0.075 \times$ body mass. Peak and mean pedaling revolution per minute (RPM) were documented for each set to compare performance decrements over 10 sets between conditions. Hyperventilation (60 breaths/min and $P_{ET}CO_2$ maintained at 20–25 mmHg) was performed 30 s before each sprint set.

Results: Successful intervention was evidenced by an increased blood pH by 0.03–0.07 and a lowered PCO_2 by 1.2–8.4 mmHg throughout exercise ($P<0.01$). A significant time effect ($p<0.01$) was evident for the peak and mean RPM, and blood $[La^-]$ accumulation, indicating a gradual decrease in RPM and increase in $[La^-]$ with sprint set number. The condition effect was not significant for these variables. However, a significant condition \times time interaction seen in peak and mean RPM ($P<0.05$) meant that power decrement was attenuated with hyperventilation in later sprint sets.

Discussion: The ergogenic effects of hyperventilation, notable especially in later sprint sets, may be explained by prolonged anaerobic energy supply processes via phosphocreatine, glycolysis or glycogenolysis, and delayed excitation/contraction failure, enabling powerful force generations to be maintained for the sprinting duration. Additionally, increased activity of respiratory and trunk muscles may serve as a diverting activity that accelerates recovery of central fatigue – a mechanism proposed as the “Setchenov phenomenon”. Attenuation of power decrement with hyperventilation suggests that a training session can be sustained under relatively higher exercise intensity to enable greater adaptive changes, and thus enhanced training efficacy. Furthermore, improved performance would be expected to lead to success in sport events, when the game outcomes are appreciably influenced by repeated intensive anaerobic fitness. The present study provides the potential of hyperventilation for replacing sodium bicarbonate ingestion, which is often associated with adverse gastrointestinal effects.

104 Are swimmers prone to deloading related dysfunction of gluteus medius and gluteus minimus?

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Introduction: Recent bed rest research suggests that gluteus minimus (GMin) undergoes rapid muscle atrophy in response to deloading, while gluteus medius (GMed) is relatively resistant. Similar imbalances in swimmers as a result of exercise in a non-weight bearing environment may explain the frequent lower limb injuries experienced by swimmers during cross training tasks. The purpose of this study was to establish whether GMin and GMed muscle activity in swimmers was different from that of a control population in a weight bearing task.

Methods: Utilising a cross-sectional study design, GMin and GMed muscle activity was compared between healthy active controls (N=15, mean 22.5 years) and two groups of swimmers (non-elite, N=7, mean 23.6 years; elite N=7, mean 23.1 years). The time to peak (TTP) for each electromyographic (EMG) burst was collected from two segments of GMin (anterior and posterior) and three segments of GMed (anterior, middle and posterior) using fine wire EMG electrodes while participants walked at a self-selected speed. TTP was collected from 3 phases of the gait cycle representing the first burst of activity (0% to 20% gait cycle), second burst of activity (20% to 60% gait cycle) and the total stance phase (heel strike to toe off). Separate analysis was performed within each phase of the gait cycle. ANOVA was used to compare the TTP between groups for each muscle segment. A further analysis was conducted within each group to determine if segments within GMin (independent t-test) or GMed (ANOVA) peaked at different points along the gait cycle, reflecting functionally unique activity patterns.

Results: For each muscle segment there was no significant difference in TTP between groups across all phases of the gait cycle ($p>0.05$). However, when each group was considered separately, anterior GMin peaked significantly later than posterior GMin during stance in control participants ($p=0.03$). Differences in TTP between GMin segments were less apparent in non-elite swimmers ($p=0.11$) and elite swimmers ($p=0.84$), due largely to additional EMG activity of anterior GMin in early stance. Conversely, a consistent pattern of EMG activity within GMed was observed in TTP across all groups where anterior GMed peaked later than the remaining segments during both bursts of activity in the gait cycle. Discussion: Swimmers (especially elite) demonstrate additional EMG activity of anterior GMin in early stance, perhaps reflecting recruitment of additional motor units to compensate for weak abductor synergists or reflecting a carry-over of swimming specific recruitment strategies into gait.

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Impact of lean body mass on exercise training-induced ventricular adaptation: Evidence for genuine cardiac hypertrophy?

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Introduction: The existence of exercise training-induced cardiac hypertrophy – independent of changes in body size and composition – remains controversial. We aimed to determine whether appropriate allometric scaling for exercise-induced increases in lean body mass would abolish the apparent increases in left ventricular (LV) mass and volume resulting from 6-months of resistance or endurance exercise training.

Methods: Twenty-three subjects completed an intensive, supervised 6-month endurance (N=10) or resistance (N=13) exercise-training programme. Lean body mass was assessed using dual energy x-ray absorptiometry, while LV mass and end-diastolic volume were measured using cardiac magnetic resonance imaging. Log-transformed data were analysed using linear mixed modelling to derive the percentage change in LV mass and LV end diastolic volume, and assess the extent to which these cardiac adaptations were mediated by changes in lean body mass. The focus was specifically on the effect of the covariate (change in lean body mass) on the outcome (change in LV mass or volume) with each training regimen; therefore, within-group comparisons rather than differences between groups are presented. Probabilistic inferences were based on a standardized threshold of 0.2 between-subject standard deviations denoting a substantial change (positive or negative).

Results: Lean body mass increased by 4% (90% confidence interval, 3 to 5%) following resistance training and 2% (0 to 4%) after endurance training. The unadjusted increases in LV mass were 5% (0 to 10%) in the resistance-training group and 9% (5 to 14%) after endurance training. After adjustment for changes in lean body mass, there was a likely trivial effect on LV mass after resistance training of 0% (-4 to 4%) and a likely substantially positive effect of 6% (2 to 11%) after endurance training. LV volume increased by 2% (-2 to 6%) after resistance training and by 7% (0 to 14%) after endurance training. Adjustment for the change in lean body mass reduced these mean effects to -2% (-5 to 2%) for resistance training (likely trivial) and 5% (-1 to 12%) for endurance training (possibly substantially positive).

Discussion: The increase in LV mass after resistance training was mediated completely by the change in lean body mass. In contrast, around two-thirds of the increase in LV mass and volume was independent of changes in lean body mass following endurance training. We conclude that a 'true' cardiac hypertrophy occurs following endurance, but not resistance exercise training.

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Assessing physical activity and sedentary time after a 12-week intervention for male university staff: Initial findings

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Introduction: Physical inactivity and prolonged sedentary time (ST) are independent risk factors for a range of chronic diseases. In a university environment, employees often spend prolonged periods of time being sedentary, and opportunities for physical activity (PA) may be restricted. Promoting PA and reducing ST in males can be particularly challenging, and male-specific interventions are limited.

Methods: The ManUp UWS program, adapted from the ManUp Study based in regional Queensland, Australia, was implemented as a 2-arm randomised controlled trial comparing two approaches to increasing PA and reducing ST in a university setting. The internet group received access to an online PA program plus printed materials on PA and health, and the print only group received only printed materials on PA and health. Participants were male employees (aged 35–64y) from a large multi-campus Australian university. The first 23 participants with valid data at the end of the intervention period were included for initial analysis. Participants' mean (\pm SD) age was 49.0 (\pm 7.8y), and 69.57% of the sample were general/professional staff. Height, weight, waist circumference, blood pressure, PA and ST were measured at three time-points (baseline, 12-week, 24-week). To assess changes in PA and ST, participants wore one ActiGraph GT3X accelerometer on their right hip for 7 days at each time-point. Cut-points developed by Troiano were used to determine PA intensity and 10 second epochs were used. Changes in PA and ST from baseline to the end of the 12-week intervention were assessed using paired samples t-tests.

Results: At 12-weeks, the internet group showed no significant changes in PA or ST, however, a significant decrease in waist circumference (106.2 ± 15.7 cm vs 108.4 ± 15.7 cm; $t=-2.55$, $p<0.05$) was observed compared to baseline. The print only group showed a significant reduction in their percentage of light PA (20.75 ± 3.39 vs 17.31 ± 2.76 ; $t=-5.90$, $p<0.001$) and a significant increase in their percentage of ST ($73.65\pm 4.09\%$ vs $77.39\pm 3.10\%$; $t=4.30$, $p<0.05$) at 12-weeks, compared to baseline. No significant changes in anthropometric measurements were observed for the print only group.

Discussion: The ManUp UWS program was adapted from a previous evidence-based intervention designed specifically for males. Males in the internet group showed no change in PA or ST, while males in the print only group decreased their PA and increased their ST. Based on these initial findings, it is recommended that future research should explore further opportunities for university staff to increase PA and reduce ST during work hours.

107 My best move: Physical activity for long term conditions

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Introduction: A pilot initiative to train general practitioners (GP) and other health professionals to deliver PA interventions was delivered in 67 GP practices across London. Despite the mounting evidence for the benefits of PA, few health care professionals use PA as an intervention. This may be due to a) lack of knowledge about the benefits of PA b) lack of confidence in delivery of PA c) poor access to available opportunities d) lack of feedback and e) lack of incentives. This initiative was delivered by Intelligent Health Ltd and the National Health Service in London to bridge these barriers and encourage PA uptake as part of the London 2012 Olympic and Paralympic health legacy.

Methods: Between January and August 2012, 311 staff from 67 GP practices received training to prescribe PA to patients with long term conditions which consisted of four main areas: 1) Information on how PA can be promoted 2) Consistency on how to diagnose physical inactivity 3) Methods to encourage individuals to change their behavior 4) Methods to signpost individuals to suitable activities. The training sessions lasted for approximately 60 minutes. An accompanying manual was provided with the latest evidence, contraindications, recommendations and behavior change. Outcome evaluation was focused on process, lessons learned and monitoring against delivery objectives with the aim of examining how the programme could be developed further. All GPs were asked to recall the latest government PA recommendations of 150 minutes of moderate activity a week. An importance / confidence ruler was used understand the participants' rated level of importance of PA and confidence in delivering PA interventions.

Results: Training was delivered to 311 staff from 67 practices across 22 boroughs; with 167 GPs, 70 nurses and health care assistants, 26 people from health promotion and 48 administration staff. Data from 112 participants using the importance / confidence ruler showed statistically significant changes in both in average importance scores of 7.8 and 9.3 before and after training and average confidence ranking of 6.2 and 8.5 before and after training. Not one of the 167 GPs was able to correctly recall the current Government PA recommendations.

Discussion: Although GPs are ideal professionals to advocate and prescribe PA, due to lack of knowledge and confidence, this was not being translated into practice. This pilot initiative identified and overcame barriers to prescribing PA and provided a platform for further recommendations to be developed.

108 Osteoarthritis and the injured sports person

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Introduction: A serious injury often means the end of a sports person's ability to continue in the sport. There are a number of studies that have shown a link between sports injuries, particularly of the knee and hip, and the later development of osteoarthritis (OA). Arthritis leads to pain, loss of function and impacts on quality of life. Arthritis is one of the most significant causes of disability in the Western world and the prevalence and impact of OA is predicted to double by 2020. People affected by OA are often given conflicting information as to what is the best advice to follow for the management of their OA and associated symptoms. It is therefore important to explore and engage in cost-effective best practice management interventions to reduce the impact of OA, and delay surgery. Therefore a review was undertaken to identify international current pre-surgery best practice guidelines.

Methods: An in-depth literature search was undertaken to identify current international guidelines and systematic reviews to determine appropriate best practice recommendations for the physical management and treatment of OA. International arthritis groups were also searched for recommendations. Identified guidelines and systematic reviews were critiqued, using the AGREE II tool, and synthesis of the evidence was undertaken.

Results: Sixteen guidelines with recommendations on the physical management of OA were identified from the literature search. Forty two treatment modalities were identified. Recommendations were graded from 'strongly recommended' to 'unsupported'. Exercise and education were found to be strongly recommended by most guidelines.

Discussion: Current practice suggests that rest and medication rather than exercise are often the first recommendation given to people affected by OA. By contrast international evidence based guidelines provide clear recommendations that exercise and education should be the first advice given. This implication has particular importance for sports people and therapists working alongside them. Consideration needs to be given around the advice concerning the type and amount of exercise to safely engage.

109 Hip and knee arthroplasty surgery does not change physical activity

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Introduction: Most people with moderate to severe osteoarthritis, who undergo total hip arthroplasty (THA) or total knee arthroplasty (TKA) surgery gain substantial improvements in pain, physical function and quality of life. However it is less clear whether these positive outcomes lead to improvements in physical activity of sufficient magnitude to promote good health and well-being. The aim of this research was to document changes in physical activity at six months following THA and TKA, compared to pre-operatively. A second aim was to compare these results against physical activity guidelines to determine if the amount of physical activity was sufficient to promote health and well-being.

Methods: A prospective, within-group, pre and post interventional research design was used. Physical activity was measured using accelerometers over seven days pre-operatively (baseline) and then again six months following THA or TKA. Sixty-three people (mean age 68.8 years, range 51–80) with hip or knee osteoarthritis awaiting surgery, were recruited to the study and complete datasets were available for 44 participants.

Results: Pre-operatively, participants spent 82% of a 24 hour day in sedentary activity compared to 83% at six months post-operatively. None of the participants met the Australian Physical Activity Guidelines preoperatively, and at six months post-operatively one out of 52 (2%) participants met the guidelines. This was despite self-reported improvements in pain, physical function, quality of life, and physical activity measured using questionnaires at six months following THA and TKA.

Discussion: In this sample of people with osteoarthritis who underwent THA and TKA, surgery did not appear to influence physical activity. These findings are inconsistent with the findings reported by previously published studies, which have shown statistically significant increases in physical activity. However, previous studies measured physical activity over a 24–48 hour period which is less than the recommended duration. This study measured physical activity over seven days inclusive of a weekend day. Findings from this research suggest health professionals should not assume improvements in self-reported measures of: pain, physical function, quality of life, and physical activity will result in actual changes in physical activity. These findings may assist health professionals in their roles of assessing physical activity levels and providing practical strategies for people to increase their physical activity levels in accordance with the positive results of their surgery and in order to meet basic guidelines for health and well-being.

110 Smartphone apps for physical activity: A systematic review

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Introduction: Smartphones are Australia's most popular mobile device, and it is estimated that by 2015, 90% of Australians will own a smartphone. Over 19,000 health-related smartphone apps are available and many are focused on physical activity and exercise. Previous research has identified a number of intervention components associated with improved intervention efficacy including self-monitoring, goal setting, personalised feedback and social support. Therefore this study sought to systematically review the most popular physical activity apps on the iOS and android platforms in terms of provision of these components.

Methods: Four hundred of the most popular free apps (health and fitness category) from the Apple iTunes (n=200) and Google Play store (n=200) were downloaded. Apps were included for review if they referred to physical activity and allowed self-monitoring of physical activity. Apps that satisfied these inclusion criteria were coded in terms of educational content, and evidence based features (self-monitoring, goal setting, personalised feedback and social support).

Results: Of the 400 apps examined, 81 apps were reviewed (40 from iTunes, 41 from Google Play), 17.3% (n=14) provided educational content, only 2.5% (n=2) of apps provided educational content aligned with national guidelines for physical activity. Only, 69.1% of apps (n=56) allowed users to manually self-monitor physical activity; 72.8% allowed automated self-monitoring using inbuilt features (i.e. GPS, pedometer, accelerometer) or an external device (e.g. Fitbit). Over 54%, (n=44) also provided the option to track at least one other behaviour (diet, sitting time, sleep, mood, alcohol intake, weight, and stress). Goal setting options were included in 56 apps (69.1%), and almost all apps (97.5%, n=79) provided personalised feedback on progress towards their goal. In relation to social support, most apps included at least one feature (93.8%, n=76).

Discussion: To the authors knowledge this is the first study to systematically review the most popular physical activity apps downloaded by consumers. Findings highlight the low adherence of apps to provide evidence based educational content. These omissions represent a serious weakness of existing apps and in light of the popularity of apps it can be considered a missed opportunity for physical activity promotion. In relation to other features, most apps fared well – with a trend showing that developers are providing more sophisticated means to track activity, utilising the devices' GPS and accelerometry capabilities. Due to the potential of these apps to help consumers improve their health it is recommended that apps be developed or revised around evidence based behaviour change principles, and that all apps undergo rigorous evaluations.

111 Translating health promotion research into community practice: The ManUp physical activity and nutrition project

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Introduction: Translating evidence-based interventions into community practice, along with impact evaluation of such interventions, is paramount to the further development of health promotion initiatives. This study used the RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework to examine the impact of the ManUp intervention, a comprehensive Information Technology-based intervention (website and mobile phone applications) to improve physical activity and nutrition behaviours of middle-aged males residing in a regional environment.

Methods: Data were collected at an individual and organisational level for each of the RE-AIM measures using computer-assisted telephone interview (CATI) surveys (N=312), interviews with local organisations (N=12), and examination of project related statistics and findings. Reach was assessed by level of awareness in the target community (CATI survey). Effectiveness was measured by comparing levels of physical activity and healthy nutrition between individuals who were aware of ManUp and those who were unaware. Adoption was assessed through overall participant registration as well as the percentage of organisations who adopted ManUp in their workplace. Implementation was assessed at an individual level through web statistics of logons and engagement in web-based ManUp physical activity and nutrition activities (challenges). Maintenance was measured at the individual level through Information Technology platform usage patterns over the 12-week intervention and 9-month post-intervention period.

Results: In terms of Reach, 47% of surveyed people were aware of the ManUp intervention. For Effectiveness, there were no differences between physical activity and healthy nutrition in those aware and unaware of ManUp. For Adoption, 73 participants registered for the intervention and 25% of organisations adopted some part of ManUp. In relation to Implementation, 26% of participants initially logged onto the website, and 29% and 17% started the web-based physical activity and nutrition activities (challenges), respectively. As well, 33% of organisations implemented the intervention and a further 42% were considering implementation. For Maintenance, an average of 0.57 logins and 1.35 entries per week during the 12-week intervention and 0.27 logins and 0.63 entries per week during the 9-month follow-up were achieved. Further, 33% of organisations intended to keep ManUp as part of their workplace health initiative.

Discussion: Although the ManUp intervention demonstrated good reach, it was clear that the other elements of the RE-AIM framework were not as strong. These findings should be considered when planning and developing other community-based health promotion interventions.

INVITED

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Blood flow restricted exercise at low-to-moderate loading intensity (20–50% 1RM) using concurrent blood flow restriction (BFRE) has gained increasing attention in both the scientific and applied fields. Notably, skeletal muscle mass and maximal muscle strength appear to increase similarly or to a greater extent with BFRE compared to conventional heavy-resistance strength training. Further, BFRE results in amplified hypertrophy responses and strength gains compared to resistance exercise using identical loads and volume without vascular occlusion (i.e. free blood flow), although recent data suggest that a potential hypertrophic role of free-flow low-intensity resistance training may also exist per se.

Satellite cells (SCs) are undifferentiated myogenic precursor cells with the ability to re-enter the cell cycle to generate new muscle fibers and/or to provide new myonuclei to existing muscle fibers during postnatal growth. Activation and proliferation of myogenic SCs are associated with accelerated and amplified hypertrophy responses following resistance training and the amount of myonuclei in the myofiber has been proposed to impose a ceiling effect on the magnitude of myofiber hypertrophy. In consequence, SC activation has been suggested to play an essential role in conditions of amplified muscle protein synthesis by providing increased transcriptional capacity to the muscle cell.

We recently investigated the magnitude of myogenic SC proliferation and myonuclear addition in response to BFRE and found evidence of SC proliferation and myonuclear addition following short-term BFRE, accompanied by marked gains in myofiber size. Density and number of Pax-7+ SCs increased 1–2 fold (+100–200%) after 19 days of BFRE, thus markedly exceeding the 20–40% gain in SC number typically seen in response to months of conventional resistance training. Further, myonuclei number increased (+22–33%) with BFRE along with substantial myofiber hypertrophy (+30–40%) in type I and II myofibers from VL biopsies obtained 3–10 days post training. In addition, BFRE led to significant gains in maximal isometric muscle strength (+10%) and rapid force capacity (RFD) (16–21%).

The specific pathways of stimulatory action of BFRE on myogenic SCs remain largely unknown. Down-regulated myostatin expression following BFRE may play an important role, since myostatin is a potent inhibitor of myogenic SC activation. Further, mechanical stress on muscle fibers can trigger SC activation through the release of nitric oxide (NO) that stimulates local hepatocyte growth factor (HGF) production. Consequently, NO signaling may be of importance for the hyper-activation of myogenic SCs observed with BFRE since transient rises in NO may likely occur in result of the ischemic conditions during BFRE.

In conclusion, BFRE leads to marked proliferation of myogenic stem cells and results in myonuclear addition in human skeletal muscle, which contribute to the accelerated time course and marked degree of myofiber hypertrophy observed with this type of training. The accelerated and amplified hypertrophy response observed with low-intensity BFRE may be exploited to maximize muscle mass in strength/power athletes, as well as to prevent muscle loss in atrophic/sarcopenic patients and injured athletes. Notably, the marked up-regulation in skeletal muscle SC content elicited by BFRE represents an effective non-pharmacological tool to increase the regenerative and adaptive capacity of human skeletal muscle.

INVITED

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The observation that skeletal muscle disuse leads to atrophy is far from new and the negative effects of unloading on skeletal muscle in young individuals are relatively well elucidated. In contrast, very little is known about how immobilisation and skeletal muscle disuse affects aged muscle. Thus, the present knowledge is primarily based on animal data where hind-limb suspension (HS) has been used as a model of muscle unloading to investigate the underlying mechanisms associated with disuse muscle atrophy in aging. The majority of studies have reported young animals to be more affected by HS and there are substantial indications that the muscle tissue of old animals demonstrates an attenuated recovery response after immobilisation and injury. Although it is evident that aging leads to a multitude of changes in the neuromuscular system that are similar to those evoked by unloading, the lack of research into the effect of unloading in elderly humans makes it difficult to ascertain what effects can be attributed to a decreased physical activity per se and which to the aging process, as such. An important question is therefore whether processes responsible for the loss of muscle mass due to acute or chronic disuse are similar to those underlying sarcopenia and additionally, whether disuse in old muscle is similar to that in young. On this background, we have studied young and older individuals with similar activity levels following various periods of immobilisation and subsequent re-training. Our data demonstrated that aging is accompanied by an attenuated rate of muscle atrophy in response to immobilization compared with that of younger individuals, and importantly that older subjects demonstrated a diminished capacity to restore muscle size and muscle architecture during subsequent retraining. Furthermore, immobilisation led to reduced muscle activation in older but not younger subjects. Thus, the present data suggest that the adaptive plasticity in skeletal muscle mass and central nervous system function associated with unloading and subsequent remobilisation, respectively, may differ between old and young individuals. Collectively, our findings suggest that old individuals may be more affected with respect to neural function, and young individuals more affected in terms of muscle size, in response to short-term immobilization. Furthermore, the present data indicate that aging is accompanied by an impaired ability to recover from disuse muscle atrophy, and, consequently, older individuals may need a longer time to recover from periods of disuse compared with younger individuals.

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Introduction: Previous research has highlighted the lack of data examining the performance of team sport officials in regards to decision-making abilities. The use of an high-intensity intermittent team sport simulation (TSS) in conjunction with repeated decision-making tasks provides opportunities to examine the cognitive performance during valid physiological intensities. The main purpose of this study was to examine the decision-making performance of team sport officials during a match simulation on a non-motorised treadmill.

Methods: Ten (mean age: 34 years range 25–42, height: 179.3±6.7 cm, mass: 78.6±7.3 kg, VO_{2max} : 58.1±4.3 ml·kg⁻¹·min⁻¹.) team-sport officials completed an intermittent TSS (4 x 25 min), on a non-motorised treadmill. Based on individual maximal sprinting speed (MSS), 6 movement categories were created [stand (0% of MSS), walk (20%), jog (35%), run (45%) high speed run (65%) and sprint (100%)]. Heart rate was recorded continuously throughout the test, and blood lactate concentration ([BLa-]) was assessed every 12.5 min. A modified Eriksen Flanker task (4 choice reaction task) was completed at 2:00, 11:30, 14:30 and 24:00 min:s into each quarter. Each task lasted 1 min, consisting of 15 stimuli presented for 1.5 s, with participants giving responses via hand-held wireless controllers. Repeated measures ANOVA was performed on physical (distance covered, high speed running distance), physiological ([BLa-], RPE), and cognitive (response time) measures across each quarter.

Results: Significant reductions ($P<0.01$) in the distance completed during the third and fourth quarters was identified. Significant changes ($P<0.01$) in [BLa-] were also identified across the TSS. Response times during the Eriksen Flanker task varied significantly ($P<0.01$), with slowest response times observed in the first quarter. No changes in accuracy were found across the match. Ratings of perceived exertion increased throughout the simulation ($P<0.01$).

Discussion: The current study identified that cognitive performance as measured by the Eriksen Flanker task remained high across a match simulation, despite significant declines observed in running performance. Improvements in response time were identified towards the end of each half, which suggest that improvements in cognitive performance may be related to an exercise-induced arousal, thus improving multi-choice response time. A higher RPE and changes in [BLa-] suggest that participant's experienced moderate physical fatigue throughout the simulation. Taken together, the current study shows that despite experiencing physical fatigue, cognitive performance remained consistently high across a high-intensity intermittent match simulation.

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Introduction: Previous research has identified factors considered by master's athletes to be significant in motivating their participation and adherence to sport. While this research may be useful in guiding strategies to combat inactivity, in order to ensure that these strategies are affective it is important to identify any differences in the factors motivating individuals to adhere to sport which may exist between populations.

As such, the current study assessed gender differences in the motivational factors of master's athletes competing in the 2010 Pan Pacific Masters Games. The aim was to identify any gender differences in the importance of factors motivating master's athletes to participate and adhere to sport.

Methods: 851 female athletes aged between 25 and 79 (mean=47.63, SD=8.41, SE=.288) and 739 male athletes aged between 25 and 83 (mean=50.82 years, SD=9.382, SE=.345) completed the Motivations of Marathoners Scales (MOMS). A t-test was conducted to identify gender differences in the importance of factors listed on the MOMS. Following the t-test discriminant function analyses were conducted in order to determine the percent of variance in the dependent variable which could be explained by the independent variables.

Results: The t-test revealed significant (p-values between .038 to <.001) differences in the importance of self-esteem, general health orientation, affiliation, recognition and competition. Females had higher scores than males on self-esteem, general health orientation, affiliation, whereas males had higher scores for recognition and competition. No significant differences were observed for psychological coping, life meaning, weight concern and goal achievement. Multivariate discriminant analysis indicated the hierarchy of importance between genders was competition, self-esteem, recognition, and affiliation from the most to the least discriminating constructs. In the discriminant function analyses using the stepwise method the following order of importance was established competition, self-esteem, recognition, affiliation, weight concern and 63% of the variance in the motive to participate could be explained by the gender.

Discussion: Gender differences exist in the importance of self-esteem, general health orientation, affiliation, recognition and competition in motivating master's athletes to participate in sport. The implications are intervention programs to enhance participation in masters sports will have to focus on those factors that are related to gender, such as self-esteem, general health orientation and affiliation for female master's, and recognition and competition for male master's athletes.

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Introduction: Individuals have affective associations with behaviours. These associations have been shown to play a central role in the decision making processes of adults and to influence their physical activity (PA) behaviour, but no research has explored this concept within an adolescent population. This paper describes two studies that examine affective association and PA behaviour in adolescents.

Methods: Study 1: Adolescent males (n=199) and females (n=377) self-reported their current physical activity levels with the Physical Activity Questionnaire for Older Children (a validated 7-day recall instrument) and completed validated inventories to assess PA beliefs and attitudes and affective associations with PA. Study 2: Adolescent females (n=27) wore a GENEActiv accelerometer for 7 consecutive days to measure PA (time in moderate-to-vigorous PA was recorded) and completed the affective associations inventory.

Results: Study 1: More positive affective associations with PA significantly predicted greater physical activity behaviour ($b=.159$, $t(529)=3.144$, $p<.005$, $r^2=.27$). Further, the relationships between beliefs and attitudes and PA were mediated through affective associations. Study 2: Affective associations significantly predicted time in moderate-to-vigorous intensity PA ($p<0.05$, $r^2=.17$).

Discussion: Results from Study 1 support previous research conducted with adult populations and show that in adolescents, although beliefs and attitudes are associated with PA, this association is mediated by affective associations. The limitation in Study 1 of self-reported PA was addressed in Study 2: data from both studies support the relevance of considering affective associations in PA behaviour of adolescents. Interventions to modify or improve affective associations should support PA behaviour change initiatives.

117 Relationships between motivation and burnout in sub-elite rowers

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Introduction: The development of burnout is specific to highly motivated individuals, a characteristic that predominates in high performance sport. Furthermore, self-determined motivation at the start of a season can predict burnout risk at the end of a season. The underlying notion that initial motivation may be representative of motivation throughout the course of the season requires verification. Therefore, the purposes of this study were to investigate whether motivation at the start of a training phase was related to motivation at the end of the phase (immediately pre-competition), and to examine whether start-of-phase motivation could predict end-of-phase burnout in sub-elite rowers.

Methods: Nineteen national-level rowers participated (8 males, 11 females; mean 20.4 years, range 18–24). The Sport Motivation Scale (SMS) (seven subscales relating to intrinsic motivation, extrinsic motivation, and amotivation) and Athlete Burnout Questionnaire (ABQ) (three subscales: “emotional/physical exhaustion”, “reduced sense of accomplishment”, and “devaluation”) were administered monthly throughout a four-month training period. Spearman’s correlations were calculated between start- and end-of-phase SMS subscales, and between start-of-phase SMS subscales and end-of-phase ABQ subscales. Linear regression analyses were conducted to assess the capacity of SMS subscales to predict end-of-phase burnout. Magnitude-based inferences were drawn from the effect size of model fit (adjusted r^2).

Results: Start-of-phase motivation scores strongly correlated with end-of-phase scores for all intrinsic motivation subscales (ρ range=0.49–0.65), “Identified Regulation” ($\rho=0.57$), and “Amotivation” ($\rho=0.72$). No significant correlations were observed for “Introjected Regulation” or “External Regulation” between the start- and end-of-phase measures. “Intrinsic Motivation: To Know” was predictive of “Emotional/Physical Exhaustion” (adjusted $r^2=0.29$, true effect very likely negative), while “Amotivation” was predictive of “Reduced Sense of Accomplishment” (adjusted $r^2=0.35$, true effect very likely positive) and “Devaluation” (adjusted $r^2=0.21$, true effect likely positive).

Conclusion: Self-determined motivation factors (intrinsic motivation subscales, “Identified Regulation”) and “Amotivation” were correlated between start- and end-of-phase measures, whereas less self-determined factors (“Introjected Regulation”, “External Regulation”) were not related between these two timepoints. Low intrinsic motivation and high amotivation were predictive of an increased likelihood of burnout. These findings are consistent with self-determination theory, and indicate that athletes who initially feel highly motivated, and who perceive their motivation to be largely self-determined, are less likely to exhibit burnout symptoms.

118 Monitoring athletes through self-report: Perceived benefits and outcomes

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Introduction: Monitoring and evaluation of an athlete’s training state is an essential component of measured athletic preparation. To date, measures of subjective well-being have been shown to be responsive to changes in training stress encountered by athletes, with practical advantages over performance and physiological measures. Typically the use of athlete self-report measures (ASRM) are driven by the coach and/or sport science staff to avoid undesirable training outcomes such as overtraining or injury. Effective implementation of ASRM is dependent on all stakeholders understanding this cyclic monitoring process and being willing to make changes as necessary. However it is not clear whether those involved in athlete preparation are aware of the reasons for their usage, therefore the aim of this study was to investigate the perceived benefits and outcomes of ASRM use in elite sport.

Methods: Semi-structured interviews were conducted one-on-one with ASRM stakeholders (8 athletes, 7 coaches, 15 sport science and medicine staff) at a national sporting institute. Transcripts were analysed for emergent themes using sound qualitative methods.

Results and Discussion: The variety of perceived benefits and outcomes of ASRM use reflected a general uncertainty amongst stakeholders. ASRM were generally perceived to be implemented to measure athlete responses to training load (emphasised by coaches), and enable training modification (athletes). In comparison, sport science and medicine staff viewed the benefits more holistically with identification of red-flag responses, to ultimately prevent undesired outcomes. Other potential outcomes identified included facilitating athlete self-management and the use of longitudinal data sets to improve knowledge and future practice. However current ASRM outcomes appeared to deviate from these perceived benefits, with the most significant outcome identified being the role of the ASRM in initiating targeted conversation between athletes and staff (all stakeholders). Such conversation helps build inter-personal relationships as well as providing staff with context to any potential issues prior to any action. Communication was also facilitated amongst the multidisciplinary team, keeping staff in the loop and encouraging improved coordination.

Conclusion: While key stakeholders understood the theoretical benefits of ASRM, their full potential may not be currently realised. Possibly due to lack of understanding of the cyclic monitoring process among those involved in athlete preparation, or the rationale for the implementation of the ASRM. The findings of the current study demonstrate that ASRM are primarily used to encourage communication amongst stakeholders, which lends to a shift in perceptions of the role which ASRM may play in athletic preparation.

119 Development and validation of the Perceived Social Influences in Sport Scale-2 (PSISS-2): A cross cultural study

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Introduction: Participation in youth sport is suggested to be a significant predictor of physical activity and health in later life. A growing body of research identifies influential roles for coaches, parents and peers in influencing the children's enjoyment and participation in sport. Current questionnaires for assessing perceptions of social influence on motivation are either exclusive to a single social agent – preventing comparison of relative effects – or they require researchers to explicitly accept/endorse a guiding theory prior to data collection – limiting the scope for new and novel findings. In order to effectively measure, quantify and compare the roles of significant others, the present study set out to develop and validate the Perceived Social Influences in Sport Scale-2 (PSISS-2) – measuring perceptions of praise/positive-reinforcement, punishment/criticism, affiliation/closeness, and conflict/dysfunction – with each social agent.

Methodology: In collaboration with experts in this area (n=10), 49 items were generated by drawing from recent qualitative studies in youth sport. Content validity as-well-as reading-age appropriacy were assessed by an expert panel, before two separate samples of youth athletes were recruited from China (n=191) and the UK (n=187) respectively, for the completion of PSISS-2 and items measuring intrinsic motivation, competence, and competitive anxiety.

Results: From exploratory and confirmatory factor analyses, a three-factor model emerged demonstrating satisfactory factorial validity and predictive validity with regard to intrinsic motivation, perceived competence, and competitive anxiety. The relative social influences of coaches, parents, and peers were moderated by athletes' age and gender.

Conclusion: The PSISS-2 appears to be a relatively reliable and theory-neutral tool for assessing children's perceptions of the influences exerted by key social agents in sport. The findings of this study are reconcilable with existing research, but also suggest new directions and opportunities for progress in this area, for example by allowing researchers to compare the relative effects of coaches, parents and peers. The limitations of the questionnaire design process and reflections on the way that factorial structures are determined are also offered as a point of discussion.

120 A qualitative exploration of social motivational influences in determining the physical activity of 30–60 year old adults

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Introduction: Adults over 60–65 years old are a group considered vulnerable to the risks of sedentary lifestyle causing decreased quality of life and poor health. Australian government figures estimate the number of over 65s will reach 8.1 million by 2056, and 11.2 million by 2101. One key opportunity to prevent sedentary lifestyles in older adults is to understand and promote motivation towards physical activity in middle-aged adults. This study qualitatively examined the motivationally relevant behaviours ('motivational atmosphere') of key social agents towards physical activity and sedentary lifestyles in adults between 30–60 years of age.

Methodology: Twenty participants (32–60 years old) of varying activity levels were recruited from local workplaces and a GP referral scheme. Participants took part in semi-structured interviews to examine which social agents affected their motivation towards PA and how/why. A critical realist philosophy was deployed in the gathering and analysis of data.

Results: Using inductive content analysis, 307 raw themes were coded into 38 categories and five higher dimensions, labelled: 1) providing information and impetus; 2) supporting progress and competence; 3) affiliation and belongingness; 4) logistical considerations; and 5) emotional support. Spouses, close family, work colleagues, GPs and the media were perceived to be highly influential social agents, with many others listed (e.g., personal trainers, local government). Whilst spouses, family and work colleagues influenced motivation through 'leading-by-example', 'reminding/persuading' and 'support/encouragement', GPs and the media were more likely to exert an influence by offering advice, guidance and recommendations, or in some cases 'sounding-the-alarm-bell'. The consistency of messages from these different agents (media, health professionals, friends/family) was also noted as a key determinant of attitudes and actions. Whilst health was often central to participants' responses, social interactions and friendships were also key reasons people gave for becoming or staying active (and for being sedentary). Further, there was preliminary evidence that the sources and types of influence changed as a function of current activity level.

Conclusion: The results facilitate future interventions by suggesting specific behavioural recommendations in relation to known social agents, as well as guiding theoretical development/refinement. The findings suggest that interventions should encompass psychological and social as-well-as health considerations, and that health professionals must understand the 'motivational atmosphere' of each client. Finally, the findings suggest that future research and modelling should adopt methodologies that better address the complexity inherent in the social determination of motivation.

121 Physical activity and optimism in young and mid-aged women

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Introduction: Physical activity has previously been shown to have a positive association with mental health. Most of this work has focussed on reducing the risk of poor mental health, such as depression. Much less work has focussed on promoting positive wellbeing. The association between physical activity and mental health may also differ by age. The aim of this prospective study was to assess the longitudinal association between physical activity and a specific aspect of positive wellbeing – optimism, in young and mid-aged women.

Methods: The study involved young (n=9545) and mid-aged (n=11319) participants in the Australian Longitudinal Study on Women's Health, who completed triennial surveys from 1998 to 2010. Baseline age in 1998 was 22–27 years for young and 47–52 years for mid-aged participants. Physical activity was assessed as time spent in walking, moderate and vigorous activity in the previous week, and an index of MET.mins/week was derived and categorized into one of four levels (none, low activity, meeting guidelines, high activity). Optimism was assessed using the Life Orientation Test – Revised (LOT-R). Generalised estimating equation models (with 3-year time lag), with adjustment for sociodemographic, behavioural and health-related variables, were used to examine the relationship between physical activity level and optimism score, with no activity as the referent. Odds ratios and 95% confidence intervals are reported.

Results: In young and mid-aged women, a dose response relationship was seen with increasingly higher optimism scores with level of physical activity (vs no activity). Unadjusted results were low activity (2.03, 1.53–2.70), meeting guidelines (3.49, 2.59–4.67) and high activity (4.28, 3.16–5.64) for young women; low activity (2.52, 2.13–2.98), meeting guidelines (3.94, 3.31–4.68) and high activity (5.25, 3.16–5.64) for mid-aged women. After adjustment for potential covariates the odds ratios were attenuated but still significant; low activity (1.24, 1.01–1.60), meeting guidelines (1.52, 1.16–1.98) and high activity (1.64, 1.26–2.12) for young women; low activity (1.19, 1.03–1.37), meeting guidelines (1.41, 1.22–1.65) and high activity (1.59, 1.37–1.84) for mid-aged women.

Conclusions: In both young and mid-aged women, even low levels of physical activity appear to promote optimism, with increasing benefits from higher levels of physical activity. As optimism is an important component of positive wellbeing, physical activity should be encouraged as an integral component of a psychologically healthy lifestyle.

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Population attributable risk factors in women: Should we be investing more in the promotion of physical activity?

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Background: The Global Burden of Disease (GBoD) report suggests that high BMI, smoking, hypertension and physical inactivity are the major risk factors (in that order) for chronic disease in Australasia (1). This is based on population attributable risks (PAR), which explain how much the burden from a specific disease would be reduced, if the effects of a single causal risk factor were eliminated. Estimates of PAR depend on the strength of the association between risk factors and disease, and the prevalence of the risk factor in the population. The aim of this study was to estimate changes in PARs for ischaemic heart disease attributable to these four major risk factors, across the adult lifespan in women.

Methods: Younger (age 18–23 years at baseline; N=14175), mid-age (45–50; N=13205), and older (70–75; N=11574) women, recruited by random sampling from the Medicare data base, completed 3-yearly mailed surveys for the Australian Longitudinal Study of Women's Health (ALSWH) from 1996 to 2012. Prevalence estimates (P) for high BMI, smoking, high blood pressure and inactivity were obtained from the ALSWH for women in 15 age groups, using category cutpoints described in the GBoD report. Age and gender specific relative risks (RR) were extracted from the GBoD database. Population attributable risks (PAR) for each risk factor over 12 years were calculated using the formula: $PAR = P(RR - 1) / 1 + P(RR - 1)$.

Results: The PAR for smoking decreased from a high of 59% at age 22–27 to a low of 5.3% at age 70–75. The PAR for physical inactivity was higher than for high BMI across the lifespan, ranging from 51% in the young cohort at age 31–36, to around 25% in the older cohort, compared with a range of 33% at age 31–36 years, to 11% at age 85–90, for BMI. PARs for high blood pressure were lowest across the lifespan, ranging from 3% in the young cohort to 10% in the older cohort.

Discussion: In women, the population attributable risk of inactivity (for IHD) is higher than for any of the other major risk factors from age 30 to 90 years. This is in contrast with the GBoD report which suggests that high BMI is the major cause of ill health in Australasian adults. The data support the case for greater investment in physical activity promotion across the adult lifespan.

(1)Lim SS, Vos T, Flaxman AD et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*. 2012;380(9859):2224–60.

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Six weeks of unsupervised WiiFit game play improves balance and gait speed in independent older adults aged 65–84 years

V. Nicholson^{1*} ▪ B. Burkett¹ ▪ M. McKean¹ ▪ ¹University of the Sunshine Coast

Introduction: Age related deterioration in postural control and balance are associated with an increased risk of falling and fall related injuries. Around 30% of people aged 65 years or older living in the community fall every year. Previous research has shown that various forms of exercise, including balance training can improve balance and reduce the risk and incidence of falls. The Nintendo WiiFit and Wii balance board is a commercially available computer and software package with which player movements control game play. It has been suggested that the Nintendo Wii may be an effective balance tool in older adults. The aim of this research was to determine if six weeks of unsupervised WiiFit gaming was safe and effective in improving clinical measures commonly associated with falls risk in independent community dwelling older adults.

Methods: 41 independently mobile older adults aged 74.5 years (range 65–84 years) were recruited from local retirement villages and educational settings to participate in a six-week two-group (19 Wii group, 22 control group) repeated measures study. Participants either undertook 30 minutes of unsupervised Wii balance gaming three times per week in their retirement village, or served as control participants. All participants completed the timed up and go, functional reach, lateral reach, single leg balance, 30 second chair stand, 6 meter walk test and IconFES at baseline and six-weeks. Results: The Wii group demonstrated significant ($p < 0.05$) improvements in the timed up and go, left single leg balance, lateral reach (left and right) and gait speed compared to the control group. The overall program adherence was 92%. No acute adverse events were reported.

Discussion: To the best of our knowledge this is the first controlled study that has assessed the effectiveness of unsupervised Wii-based activity in independent older adults. The majority of previous Wii-based research has typically focused on in-patient populations or those with diagnosed balance impairments. The few studies that have assessed independent older adults have generally lacked control groups, have suffered from very small sample sizes or have provided close supervision to participants. The positive results in the Wii group together with the high program adherence suggest that unsupervised Wii-based gaming could be used effectively to improve balance and potentially reduce the risk of falling in independent older adults.

Does vigorous intensity physical activity provide additional health benefits beyond those of moderate intensity in mid-aged women?

T. Pavey^{1*} ▪ G. Peeters¹ ▪ A. Bauman² ▪ W. Brown¹ ▪ ¹University of Queensland ▪ ²University of Sydney

Introduction: Although guidelines suggest that vigorous physical activity (PA) confers 'extra' benefits compared with those from moderate intensity activity alone, the magnitude of this additional benefit is unclear. The aim was to compare the reduction in risk of hypertension and depressive symptoms, over 12-years in mid-age women who reported (a) moderate only intensity PA (MOPA) and (b) a combination of moderate and vigorous PA (MVPA), after controlling for overall volume of activity. Hypertension and depression were chosen, as these conditions are the most common physical and mental health outcomes, respectively, for primary care management in Australia

Methods: The study involved 11285 participants in the Australian Longitudinal Study on Women's Health, who completed surveys in 1998 (age 46–52), 2001, 2004, 2007 and 2010. Generalised estimating equation models (with 3-year time lag) were used to examine the relationship between PA in 7 categories from 0 to >2000 MET.min/week, and occurrence of hypertension and depressive symptoms, for women who reported MOPA or MVPA.

Results: For hypertension, risk was slightly lower for MVPA than for MOPA across the entire range of PA levels, but this difference was only significant at the highest PA level (>2000; odds ratio=0.80 MOPA and 0.56 MVPA). For depressive symptoms, odds ratios were similar in both groups up to 500 MET.min/week, then slightly lower for MVPA than for MOPA at higher PA levels. Again, this difference was only significant at the highest PA level (>2000; odds ratio=0.57 MOPA and 0.42 MVPA). Odds ratios were slightly attenuated in adjusted models.

Conclusions: Doing both vigorous and moderate activity does not have significant additional benefits in terms of hypertension and depressive symptoms, above those from moderate intensity activity alone, except at very high levels of PA. Our results support the continued promotion of moderate intensity PA for protection against hypertension and depressive symptoms. Optimal benefit appears to be in the 500–1000 MET.min/week range, with or without vigorous activity.

Soccer injuries on the road to the World Cup Qatar 2022: Main obstacles and challenges

SYMPOSIUM

Aspetar Supported Session



C. Eirale^{1*} ▪ ¹Aspetar Orthopedic and Sports Medicine Hospital, Doha, Qatar

Introduction: Since regional differences have recently been shown in European professional football, regional injury epidemiology must be thoroughly investigated. Despite a growing popularity of football in Asia with 46 active member associations and the recent organization of the World Cup in 2002 in Korea/Japan, data on football injury epidemiology are scarce. Moreover the assignment of the FIFA World Cup 2022 to Qatar has raised new challenges linked to playing football in the peculiar environmental, social and cultural setting of a Middle East Muslim country.

Methods: Data were prospectively collected from the first division football league (QSL) clubs and the senior male National Team in Qatar, in accordance with the international consensus statement on football injury epidemiology. Individual time loss injuries and exposure of each player were recorded over multiple seasons. The aim of this research was to investigate prospectively injury incidence and patterns in Qatar, in order to eventually identify peculiar regional risk factors, with the ultimate purpose of developing tailored prevention programs.

Results: Football injury epidemiology in Qatar is similar but not identical to Europe. While injury incidence (6.0/1000 h) and patterns are similar, some injuries have a heavier impact in Qatar than in Europe, such as strains (2.1/1000 h) especially during matches (6.7/1000 h), ACL ruptures (0.14/1000 h) and overuse injuries mainly during training (2.8/1000 h). Also re-injuries, especially muscle strain recurrences during matches (2.4/1000 h), have a significant impact in Qatar football. It is unclear if this is due to specific intrinsic or extrinsic risk factors. Ramadan period has been investigated and no difference in risk of injury was found compared with non-Ramadan period (4.0 vs 4.9/1000 h, P=0.130) for Muslim footballers. Furthermore, we demonstrated a strong correlation (r=0.929, p=0.003) between injury incidence and final results of the teams in QSL.

Conclusion: In the Middle East, prevention can follow European guidelines, but additional risk factors related to specific injuries like strains and ACL ruptures and situations such as matches should be explored. Ramadan has showed no impact on the injury risk but the influence of other peculiar features of a Middle East country, such as heat, has to be further investigated, also in the view of protecting athletes' health during the 2022 World Cup.

The value of isokinetic testing and MRI for return to sport decision making in acute hamstring injuries

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Acute hamstring injuries are the most common injuries in professional football players. There is an on-going debate on the optimal medical criteria for return to sport (RTS) after such injuries. Currently, this decision is made upon subjective clinical criteria. Attempts have been made to introduce measurable criteria from objective investigations such as isokinetic strength testing or Magnetic Resonance Imaging (MRI) to facilitate and standardize the RTS decision: Isokinetic strength deficit of less than 10% is generally recommended but has never been documented in professional football players. Other studies have suggested that (MRI) of fresh hamstring injuries has diagnostic and prognostic value. However, both approaches have never been scientifically validated.

To investigate this question, two collectives were studied: 52 consecutive football players with Grade 1 and 2 hamstring injuries were assessed with isokinetic testing before clinical discharge. A different collective of 53 consecutive athletes with similar injuries was assessed with MRI within five days of injury and within three days of RTS.

For the athletes submitted to isokinetic testing, 67% had at least one out of the three hamstring-related isokinetic parameters displaying a deficit of more than 10%. There was no significant difference of mean isokinetic peak torques and 10% isokinetic deficits in players without re-injury (N=46) compared to players with re-injury (N=6).

In the MRI group, 89% of the injured athletes had increased intramuscular signal intensity on fluid sensitive sequences. In 42% of the athletes, there was abnormally intramuscular low signal intensity. 5 re-injuries were recorded.

In conclusion, both objective testing systems did not improve the decision making on RTS in addition to the clinical picture in the studies collectives: Normalisation of MRI signal abnormalities or a compensated deficit in the isokinetic testing do not seem to be required for a successful RTS

127 The value of physical examination procedures in predicting return to play and re-injury in hamstring injury in professional football players

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Hamstring injury in professional football players remain the greatest single cause of lost playing time. Some evidence exists to suggest that features of MRI examination are predictive of the time to return to sport however financial and logistic considerations often make this impractical. Clinicians routinely make subjective and objective examination of hamstring injured players on initial and subsequent visits on the assumption that the findings inform treatment decisions, progression, and ultimately readiness for return to play. These examinations often include reports of pain at rest and during activity as well as measures of tenderness to touch, flexibility, strength, and a variety of functional movements. The results of these examinations likely influence treatment decisions, however despite their ubiquitous performance, the utility of these routine measures is unknown. To examine the usefulness of these measures in the management of hamstring injured subjects, a stepwise regression analysis was performed on a consecutive series of athletes enrolled in a randomized controlled trial (ClinicalTrials.gov number NCT01812564) who undertook a 6-stage criterion-based rehabilitation protocol with strict progression and return to play guidelines. At initial examination and on daily treatment a broad range of subjective and objective measures were taken, and the analysis examined the value of these in predicting return to play when performed at initial examination, one, and two weeks post injury. Furthermore, discharge examination of these same measures as well as an isokinetic evaluation were scrutinized for their usefulness in predicting re-injury. This talk will present the results of these analyses as well as briefly describing the rehabilitation protocol employed. Suggestions are made for alterations to routine practice in the initial and subsequent examinations of hamstring injured athletes to more accurately guide treatment progression.

128 Tracking injuries via SMS in community Australian football

C. Ekegren^{1*} ▪ B. Gabbe¹ ▪ C. Finch² ▪ ¹Monash University ▪ ²University of Ballarat

Introduction: The use of text messaging or short message service (SMS) for injury reporting is a recent innovation in sport and has not yet been trialled at the community level. Considering the lack of personnel and resources for injury surveillance in community sport, SMS may hold promise as a feasible option for future research. However, first there is a need to evaluate the quality of reported data. This study aimed to evaluate the quality of SMS-reported data, in terms of player response rate and injury capture rate in community Australian football (AF) clubs.

Methods: Four clubs were randomly selected out of a possible 22 men's community AF clubs from across the state of Victoria. Consenting players from these clubs received an SMS after each of the 18 rounds of the season asking whether they had been injured in the preceding week. If a player replied 'yes', he received a follow-up phone call from one of the authors (a physiotherapist) during which he was interviewed about the details of his injury using a standardised injury form. Throughout the season, a staff member from participating clubs (such as a sports trainer) concurrently recorded all players' injuries using the same injury form. Both players and club personnel were blinded to the dual procedures taking place. The reports from both sources were compared so as to determine the percentage of all injuries registered by SMS only, by club personnel only and by both. Response rate was reported as the proportion of players replying to the weekly SMS and the number of reminders they required.

Results: In the sample of 139 AF players, a total of 210 injuries were reported. Eighty per cent of these injuries were captured by SMS (58–91% across clubs) while only 40% were captured by club personnel (18–71%). Only 20% of injuries were reported by both players and club personnel (9–29%). The mean weekly response rate across all four clubs was 95% (89–100% across rounds). The mean percentage of players requiring one or two reminders was 10% and 5% respectively.

Discussion: A greater proportion of injuries were captured by SMS than by club personnel although this varied across clubs. The player response rate was very high overall but slightly declined over the football season. Injury tracking via SMS yielded a high proportion of injuries and should be considered a viable injury surveillance method for community sports settings.

129 Preliminary evaluation of the FootyFirst implementation plan

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Introduction: FootyFirst is an evidence-informed exercise-based lower limb injury prevention program for community Australian Football players.

A FootyFirst implementation plan, based on Step 5 of Intervention Mapping, was operationalized in the 2012 season targeted at senior coaches of all clubs affiliated with Football Geelong, in Victoria Australia. This paper presents the preliminary findings of the evaluation of this implementation plan.

Methods: The senior coaches of 22 clubs were invited to complete an online survey at the end of the 2012 season. The survey was designed around the five RE-AIM dimensions—Reach, perceived Effectiveness, Adoption, Implementation and Maintenance.

Results: Seventeen respondents, representing 15 clubs completed a survey. Participants included nine senior coaches, four strength and conditioning/high performance coaches and four others. Fifteen were involved with the senior team at their club while two were involved with seniors and reserves. All respondents were aware of FootyFirst (Reach) while 13 indicated someone at their club had a go at implementing FootyFirst in 2012 (Adoption). The senior coach was reported to be the key FootyFirst adoption decision maker by nine of the 13 who adopted FootyFirst. By contrast, seven reported that a strength and conditioning/fitness coach actually led or delivered FootyFirst. Seven of the 13 who adopted FootyFirst reporting implementing FootyFirst regularly in the 2012 pre-season while nine reported implementing FootyFirst regularly in the 2012 playing season (Implementation). Most reported implementing the FootyFirst warm-up (run through and dynamic stretches) at every session with all players while about half implemented the other strengthening, jumping, landing and changing direction technique exercises at every session with all players. Most respondents who adopted FootyFirst reported that they perceived that most players benefited from participating in FootyFirst and that it was very or somewhat effective in preventing injuries, and improving team and individual player performance (perceived Effectiveness). Seven respondents planned to implement FootyFirst in both the pre- and the playing season in 2013 (Maintenance) with all players. Two did not intend to implement it while eight were unsure mainly because they were unsure if they would be continuing with their club.

Discussion: The preliminary findings of the evaluation of the FootyFirst implementation plan indicate that it has been successful in reaching a high proportion of the targeted community Australian football coaches and encouraging and supporting many of them to adopt and regularly implement this evidence-informed lower limb injury prevention program.

D. Pimley^{1*} ▪ ¹Sports Medicine Australia WA Branch

Introduction: Player health and well-being surveillance is now recognised as an important variable in the pursuit of high performance. Sports have reported a positive relationship between both greater training volumes resulting in greater performance and higher training intensity resulting in greater performance. However, studies have shown the highest incidence of injury and/or illness occurs when training loads are at their highest. Sporting teams therefore need to find the balance between training load and player wellbeing. The purpose of collecting this data, specific to female footballers, is to increase the knowledge around training volume and injury of female athletes in a collision sport to assist with player welfare management.

Methods: 15 female AFL players aged between 17 and 28 participating in the Female High Performance Academy were recruited for this study. Using Athletic Logic software – a program designed to monitor every aspect of an athlete's development and performance; muscle soreness, injury incidence, sleep quality, stress levels, mood and fatigue were recorded. This was then compared with their training loads and Rate of Perceived Exertion (RPE).

Results: The incidence of injuries and illness was recorded over a 26-week period, which included both preseason, and in-season training and games. Only 60% of players completed the weekly training load diary on a regular basis. A total of 5 injuries and illnesses were recorded over the 26-week period, with 3 out of the 5 injuries occurring after high volume training weeks. It was also noted that 4 players also missed training sessions due to muscle soreness after high RPE training sessions, although no specific injury was recorded.

Conclusion: Player wellbeing, training loads and RPE have previously been collected for male AFL players participating in the AIS academy enabling coaches and support staff to monitor training loads and decrease injuries. This study indicates there is a relationship between high training volumes and injury in female AFL players however further data collection is required. The information collected within this study could improve the quality of coaching at club level and the level of knowledge around female specific training, ensuring that talented young footballers are not overtraining and becoming injured.

C. Ekegren^{1*} ▪ C. Finch² ▪ B. Gabbe¹ ▪ ¹Monash University ▪ ²University of Ballarat

Introduction: Australian football (AF) consistently outranks other team sports in the frequency of hospitalisations and emergency department (ED) presentations for sports injury treatment. Understanding the profile of these and other 'medical-attention' injuries is important for developing preventative strategies and thereby reducing the health-care burden resulting from AF injuries. Currently, hospital and ED surveillance systems provide the only ongoing source of epidemiological data on community sports injuries at the population level. The purpose of this review was to describe the frequency and profile of medical-attention injuries resulting from AF reported in hospital, ED and other treatment-source datasets.

Methods: A systematic search was carried out to identify peer-reviewed articles and reports presenting original data from treatment sources (hospitals, EDs and health-care clinics) about injuries due to AF. Data were extracted independently by two of the authors and included injury frequency and rate, body region, nature of injury and mechanism of injury.

Results: Following literature search and review, a total of 12 publications were included. Four publications reported hospitalisations, six reported ED presentations, one reported both hospitalisations and ED presentations and one reported visits to sports medicine clinics. In almost all included studies, AF contributed the greatest number of treated injuries out of any sport or active recreation activity. Upper limb injuries were the most frequent AF injury reported in hospital or ED datasets while lower limb injuries were more commonly reported at sports medicine clinics. Fractures and fracture/dislocations were the most prevalent Australian football injury leading to hospitalisation; sprains/strains were the predominant injuries in adults presenting to EDs and clinics, and superficial injuries were most common for children presenting to EDs. Most injuries resulted from contact with other players. Upper limb injuries were most commonly due to falling.

Discussion: Based on their mechanisms, it is likely that many upper limb injuries resulting from AF are preventable; because they are so common they should be a priority for injury prevention in community AF. Conversely though, previous club-based surveillance studies have reported a predominance of lower limb injuries in AF. Thus, while treatment-source data are useful for providing information about the most serious injuries in football, they do not represent the full extent of the injury problem in football. Supplementing treatment-source injury surveillance systems with other datasets such as community club-based collections would provide a more comprehensive understanding of how best to prevent injuries in community sport.

Y. Maharmeh^{1,2*} ▪ ¹Jordan Football Association Medical Committee ▪ ²Member, AFC Medical Committee

From its humble beginnings in 1956, the AFC Asian Cup has grown into the continent's biggest football event, one that stands proudly alongside any top level competition around the globe in terms of excitement, entertainment and organisation. Within the span of five decades, the AFC Asian Cup has encompassed the huge continent bringing together Asia's top national teams every four years in a fantastic feast of top-notch football. With the increasing of demands of the game in terms of medical and health care of players, football medicine has also expanded its roles in the changed of the rules of the game, improvement of equipments which are all back-up with the scientific based injury research program, prevention program to reduce injuries. The effort of continuous injury data collection of FIFA & AFC with the cooperation of team doctors plays a vital role in the health protection of football players.

Aim of the Study: Analyze the incidence, circumstances, and characteristics of injury occurring in the AFC Asian Cups 2007 and 2015.

Methodology: In all Asian Cup tournaments the team doctors of the 16 participating countries in the final competition were required to record all injuries after each match on the F-MARC standard injury report form.

- The respective doctors were oriented on their role in the study during the team workshop held in each of the venue of the Asian Cup.
- Additionally, the AFC Medical officer in each venue met with the team doctors prior to the start of the group matches to confirm the procedures and their responsibilities.

Results and Findings:

- The team doctors reported a combined total of 83 injuries (2007) and 98 injuries (2011) from the 32 matches.
- The top 5 location of injuries were the lower leg, ankle, head, thigh, and knee.
- Contusions were the major characteristic of the injuries followed by sprains and strains.
- More incidences of injuries were recorded towards the end of each half. Moreover, the number of injuries in the first half increased towards the end of the half while in the second half, incidence of injuries from the 46th to 60th minute was higher than those occurring from 61st to 75th with the end of the half having the highest number of injuries.
- More number of injuries resulting from a contact without fouls as compared to contact with fouls.

Conclusion: This will briefly elaborate on the theoretical background and then more extensively address the practically relevant aspects of exercise-based injury prevention such as regular and, as importantly, correct performance of all exercises at least two times a week.

133 Injury risk factors in elite Australian football

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Introduction: Injury prevention and individual player management are increasingly prioritised as effective strategies to minimise injury time loss in professional team sport. Modifications to training practices are in part dependent on the identification of risk factors associated with injury. Despite suggestions that various components of physical fitness may either protect or predispose a player to injury, the links between physical fitness and injury risk in Australian football are relatively unexplored. The purpose of this study was to assess the relationships between individual player characteristics assessed in the pre-season and injury in elite AFL football.

Methods: Player characteristics (height, mass, age, experience, playing position) including pre-season fitness (6min run, 40m sprint, 6x40m sprint, vertical jump), and in-season injury data were collected over four AFL seasons. Data were analysed for 69 players from a single club, for a total of 3879 player rounds and 174 seasons. Injury risk (odds ratio) and injury impact (matches missed; rate ratio) were assessed using a series of multi-level univariate and multivariate hierarchical linear models.

Results: A total of 177 injuries were recorded over the four years with 494 matches missed as a result (2.8±3.3 matches/injury). The vast majority (87%) of injuries were lower body in nature, with hamstring (20%) and groin/hip (14%) being most prevalent. Nineteen players (28%) suffered a recurrent injury (34 instances, 19%). Injury risk and impact was significantly increased in players with lower body mass ($p<0.01$), lower 6min run performance ($p<0.05$) and playing as a forward ($p<0.05$). Increased height was associated with greater injury impact ($p<0.01$). There was a tendency ($p<0.1$) for slower players over 40m to have an increased risk of injury and impact. Univariate analysis suggested that higher vertical jump contact time reduced injury risk and impact, however this relationship was not supported when other variables were controlled. Age and previous AFL experience were not important predictors of injury in this playing group.

Conclusion: The identification of injury risk factors that are intrinsic and modifiable is important in individual player management, while the potential to modify these risk factors is greatest in the pre-season period. Aerobic running fitness and increased body mass appear to have a protective effect against injury risk and impact in elite AFL football and represent important characteristics for targeted development in susceptible players.

134 Injuries can be prevented in contact flag football!

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Background: Despite the growing popularity of American flag football (AFF), there are no published prospective studies that presented specific flag football mishap or injury prevention programs. The objectives of this study were to conduct a prospective prevention study in order to significantly reduce the incidence and the severity of injuries in the intervention cohort as compared to a historical cohort as well as to provide recommendations to the International Federation of Football (IFAF) regarding prevention measures to make the game safer for all involved.

Methods: A 2-season prospective injury prevention study was conducted involving 671 amateur male (mean age: 20.47±3.92 yrs) and 150 female (mean age: 18.50±1.72 yrs) players. Four prevention measures were implemented: The no-pocket rule, self-fitting mouth guards, ankle braces (for those players with recurrent ankle sprains) and an injury treatment information brochure.

Results: There was an 88% reduction in the number of injuries as well as a statistically significant reduction in the incidence rate and incidence proportion between the two cohorts ($p<0.05$). With the exception for the head and face region, there was a reduction in the number of injuries in all body parts in the intervention cohort, reaching statistical significance only in the number of finger/thumb injuries ($p<0.001$). There was a highly significant between the cohorts with regards to mechanism of injury ($p<0.001$) as well as a significant difference related to the severity of injuries ($p<0.05$).

Conclusions: This prospective prevention study has provided convincing evidence that hand injuries can be significantly reduced in flag football. Recommendations to the IFAF include the strict enforcement of the no-pocket rule, the use of head gear, comfortable-fitting ankle braces and mouth guards and finally changing the blocking rules of the game.

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Introduction: In South-Africa a reported total of 326 565 rugby players participate in club and school matches with a high risk of injury.

Rugby injuries vary at each position with respect to severity, mechanism, type and site. Although much is known about injuries sustained by professional rugby players there is little evidence of this amongst tertiary players. The purpose of this study was to identify the relationship between playing position and the frequency, severity and site of injury at University level possibly empowering coaches with injury prevention strategies.

Methods: An observational, analytical study design determining the relationship between on field position and the frequency, site and severity of injuries was done on University male rugby players, over 7 months during 141 games (188 playing hours). "Injury" was defined as: any level of pain or disability suffered by a player during a match that required first aid assistance. "Severe injury": any pain or disability during a match forcing the player to leave the field. "Rugby position": forwards-players involved in scrum; backs- players not involved in the scrum. "Site of injuries": injuries were classified into 1) Head and face. 2) Neck. 3) Shoulder. 4) Arm and hand. 5) Trunk. 6) Upper leg. 7) Knee. 8) Lower leg. 9) Foot and ankle. Injury reports were analysed using cross tabulation and chi-square.

Results: A total of 176 injuries were observed. The forwards experienced more injuries (65.3%, $p=0.04$) than the backs (34.7%). Of the 102 (58, 0%) players who left the field due to injuries, 62.6% ($p=0.09$) were forwards and 49, 2% ($p=0.09$) were backs. The head and face were the most frequently injured (35.8%, $p=0.04$) with 66.7% ($p=0.07$) of these suffered by forwards and 33.3% ($p=0.25$) by backs. The most severe injury sites in forwards (31.9%, $p=0.29$) and backs (30, 0%, $p=0.25$) were the head and face. Data suggests that forwards get injured more frequently than backs ($p=0.04$). Although forwards were injured more severely than backs, however there is no significant difference between these positions ($p=0.29$).

Discussion: Similarly to previous reports of professional rugby players, forwards were injured more frequently than backs. The study results also showed that the head and face were injured most frequently with the forwards who were injured more severely than the backs. Therefore, investigations should focus on methods to decrease the frequency and severity of injuries (e.g. protective gear) as well as on preventative training programmes.

THURSDAY 24 OCTOBER POSTERS AT A GLANCE

Please note: The scientific poster session will be held from 1730 – 1830 in Ballroom A

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Injury simulation in human vertebral body due to weight lifting in 2012 Olympics	Harcharan Singh Ranu	138
What is the inter and intra rater reliability among physiotherapists, sports medics and military nurses conducting functional assessments of injury risk?	Marian Baxter	139
The AliveCor handheld heart monitor: Turning your iPhone into a single-lead electrocardiogram (ECG)	Jessica Orchard	140
Pelvic pain: Is there a place for musculo-skeletal management?	Peter Doman	141
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Return to sport following Total Hip Arthroplasty (THA): Do we all agree?	Yonatan Kaplan	143
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Arthroscopic shoulder surgery in female professional tennis players: Ability and timing to return to play	Ebonie Rio	147
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136 Injury risk predictors among student badminton players in a Malaysian national sports school: Preliminary study

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Introduction: Despite being a widely competed sport internationally, badminton injuries is poorly researched. More limited is the work on risk factors for badminton injuries. Hence, this study was done to preliminarily explore possible injury risk predictors among our competitive badminton student athletes.

Method: This 1 year prospective observational cohort study in 2008–2009 recruited 58 badminton students who are actively training and studying in a national sports school. There were 34 boys and 24 girls from 13 to 16 years old (yo) (13yo=20, 14yo=14, 15yo=13, 16yo=11). Eleven 17 year-olds who were not actively training were excluded. No dropouts were encountered. 'Sports injury' was defined as injury that appeared to be connected with badminton training or a match and (i) handicapped player during play, and/or; (ii) required special treatment. Anthropometric (age, weight, height) and training information (experience, volume) were recorded at the beginning of the study. The number of competitions participated by each player in the study year were noted. Non parametric test were used to compare anthropometric and training characteristics of injured and injury free players. Level of significance was set at $p \leq 0.05$. Risk factors with p value ≤ 0.1 were further tested using logistic regression.

Results: A total of 63 injuries were presented by 33 players. There was significant negative correlation between training volume ($r_s = -0.31$, $p \leq 0.05$) and age ($r_s = -0.34$, $p \leq 0.05$) with injuries. However, multiple logistic regression revealed that age and training volume were not independent predictors ($p \geq 0.05$). Gender-related differences were only found among the 14 year-olds whereby the boys had more injuries ($p = 0.01$). No differences were demonstrated between the injured and injury-free group with regards to training experience in years, present training volume and changes in training volume or number of competition participated. Similar findings were noted when analyses within age group were done.

Discussion: Younger players with lower training volume and, to a certain extent, boys, appeared to be at higher risk of badminton injuries.

These findings suggested that a lack of skills and perhaps risk taking behaviour which is common in boys, may predispose a player to injuries.

This study also strongly suggested that weight and height were not predictive of injury risk, because in the within age group analysis, where the players received almost similar exposure to extrinsic risk, these factors did not show any differences between the injured and injury free group.

137 A new method to find the skin temperature change phenomenon during pitching motion for prevention of pitching elbow

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Purpose of the research: Guidelines for Prevention (ASMI, et al.) for baseball pitching elbow disorder have reported that increased the disorder as the number of baseball pitching increases. There are might not only the overuse but also the temperature change deteriorated the cause of the pitching elbow. A purpose of this study is to establish a new method to clarify the influence on temperature change phenomenon that the throw number of times and the angle of the elbow at the time of the throw give.

Methodology: The recruitment of participants' method randomly selected the person who entered a standard from an applicant using a poster. The criteria of taking part in this study were 1) an experiment of baseball more than three years, 2) no pitching elbow. The brace of the elbow flex angle (60 degrees, 90 degrees, 120 degrees) used and to maintain a constant angle of the elbow flex during pitching for them. The participant pitched multiplying 20times by 10 set. Off interval between the set and the sets was 90 seconds. Measurements were non-contact skin surface temperatures by using an infrared thermography (Thermofocus pro, Italy) the temperature was measured with artery and a vein. There are measured with the artery at brachial artery, radial artery, three positions of ulnar artery), and with the vein at brachial veins, medial vein, ulnar veins. The skin side temperature was taken at both sides. The analysis performed the time-series analysis of the set of the end from a start. It uses the cox regression analysis as an emergency phenomenon in the case that a temperature change produced more than once with progress of the time. (SPSS v20)

Results: All participants completely performed this examined. The participant was six healthy 20-years person. A temperature decline of the skin appears when in 40 pitches of throw number of times is sudden from the second set appears. In succession to the decline, it was significantly skin temperature raise up when in 80 pitches to 100 on all veins ($p < 0.05$). The skin temperature rise changed with all veins before approximately 120 pitches (rise) which was shown in prevention guidelines.

Conclusions: With a non-contact type infrared rays thermometer, there were able to measure a change of the skin surface temperature with the pitching motion. Using this method, expects to prevent a pitching elbow.

138 Injury simulation in human vertebral body due to weight lifting in 2012 Olympics

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Introduction: Lumbar vertebrae are a heavily loaded component of the human body. They are subjected to repetitive loading in daily activities. However, limited information on failure mechanism of lumbar vertebrae is available for extreme weight lifting.

Methods: At the London Olympics of 2012, Behdad Salimikordasiabi lifted a weight of 208 kg and won the Gold Medal. Thus, there is a need to develop an analytical model to predict stress-fracture characteristics of vertebral body. A linear elastic fracture mechanics approach has been considered and a mathematical model has been proposed so that the predictions can be made more easily about the occurrence of injury.

Results: The present study reveals that for a person weighing above 1600 N and lifting a weight of 208 kg during squat exercise causes a vertebral stress-fracture at seven repetitive standing lifting. While lifting the same load at lowest position yields a stress-fracture at less than two lifting. Numerical study shows that for change of position from standing to lowest position resultant compressive force acting on spine increases by two times whereas the possibility of stress-fracture increases by five times. Similarly at dead lift exercise, lifting 325 kg from standing to lowest position increases resultant compressive forces on vertebrae by 2.5 times. However, the stress ratio increases by six times. The present study reveals that for a person weighing 800 N (height=1.8 m) and lifting a weight of 900 N, vertebrae can be subjected to stress-fracture by three cyclic lifting Rate of injury is dependent on flexion angle, i.e., as flexion angle increases, so does rate of injury.

Discussion: For the first time stress-fractures in human body are simulated. But it has its limitations because of complexity of human body structure. However, these stress-fractures do occur in real life in different sports. So this simulation provides a yard stick for coaches of different sports, but weight lifting in particular to be careful of injuries which can do more harm than good to the athlete's body.

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What is the inter and intra rater reliability among physiotherapists, sports medics and military nurses conducting functional assessments of injury risk?

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Introduction Injury prevention strategies are essential to influence the high prevalence of lower limb and low back overuse injuries within society, as well as reduce their substantial costs. Recent technological advances, such as foot scanning systems, have meant that injury risk can be predicted with excellent reliability. Despite this the clinically based, functional assessment of injury risk remains to be the most common method used. The reliability among and between practitioners who use these tests has not been well investigated, which questions the justification of their continued use. The purpose of the current study was to identify the inter and intra rater reliability of three commonly used functional tests, among three different groups of clinicians to a high level of study significance (0.8).

Methods The three clinical assessment chosen for study were: the single limb stance, the hindfoot assessment and the heel raise test. A pilot study identified that 18 participants and 18 assessors were required in order to produce results of high power (0.8). The three assessor groups were: musculoskeletal physiotherapists, NZ army nurses and registered Sports Medics, all with more than three years clinical experience. The assessors completed the scoring sessions on three separate occasions in isolation, with randomised participant ordering.

Results There were no significant differences between the three groups of assessors for either inter or intra rater reliability ($p > 0.353$, $p > 0.778$ respectively). The Kappa agreement values for intra rater reliability for the hindfoot test, heel raise and single legged stance were 0.92, 0.89 and 0.94 respectively. The Kappa agreement values for inter rater reliability for the hindfoot test, heel raise and single legged stance were 0.45, 0.45 and 0.45 respectively.

Discussion There are many important findings from the current experiment. Firstly, the repeatability of clinically based functional testing for injury risk is not dependant on the assessor. There were no significant differences in the ability to reproduce results between physiotherapists, sports medicine practitioners and NZ army medical nurses. The second positive finding was that each individual practitioner could reproduce their assessments to a very high degree of consistency, the level of adequate agreement is $K = 0.7$ and all tests produced agreement of $K = 0.89$ or above. The last finding, which deserves most attention and further investigation, is that between assessor agreement was consistently $K = 0.45$. This translates to a poor-moderate level of reliability, and highlights that the use of these tests and perhaps other similar tests should be reconsidered or at least revised.

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The AliveCor handheld heart monitor: Turning your iPhone into a single-lead electrocardiogram (ECG)

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There are two major causes of preventable sudden cardiac death in athletes: cardiac arrhythmia and hypertrophic cardiomyopathy (HCM). In most countries, asymptomatic athletes are not routinely screened for these conditions, which traditionally require a full 12-lead electrocardiogram (ECG) (for arrhythmogenic abnormalities including long QT syndrome, Brugada syndrome, or HCM) or an echocardiograph (for HCM or other cardiomyopathies). Both ECG and echocardiography are costly (for mass screening) and time-consuming. The AliveCor device is an iPhone case with 2 electrodes which, when used together with the AliveCor app, can record a single-lead ECG in real time. This is typically lead I, which is ideal for rhythm detection, but other single leads including precordial (e.g. modified V1, V2 or V5), could be obtained. The app stores the ECG reading and can email, print or send a PDF of the ECG reading to a secure website. Further clean-up and analysis of the ECG trace can be done on the server and sent back to the iPhone. This extremely affordable and highly portable device has a number of potential clinical applications and research opportunities in sport and exercise medicine, particularly for exercise-only arrhythmias which may not be reproducible during a traditional exercise stress test. It could also be used as a cheap first line screening option for asymptomatic athletes. It has even more potential as a state-of-the-art portable event-recording device, e.g. for a player suffering fainting or tachycardia on the field, with much quicker access to a rhythm strip output (e.g. on the actual playing field) than even a sideline ECG. It could therefore assist with earlier diagnosis of supraventricular or ventricular tachycardia and other exercise-related arrhythmias including ventricular or atrial ectopics and atrial flutter or fibrillation.

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Pelvic pain: Is there a place for musculo-skeletal management?

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Introduction: Health professionals regularly see patients with pelvic pain presenting with signs of pudendal neuralgia. Pudendal neuralgia is a recognised cause of chronic pelvic pain in the regions served by the pudendal nerve, typically presenting as pain in the penis, scrotum, labia, perineum, anorectal region and pain during or after ejaculation. For the majority of these patients, there is a definite urological or gynaecological diagnosis. However, there may be a selected number of patients where the symptoms may arise from a musculoskeletal origin.

Objectives: 1) To review the thoraco-lumbar and sacral nerves, including the pudendal nerve and to examine their distributions to and effects on major anatomical pelvic areas. 2) To investigate the effect of musculo-skeletal management in patients with pudendal neuralgia without a urological or gynaecological diagnosis who present with dysfunction in the lumbar pelvic region.

Methods: To describe how patients with a diagnosis of pudendal neuralgia responded favourably to education, postural advice, mobilisation and exercises directed to the lumbar-pelvic region.

Conclusion: This study traces the role of thoraco-lumbar and sacral nerves in causing pelvic pain. It provides Level 2 b evidence that a musculoskeletal treatment approach has a positive influence on pain and sexual dysfunction in a specific subgroup of patients presenting with pelvic pain.

142 Effects of Nordic walking in the community dwelling subjects with hip osteoarthritis

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Introduction: Nordic walking (NW) is a walking exercise using 2 poles. NW reduces the burden on the joints of the lower extremities at the time of loading and improves posture and balance; therefore, it is becoming increasingly popular. Patients with osteoarthritis (OA) of the hip joint have a characteristic limp and abnormal standing posture. The purpose of this interventional study was to investigate the effects of NW in subjects with hip OA.

Methods: Community dwelling 18 subjects with hip OA were recruited from the cooperating medical institutions and were randomly divided into 2 groups: the NW intervention group (9 subjects; aged, 55–74 years) and the control group (9 subjects; aged, 44–73 years). The NW group performed 8 sessions of NW interventions including stretching and muscle strengthening with the poles. Muscle strength of the lower extremity, timed “Up and Go” (TUG), 6 minute-walk distance (6MWD), Harris hip score (HHS), and health-related quality of life (QOL) by SF-36 were measured in both groups before and after intervention.

Results: No significant differences were noted in physical functions and QOL between the 2 groups before intervention. The control group showed no significant changes in any of the test parameters before and after intervention. The 6MWD (before: 351.8±69.9; after: 416.8±88.3) and the pain sub score item of SF-36 (before: 50.7±17.8; after: 67.8±20.4) in the NW group significantly changed after the intervention ($p<0.05$).

Discussion: The NW group showed significant improvement in the 6-minute walk distance, which indicates the continuous walking distance and time. In addition, the pain did not worsen. Patients with hip OA find it difficult to walk long distances because of pain at the time of loading; therefore, these patients often have associated metabolic complications such as diabetes. These results suggest that NW could also be an effective therapeutic exercise to help improve the physical inactivity of patients with hip OA.

143 Return to sport following Total Hip Arthroplasty (THA): Do we all agree?

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Introduction: As younger, healthier patients are having THA, a greater emphasis is being placed on postoperative function, activity, and exercise. With recent advances in implant technology and surgical technique, the survival rates for modern prosthetic designs and patients with these high demands are promising. There is no current consensus on the safety of resuming to sport. The main concerns nevertheless are remaining instability, wear, loosening, and fracture. The objective of the study was to provide a narrative literature review relating to returning to sporting activity following a THA.

Methods: An electronic search was conducted up to September 2012, using medical subject headings and free-text words. Subject-specific search was based on the terms “total hip arthroplasty”, “return to sport” and “exercise”.

Results: Ten articles were found to be suitable. Only one was a prospective randomized study, comparing the type, intensity and frequency of sports activities performed after resurfacing hip arthroplasty vs. THA using a metal-on-metal bearing. All the rest were narrative reviews and expert opinion. One guideline consensus paper was published. Substantial limitations were observed in most of the publications, including small sample size, patient selection, trial quality, heterogeneity of outcome assessments, and potential sources of confounding variables not investigated.

Discussion: Over the past 10–15 years, many aspects of THA have changed. The age group that has demonstrated the greatest increase in THA are patients between the ages of 45 and 64. Conflicts emerge with some studies that report lower survival rates for hip and knee arthroplasty in patients participating in high-impact sports.

Conclusion: Each sport should be evaluated on its potential risk to a joint replacement, whether from the force of repetitive injury or the possibility of catastrophic failure. Likewise, a surgeon can use techniques, biomaterials, and implants that will maximize an athlete's chance of success over time. There is a need for a long-term, high-quality, prospective randomized control trial that will compare low vs. high impact sports and their effect on the prostheses. Until then, definitive recommendations should be made based on each patient's expectations, goals and the surgeon's past experience.

144 Adipose tissue stromal vascular fraction: A new method for its regenerative application in one step chondral defect repair

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Introduction: The “Stromal Vascular Fraction” is the product of lipoaspirate containing different cellular populations. Among these, it contains a large population of undifferentiated multipotent cells, called adipose derived stem cells (ADSCs), that shares a number of similarities with the bone marrow stem cells, including the multilineage differentiation capacity. Common SVF isolation procedures require sample's collagenase digestion and centrifugation and 8–10 hours work. We discuss the use of ADSCs for the repair of knee focal full thickness chondral defects by the use of an improved closed system (MyStem EvoTM) for enhanced isolation of adult viable mesenchymal stem cells from lipoaspirate in 10 minutes by simple mechanical filtration, bedside in the operating room.

Material and methods: Once the chondral defect has been arthroscopically identified and debrided, in local anesthesia, we extract, by a simple, minimally invasive method of liposuction aspirate, the marrow tissue from adult adipose tissue of the abdomen. The vacuum syringe with about 50 ml of liposuction tissue is, bedside in the OR room, connected to MyStem EvoTM kit, where the infuse content is directly mechanically filtered and the stromal-vascular fraction of cells is separated from the lipid component and the unwanted fragments. The stromal vascular fraction contains 110×10^3 cells/ml on average. Adipose stem cell yield of SVF approaches 2%: a very significant concentration if compared to 0,002% quoted for bone marrow derived stem cells. The obtained cells are then easily implanted in the osteochondral defect or by adding fibrin glue obtaining a sticky clot that is ready to be used or, most frequently, by spreading the ADSCs in the collagen membrane scaffold used to repair the chondral defect.

Results: We have prospectively followed the grade 3 and 4 chondral defects of the knee treated by ADSCc implantation with or without the use of a collagen membrane scaffold. All the patients have been treated by the same surgeon and have followed the same post-operative regimen. Patients have, at short term follow-up, showed improvements in all scores and no adverse reaction has been noted.

Discussion: Adipose tissue contains a large number of multipotent cells (approximately 0.5×10^4 to 2×10^5 stem cells per gram of adipose tissue), which is an essential prerequisite for stem-cell-based therapies. Most common isolation procedures of MSC's are based on collagenase digestion and centrifugation. The new system here in use ensures the treatment of the biologic sample in a closed, sterile system, allows to obtain a sample with homogenous cellularity, free of unwanted debris and avoids the use of centrifugation, reducing processing times and sample handling by the operator.

Conclusions: We can therefore conclude that this proposed procedure is simple, quick, low cost and less invasive to the patient. Specifically, it has the advantage of not requiring harvesting of cells from the joint surface, and its associated donor site morbidity. The adipose tissue lipoaspirate procedure is well known, simple and low-risk. The direct culture in the OR of the adipose mechanically separated layer of cells, without the need to perform collagenase lysis and sample's centrifugation, makes it a quick procedure, easy and safe to perform in the OR, and perfectly adapting to the timing requested for a single step chondral defect repair procedure. One step patient-side surgery is certainly becoming the technique of choice for chondral and osteochondral defects repair. This single-step ADSCc implantation procedure reduces time, costs and is less invasive to the patient, but although promising, needs more patients and longer follow-ups.

145 Parsonage-Turner Syndrome – a case study report

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A 37 male track and field athlete presenting with acute shoulder pain was diagnosed with Parsonage-Turner Syndrome, neuropathy of the brachial plexus. Initial symptoms of insidious onset, severe upper limb pain, non-dermatomal and non-mechanical in nature, was not relieved by analgesia. Exclusion of potential differential diagnoses, such as mass lesions, cervical disc herniation, foraminal stenosis and adhesive capsulitis was confirmed with imaging. There were no initial signs of mobility loss, muscle weakness or atrophy, however weakness in the right upper limb was evident within 3 weeks, limiting active range of shoulder movement, with maintenance of passive range. In particular, weakness of serratus anterior, deltoid, supraspinatus, infraspinatus and triceps was noted, implicating involvement of the axillary, long thoracic and suprascapular nerves. Discussion: A comprehensive literature review, cadaveric anatomical dissection and video images of the case report were examined. Common peripheral nerves affected in Parsonage-Turner Syndrome are the long thoracic nerve arising from the upper trunk (C5 and C6 nerve roots), long thoracic nerve arising from the upper and middle trunks (C5, C6, C7 nerve roots) and the axillary nerve arising from the posterior cord (C5, C6 nerve roots). Insidious onset or following viral illness, trauma, surgery and vaccination have been reported as possible causes, however Parsonage-Turner Syndrome can be a diagnostic challenge for the clinician. Diagnosis is based on thorough history, physical examination, exclusion of co-morbidities and confirmed with electromyography (EMG) and nerve conduction studies (NCS). A key diagnostic clue is evidence of muscle weakness and atrophy in different peripheral nerves rather than dermatomal or myotomal pattern.

The male athlete demonstrated loss of active shoulder range within 3 weeks of initial onset, with neurological examination demonstrating normal sensation and reflex testing but reduced isometric muscle strength tests. At this stage EMG and NCS demonstrated denervation in the axillary, long thoracic and suprascapular nerves which when repeated at 9 months revealed re-innervation signs. Physiotherapy was undertaken in early stages to maintain mobility and muscle strength of unaffected musculature. Once re-innervation had been established, a graduated strengthening program was instituted with single muscle activation, muscle patterning and motor retraining. Active elevation was achieved by 18 months, with residual strength deficits resolving.

Physiotherapy played a crucial role in facilitating an early diagnosis via onward referral for EMG and NCS confirmation, early pain management, education, prevention of secondary loss of mobility and further muscle atrophy, followed by implementation of targeted muscle and motor pattern retraining and subsequent sport specific rehabilitation.

146 A pilot randomized crossover trial comparing the effect of two exercise based management protocols on multidirectional instability of the glenohumeral joint: A research protocol

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Introduction: The most commonly recommended treatment for multidirectional instability (MDI) is primarily exercise based management.

Despite this recommendation, there is limited evidence to support exercise as a primary treatment for MDI. Evaluation of the true effects of exercise for MDI is challenging as relevant intervention studies fail to report important exercise parameters, display heterogeneity in participant samples, and use impairment outcome measures or outcome measures that are not specific to instability. Currently, no published studies have compared the effect of one exercise program to another on outcomes of patients with MDI. A pilot randomized crossover trial is planned to compare and evaluate the effectiveness of two standardized exercise protocols, the Rockwood program and the Lyn Watson program; on instability specific and functional outcomes of patients with clinically diagnosed MDI. The aim will be to describe the trial methodology for the proposed research.

Methods: A multi centre pilot randomized controlled crossover trial is proposed. Participants between the ages of 12 and 35 years, with clinically diagnosed, non traumatic MDI, will be recruited for the study. Consenting participants will be randomly allocated to participate in either the Rockwood program or the Lyn Watson Program, including 12 physiotherapy sessions over 12 weeks involving exercise prescription, review and progression of the intervention specific home program. Outcomes will be assessed at baseline, 6 weeks and 12 weeks. Following the 12 week outcome measures, participants who measure less than a minimal detectable change on the primary outcome measures will cross over into the alternative intervention for a subsequent 12 weeks. Outcomes will again be assessed 6 weeks and 12 weeks post crossover. Primary outcome measures will be the Melbourne Instability Shoulder Score (MISS) and the Western Ontario Shoulder Index (WOSI). Secondary outcomes will include a 7 point global rating of change score and satisfaction with physiotherapy treatment scale. Adverse events and co-interventions will also be measured. Data will be analysed on a per protocol basis and intention to treat principles with appropriate statistics for continuous and ordinal data.

Discussion: This trial will determine the difference in outcomes between the Lyn Watson protocol and the Rockwood Protocol, as well as between subject effects for exercise based management for non traumatic MDI. It is hypothesized that the proposed research will assist in evidence based guidance for clinicians when treating MDI with exercise.

147 Arthroscopic shoulder surgery in female professional tennis players: Ability and timing to return to play

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Introduction: Surgery on the shoulder can cause considerable anxiety to professional tennis players, coaches and medical staff; however there is minimal information in the literature to guide prognosis in this elite population. Recent publications have highlighted the relatively poor rate of return to sport after shoulder surgery in overhead athletes, particularly male baseball players. In professional tennis, individual singles ranking allows a more objective measure of return to preoperative function than simple 'return to play'. The objective was to assess outcome and time to return to previous level of function following shoulder surgery in professional female tennis players.

Methods: The records of all female tennis players on the Women's Tennis Association (WTA) professional circuit between January 2008 and June 2010 were reviewed to identify players who underwent shoulder surgery on their dominant (serving) shoulder. Surgical details including date, procedures performed, and complications were recorded. The primary outcomes were ability and time to return to professional play, and ability to return to previous level of function, as determined by their highest singles ranking pre-injury and post operatively over a 2½ year period.

Results/Discussion: During the study period eight WTA players underwent dominant arm shoulder surgery. All procedures were arthroscopic, most (88%) of players had more than one procedure performed during surgery. The mean age of players at surgery was 25 (range 18–31), and mean follow up was 39 months (range 24–54). A high rate of return to play was noted with seven players (88%) returning to professional play with a mean time of 7.0 months after surgery. However a prolonged and often incomplete recovery time to previous functional level was noted following surgery, with only 2 out of 8 players achieving their previous singles ranking by 18 months post operatively. At nearly 2½ years only four players (50%) returned to their pre-injury singles ranking, with their peak singles ranking being attained at a mean of 2.4 years post. To our knowledge, this represents the first study to assess the outcomes of shoulder surgery in professional tennis players, or in professional female overhead athletes. Previous studies have focused on return to play of elite baseballers or older recreational tennis athletes. We believe our methodology of assessing ranking is a more sensitive tool to assess level of recovery. This information is useful when counselling patients, coaching staff on expectations regarding return to play and likely attainment of pre-surgical level of function.

148 Is intradiscal methylene blue injection an effective treatment alternative for discogenic low back pain?

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Background: Discogenic low back pain (LBP) is caused by internal disc disruption, expansion of sensory nerve endings along annular tears, and inflammatory reactions in the degenerated nucleus pulposus by a number of cytokines and nitric oxide. Methylene Blue (MB), an inhibitor of nitric oxide synthase has been controversially suggested as an effective treatment for chronic intractable discogenic pain. Peng and colleagues (Peng et al. Pain 2010) reported in a randomised controlled study, the active group receiving intradiscal MB injections resulted in a 52.5 point reduction in mean numeric pain rating score and 91.6% in satisfaction rate at 24 months after procedure, a result that surpasses most other non-surgical LBP treatments. However a more recent, smaller cohort study has shown that the efficacy of intradiscal MB injection is maintained in only 20% of patients after 12 months (Kim et al. Ann Rehabil Med. 2012). Here we report on the outcome of our first 7 consecutive patients receiving MB to treat discogenic LBP.

Method: Seven patients diagnosed with at least one symptomatic lumbar disc as confirmed using ISIS (International Spine Intervention Society) standardised provocative discography, received 1ml of 1% Methylene Blue (10mg) into the center of the nucleus pulposus under fluoroscopic guidance. Pain levels and analgesic use was recorded and patients followed up 6–9 months post procedure.

Results: All seven patients reported nil pain relief following intradiscal MB treatment. Similarly no reduction to analgesic use was observed either. Within the following 6–9 months, 4 patients had undergone either a posterior or anterior lumbar interbody fusion, whilst another 2 had undergone a nucleoplasty procedure for their discogenic LBP. The remaining patient (currently 6 weeks post MB injection) is considering their next treatment option.

Discussion: All seven of our consecutive patients receiving intradiscal MB failed to respond to the injections and either proceeded to or considering alternative interventional and/or surgical procedures. Both published studies and our seven patients used similar patient selection criteria and low dose (0.5% or 1%) MB. Further studies about whether repeated MB injections work for chronic discogenic pain might be necessary, however, larger doses of MB or multiple injection regimes must proceed with caution due to experimental evidence of neurological impairment with large dose MB.

Conclusion: These poor 6–9 month results combined with the 12 month outcome data reported by Kim and colleagues seriously questions whether MB injection is in actual fact an effective treatment method for discogenic low back pain.

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Introduction: Hamstring muscle strain injuries continue to be the most common injury and cause of missed games in the Australian Football League (AFL). Despite the research that has been conducted into this injury, the injury rates have remained relatively steady over the past 20 years in the AFL. The identification of risk factors and the implementation of prevention strategies could be being counteracted by continual changes in the game demands and the emergence of new risk factors. The aim of the current study was to collect data surrounding every hamstring injury during the 2011 AFL season.

Methods: Data were collected on player factors, injury details, extrinsic factors, and recovery information associated with the injured player and the hamstring injury.

Results: Ninety-one hamstring muscle strain injuries from 75 players were reported during the 2011 season. Sixteen injuries were recurrent strains (21%) and of these, three players had two recurrences. Players aged <20 years were 1.7 times more likely to sustain an injury than those aged >24 years. The biceps femoris muscle was injured in 85% of cases, most commonly at the distal musculotendinous junction. The majority of strains occurred during high speed running or when combining running with lumbar flexion. There was no relationship between mechanism of injury and resultant location of injury within the muscle, however players who sustained an acceleration injury were significantly more likely to take longer to return to play (>25 days). Where there was no clear injury incident, players were 8 times more likely to return to play within 3 weeks. Hamstring injuries most commonly occurred during games, in the later rounds of the season, in the third quarter of a game and during or the week following playing on a significantly harder ground. Workload data revealed a greater game percentage three weeks prior to injury.

Discussion: In a previous study conducted in the 2002 season, players over 24 years old were four times more likely to sustain a hamstring injury than those under 20 years. The reverse was true in 2011 and might reflect the changing nature of the game. Considering that injuries occurred later in games, later in the season, following and during playing on harder grounds, and following an increased game load it could implicate cumulative loading and fatigue as associated factors in hamstring injury.

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Introduction: Discrepancies in size between vastus medialis (VM) and the rest of the quadriceps musculature (vastus intermedius (VI), vastus lateralis (VL), and rectus femoris (RF)) are thought to be present in a population with patellofemoral pain syndrome (PFPS). Thickness measures with diagnostic ultrasound could provide a cheap, time efficient method of measuring individual quadriceps muscle size for research and clinical purposes. This study aimed to determine the validity of ultrasound in measuring individual quadriceps muscle thickness by comparing results to magnetic resonance imaging (MRI) measures of muscle thickness and cross sectional area (CSA).

Methods: Three female and two male participants with unilateral PFPS underwent bilateral ultrasound and MRI scanning of the quadriceps.

Points were marked on the skin bilaterally over the mid-belly of VM, VL, VI, RF, and VMO. Comparisons were drawn for each muscle between ultrasound muscle thickness (USMT), and MRI muscle thickness (MRIMT) and CSA at these points. Pearson's correlation coefficient (r) and intraclass correlation coefficient (ICC) using a random effects model (absolute agreement) were used to compare USMT and MRIMT, and compare the thickness ratio for MRI and US of VM:VL and VMO:VL. Spearman's correlation coefficient (rho) was used to compare USMT with MRI CSA.

Results: Ultrasound thickness measures were significantly correlated to MRIMT for VMO (r=0.86, ICC=0.63), VM (r=0.86, ICC=0.43), VL (r=0.94, ICC=0.81), and RF (r=0.86, ICC=0.71), no significant correlation was found for VI (r=0.37, ICC=0.24). The ratio of thickness between muscles for MRI and ultrasound were significantly correlated for VM:VL (r=0.86, ICC=0.82) and VMO:VL (r=0.92, ICC=0.921). Ultrasound thickness measures were significant correlated to MRI CSA measures for VM (rho=0.73), VL (rho=0.83), and RF (rho=0.88), and no significant correlation was found for VMO (rho=0.20) and VI (rho=0.310).

Conclusion: Significant correlations were found for VM, VL and RF between USMT and MRI measures of muscle thickness and CSA, indicating these measures can be used to measure muscle size. The VMO USMT measure was significantly correlated to MRIMT but not to MRI CSA, and the VI USMT measure was not significantly correlated to either MRIMT or MRI CSA. Caution is advised in interpretation of these results as the small sample size in this study highlights the risk of type II error. Significant correlations were found between MRI and Ultrasound muscle thickness ratios for VM:VL and VMO:VL, indicating these measures may be useful for investigating if a difference is present in the size of VM and VL in PFPS.

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Background: Despite the fact that acute Achilles tendon ruptures (AATR) are common sports injuries, there is a lack of consensus on the best management. The primary aim of medical professionals should be to return these patients to full functional pain-free activity in the shortest time possible, without increasing their susceptibility to re-rupture. Herein lies the controversy in the literature. The question remains whether surgery is always indicated for these cases, or can early, gradual rehabilitation achieve the same or even better short and long-term results. The aims of the research were to identify and summarize the up-to-date evidence-based practice concerning the optimal effectiveness of different interventions in the treatment of AATR.

Methods: A search was conducted using multiple databases, including the Cochrane Musculoskeletal Injuries Group's specialized register the Medline, PubMed, Embase and Cinahl search registers (to March 2013). All prospective, level 1 and 2, randomized and quasi-randomized were reviewed including their conclusions and recommendations. Search headings included "non-operative vs operative treatment", acute Achilles tendon ruptures", "randomized control trials".

Results: Twelve studies, involving 1074 patients were included. Most of the studies had poor methodology and inadequate reporting of outcomes. Most trials showed good to excellent long-term results in the non-operated group, with no significantly higher re-rupture rate compared to the operative cases. These all used early functional post-op rehabilitation. Patients fitted post-operatively with a functional brace rather than a cast tended to have shorter in-patient stay, fewer days off work, a quicker return to sporting activity, better range of ankle motion and strength.

Conclusions: Contrary to previously reported studies, there is strong evidence that AATR may be successfully rehabilitated in a non-operative manner without increasing their susceptibility to re-rupture. This needs to be further studied with larger sample sizes and further high-quality research protocols. What is more apparent is that early functional rehabilitation in an active brace post-surgery is more advantageous than the current protocol of immobilization. This is irrespective of whether surgery has occurred or not.

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Factors influencing the implementation of self-report measures for athlete monitoring

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Introduction: Self-report measures are a relatively simple and theoretically effective means of athlete monitoring above traditional physiological and performance measures. The objectives of self-report measures include early detection and ultimately prevention of undesired outcomes such as overtraining and injury. However achieving such objectives is dependent on how the measure is implemented. This study sought to investigate how athlete self-report measures (ASRM) were implemented in elite sport settings, and to identify barriers and enablers to implementation.

Methods: Semi-structured interviews were conducted one-on-one with ASRM stakeholders (8 athletes, 7 coaches, 15 sports science and medicine staff) at a national sporting institute. Interviewees represented 20 different elite sport programs. Transcripts were analysed for emergent themes using sound qualitative methods.

Results: Overall, ASRM were well-received by stakeholders, though more due to their potential benefits. The realisation of such benefits was compromised, largely due to ASRM implementation practices. Factors identified as influencing implementation related to either the ASRM itself (eg. mode, accessibility, questions, interface, time burden), how it was implemented (eg. timing of completion, feedback) or the social environment (eg. engagement of stakeholders, culture). Collectively, these factors inter-related to encourage or discourage compliant and accurate completion by athletes, and use by staff.

Discussion: Whilst factors related to the ASRM influenced athlete and staff engagement, the larger issue related to how the measure was implemented and the social environment supporting this. Addressing each of the factors identified to influence ASRM implementation will improve data integrity, which is necessary to realise the objectives of ASRM.

Conclusion: The findings of this study improve our understanding of the various factors that influence the implementation of ASRM in the unique environment of elite sports. These results create a platform to guide improved implementation practices in the future.

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Effects of moderate cycling exercise with and without carbohydrate-electrolyte solution on urinary α -amylase isoenzyme activity

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Introduction: It has been known that urinary α -amylase occurs mainly in the form of two isoenzymes of pancreatic (P) and (S) salivary origin. Previous research demonstrated the effects of endurance exercise on those urinary isoenzyme activity. However, whether prolonged exercise with and without carbohydrate-electrolyte solution influences the urinary α -amylase isoenzyme levels still remains to be elucidated. The purpose of this study was to determine the effects of 2 hours of prolonged cycling exercise with and without carbohydrate-electrolyte solution on urinary α -amylase isoenzyme (P and S) activity in moderately trained men.

Methods: Eleven aerobically trained men served as the subjects [age: 19.6 \pm 1.2 year; height: 171.2 \pm 3.7 cm; body weight: 67.7 \pm 13.0 kg; body mass index: 23.0 \pm 3.7 kg/m²; body fat: 15.1 \pm 6.6 %; VO_{2peak}: 62.1 \pm 8.9 ml/kg/min (mean \pm SD)]. To determine their peak oxygen uptake, all subjects performed an incremental cycling exercise until volitional exhaustion. On two different occasions, each subject performed 2 hours of cycling exercise corresponding to a constant power output at 60% VO_{2peak}. After an overnight fast, all subjects drank either carbohydrate-electrolyte solution (CHO)(glucose: 62 g/L, Na+: 49 mg/dL; K+: 20 mg/dL; Ca2+: 2 mg/dL; Mg2+: 0.6 mg/dL) or water placebo (WP)(Na+: 0.53 mg/dL; K+: 0.05 mg/dL; Ca2+: 1.20 mg/dL; Mg2+: 0.28 mg/dL, pH: 6.8) immediately before cycling and every twenty minutes thereafter (2 ml/kg body weight). Spot urinary samples were obtained at the 10-min period before (Pre) and after (Post) 2 hours of cycling exercise for the later analysis of the urinary α -amylase isoenzyme (P and S) activity, which was quantified by cellulose acetate membrane electrophoresis.

Results: A two-way (time x treatment) analysis of variances (ANOVA) showed no significant main effects or interactions (Total P: Pre: 63.1 \pm 15.6, Post: 64.1 \pm 11.5 % for CHO; Pre: 65.7 \pm 15.2, Post: 64.7 \pm 14.5 % for WP, Total S: Pre: 36.9 \pm 15.6, Post: 35.9 \pm 11.5 % for CHO; Pre: 34.3 \pm 15.2, Post: 35.3 \pm 14.5 % for WP).

Discussion and Conclusions: Previous studies have reported greater changes of urinary isoenzyme activity following endurance exercise in untrained individuals. However, the effects of prolonged exercise with and without carbohydrate-electrolyte solution on urinary salivary isoenzyme activity in moderately trained individuals were still unclear. The findings of the present study suggest that 2 hours of cycling exercise with a constant carbohydrate-electrolyte ingestion in moderately trained individuals appears not to influence urinary isoenzyme activity.

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Introduction: Adherence to a gluten-free diet (GFD) for non-coeliac, non-gluten sensitive athletes (NCA) has become increasingly popular. Many of these athletes associate the elimination of dietary gluten with improved exercise performance, reduced gastrointestinal distress and inflammation despite the lack of supportive medical evidence. The restrictive nature of a GFD has the potential risk of suboptimal nutrient intake, compromising beneficial gut bacterial populations and increasing food expenditure. The aim of this study was to quantify the types of athletes following a GFD and subsequently investigate the beliefs, experiences, recommendations and sources of information for GFDs and their prescription.

Methods: Athletes (n=922) were recruited via National Sport Institutes and social media outlets from Canada, the United States, Australia, Europe and Asia. A 17-question survey was delivered through Survey Monkey and included questions that addressed sport and level of competition, experiences and beliefs pertaining to a GFD and sources of gluten-free dietary information. Data were analyzed using SPSS.

Results: Survey results indicated that 40% of NCA respondents, including 10 Olympic medalists, follow a GFD 50%–100% of the time; however, only 14.5% of this was attributed to medical-related reasons, such as clinically diagnosed gluten-sensitivity or wheat allergy. Endurance sport athletes were most likely to adhere to a GFD (69% of respondents) with 25% following a GFD 100% of the time. Fifty-two% reported reduced gastrointestinal distress with gluten elimination. Athletes also believed a GFD favored athletic body composition (56%), exercise performance (34%) and reduced inflammation (44%). Symptom-based self-diagnosed gluten-sensitivity (19%) and non-symptom based GFD self-prescription (13%) were the most common reasons for adopting a GFD. The most prevalent source of GFD information was other athletes (37%) and online forums (38%). Sixty to seventy% of respondents believed that the adoption of GFD was associated with the consumption of less processed foods and more fruit and vegetables.

Discussion: The percent of NCA following a GFD (40%) was greater than the incidence of individuals in the general population than are estimated to benefit clinically from a GFD (~5–10%). The prescription of a GFD amongst athletes is not as a result of evidence-based or clinical practice, which suggests three possible rationalizations; 1) higher rates of gluten-sensitivity or undiagnosed coeliac disease in athletes, 2) athletes follow a GFD due to perceived physiological improvements that may coincide with other simultaneous dietary changes, or, 3) a potentially unidentified association between exercise stress, gut function and dietary gluten in NCA, which warrants further investigation.

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Introduction: Exercise may influence subsequent energy intake through a change in the circulating concentration of hormones that influence energy intake. The objective of this study was to investigate the impact of an acute bout of exercise at moderate (40% VO_{2max}) and high intensity (70% VO_{2max}) on post-exercise energy intake and energy balance hormones.

Methods: Ten active males (Age, 25±2 years; Body Mass Index, 24±1 kg·m²; maximum oxygen consumption, 61.2±2 ml·kg⁻¹·min⁻¹; resting heart rate, 59±2 beats·min⁻¹; total percent body fat, 17±2%; and physical activity level (total energy expenditure/resting energy expenditure), 2.3±0.1; mean±SE) participated in this study, which had local ethics committee approval. On two occasions participants performed a standardized bout of exercise at a target exercise intensity of 40% and 70% VO_{2max} until they expended 900 kcal. On another occasion they rested in the laboratory, each trial was separated by at least two weeks. Fasting venous blood samples were taken at regular intervals before and up to 48 hrs after rest or exercise. A buffet meal was provided one hour following rest or exercise. The data were analyzed using two way repeated measures ANOVA and paired t-test.

Results: Plasma acylated ghrelin concentrations immediately following high intensity exercise (49±14 pg/ml) were lower than after resting (109±16 pg/ml) and moderate intensity exercise (107±20 pg/ml; P=0.01). Total PYY concentrations immediately after exercise at 70% VO_{2max} (121±13 pg/ml) tended to be greater than 40% VO_{2max} (93±12 pg/ml) and resting (83±12 pg/ml). Serum leptin concentrations were not different between trials. There was no difference in absolute energy intake during a buffet meal following moderate or high intensity exercise.

Discussion: Circulating plasma acylated ghrelin concentrations were suppressed while plasma total PYY concentrations tended to increase immediately following high intensity exercise compared with resting and moderate intensity exercise. However, the impact of acute exercise on plasma acylated ghrelin and total PYY was short-lived and did not appear to alter energy intake and appetite during a subsequent buffet meal.

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Introduction: The effect of food restriction on physiological response still unclear. Reduction in energy intake might affect on appetite, body composition, and physical performance in sedentary males. Therefore, the objective of this research was to investigate the impact of three days food restriction on appetite hormone, body composition, muscle strength, reaction time, subjective feeling of hunger and rating of perceived exertion in young sedentary males.

Methods: Twelve sedentary males age between 19 and 22 years participated in this study, which had been approved by the local ethics committee (body mass index, 24±5 kg/m²; percent body fat, 18±8%; percent fat free mass, 82±8%; resting heart rate, 74±9 beat/min; systolic/diastolic blood pressure, 126±11/66±6 mmHg; maximum oxygen consumption, 39±6 ml/kg/min; mean±SD). This experiment was cross-over design with two main trials separately by at least 14 days. Participants reduced their daily energy intake approximately 50% for three days. Body composition, muscle strength, reaction time, subjective feeling of hunger as well as rating of perceived exertion were measured before and after in control and food restriction trials. Fasting total peptide YY (PYY), creatine kinase and triglyceride concentrations were assessed at the same period of time. The data were analyzed using two way repeated measures ANOVA and paired t-test.

Results: Total body fat free mass (control: 57.2±8.2 kg; food restriction: 55.7±8.0 kg, $P<0.05$) decreased significantly following 50% of food restriction. Body weight and total body water following food restriction tended to be lower than control. In addition, subjective feeling of hunger tended to increase at 24 and 48 hrs following food restriction. However, there was no change in circulating total PYY concentrations, triglyceride concentrations, creatine kinase concentrations, rating of perceived exertion, muscle strength, muscle mass, fat mass and reaction time. Discussion: A decreased 50% of daily energy intake for three days induced decreased in total fat free mass and it might related to the reduction in body weight as well as total body water. Although subjective feeling of hunger tended to increase after food restriction but there was no change in appetite hormone such as PYY after food restriction. Moreover, there was no affect of 50% food restriction on circulating triglyceride concentrations, creatine kinase concentrations fat mass, muscle mass, reaction time and muscle strength in sedentary males.

157 Measurement of dehydration status among collegiate athletes following assorted exercise training

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Introduction: Temperature regulation, thermal and cardiovascular strain, and heat tolerance during sport specific training in warm to hot conditions could directly be modulated by hydration status. However, it remains unclear whether collegiate athletes have knowledge and strategies of optimal fluid intake in sport specific training conditions. The purpose of this study was to assess hydration status associated with fluid intake behavior and patterns for collegiate athletes in different modes of habitual exercise training.

Methods: A total of fifty nationally ranked collegiate athletes were recruited from four different sport clubs (men's soccer, n=13; men's kendo, n=12; women's handball, n=12; women's basketball, n=13) as a category of intermittent exercise. Spot urine was collected within 10 minutes before (Pre) and after (Post) each training session over three consecutive days (Day 1, Day 3, and Day 5) which was randomly chosen for each sport club. A representative value for each sport club at Pre and Post was expressed as a mean value of three consecutive days. Each subject was allowed to drink water ad libitum during each training session over three consecutive days. Exercise training session per day lasted approximately 3 hours for each club. For analysis of hydration status, urine specific gravity (Usg) was determined using a handheld refractometer.

Results: In terms of urine specific gravity, a two-way analysis of variances (ANOVA) showed significant main effects of time before and after training session in men's soccer (Pre=1.021±0.007, Post=1.024±0.006 g/mL, $p<0.05$), men's kendo (Pre=1.021±0.008, Post=1.027±0.007 g/mL, $p<0.05$), women's handball (Pre=1.025±0.005, Post=1.027±0.004 g/mL, $p<0.05$), and women's basketball (Pre=1.023±0.008, Post=1.027±0.005 g/mL, $p<0.05$), whereas no significant main effects of day or interactions were found in each club.

Discussion and Conclusions: The results of the present study suggest that there appears to be a trend for collegiate athletes to be dehydrated even when they take sufficient water fluid. In other words, it is possible for athletes to have insufficient electrolytes such as sodium (which retains water in the body) even when they take plenty of water during exercise training. To minimize fluid deficits, ad libitum consumption of a carbohydrate-electrolyte fluid intake can be more effective than water.

158 Mitochondrial DNA haplogroups associated with elite Chinese athlete status

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Introduction: previous studies have suggested an association of mitochondrial DNA (mtDNA) haplogroups with athletic performance. Because of the regional and populational specific characteristics of mtDNA haplogroups, it is necessary to probe into the distribution of mtDNA haplogroups of different populations to get the special profile of them respectively.

Methods: We conducted a population-based study of 185 elite Chinese athletes of Northern Han (95 endurance athletes and 90 power athletes) as the case subjects, and 92 Chinese college students of Northern Han at the similar age randomly collected as controls. All the athletes participated in Olympic Games on behalf of China. Total DNA was extracted from blood with a DNA extractor Kit (Promega Co.USA). According to Anderson mtDNA sequence in Gene bank, the primers were designed. The PCR products (449bp special segment) were directly sequenced. We classified the mtDNA haplogroups of all subjects, calculated the frequency of every mtDNA haplogroup and examined the frequency differences between athletes and controls. The results show the endurance athletes have a statistically significant excess of haplogroup M7 (OR 4.703, 95% CI 1.29 to 17.10, $p=0.011$), with 13.68% compared with 3.26% in controls, and the controls have a statistically significant excess of haplogroup B (OR 0.378, 95% CI 0.14 to 0.97, $p=0.037$), with 17.39% compared with 7.37% in the endurance athletes.

Discussion: These data suggest mtDNA haplogroup M7 is positively associated with endurance athlete status, indicating this haplogroup or some polymorphic sites of it could influence aerobic capacity. Haplogroup B is negatively associated with endurance athlete status, meaning people of this haplogroup are disadvantageous in aerobic exercises. No haplogroups were found to be associated with power athlete status.

159 Oral contraceptive use for manipulation of menstruation in active women and competitive female athletes

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Introduction: Little is known regarding the oral contraceptive (OC) habits of physically active females, in particular whether OC is used to manipulate the menstrual cycle (i.e. delay or reschedule menstruation). In previously presented data from this study, physically active females were more likely to avoid physical activity (PA) during menstruation and whilst experiencing menstrual symptoms. Therefore, extended OC regimes (i.e. skipping the period whilst on an OC by continually taking hormone) may be used to reduce the effect of menstruation and/or menstrual symptoms on PA and competitive sport. The aim was to investigate prevalence of and reasons for menstrual manipulation with OC in physically active and athletic women.

Methods: A convenience sample of 200 active (PA>150 min/wk) females (aged 21±4 years) and 50 competitive (state, national or international level) athletes (aged 22±7 years) completed a 32-page questionnaire assessing OC use, reasons for OC use and OC regime habits. In addition, frequency and reasons for manipulation of menstruation were explored. Participants rated importance of, and agreement to, statements on a five-point Likert scale.

Results: Prevalence of OC use was 57%. The majority (80%) of OC users reported skipping their period at least once during the previous year, with 28% reporting skipping their period two to three times. Skipping menstruation for at least three months in a row was reported by 40% of women. The most important reason provided for skipping menstruation was special events or holidays, with 79% rating it as important/very important. Additional important reasons for manipulating menstruation included convenience (64%), sport competition (41%) and sport training (32%). Competitive athletes reported a higher prevalence of OC use (71%). Prevalence of menstrual manipulation was similar in competitive athletes (84%) compared to physically active women. Competitive athletes noted that the most important reason for menstrual manipulation was sport competition (76%), with special events or holidays (73%) and sport training (56%) also rated as important/very important. Discussion: Menstrual manipulation or extended OC regimes are common practice in physically active and athletic females. Skipping menstruation for convenience was highly rated in active women but not competitive athletes; with competitive athletes competition and training were rated as more important reasons for skipping menstruation. These results indicate that menstrual manipulation is prevalent in physically active and athletic females however further investigation into whether manipulation reduces the influence of menstruation on PA and competitive sport is warranted.

160 Does oral contraceptive use influence physical activity participation among physically active women?

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Introduction: Little is known regarding oral contraceptive (OC) habits of physically active females, or whether OC use and menstrual symptoms influence physical activity (PA) participation. Given that OC use has been shown to reduce exercise capacity in highly trained and recreationally active females, the present study investigated OC use among physically active women.

Methods: A convenience sample of 235 active (PA>150 min/wk) females (22±4 years) completed a 32-page questionnaire assessing OC use, experience of side-effects and menstrual symptoms, experience of hormone-specific barriers to PA and impact on PA participation. Participants rated agreement to statements on a five-point Likert Scale.

Results: Prevalence of OC use was 60%. Of the 40% of women not using OC, 5% were using another hormonal contraceptive; 35% were not using hormone contraceptive and 65% had previously used OC. Just 2% of women using OC reported avoiding PA often/very often due to menstrual symptoms, compared with 20% of those not using OC. Only 10% of women using OC reported avoiding PA often/very often because of menstrual bleeding, compared with 40% of those not using OC. Only 2% OC-users felt that menstrual symptoms often/very often affected their ability to train compared to 40% of non-OC users. Of those using OC, 89% reported never/rarely reducing PA involvement due to menstrual symptoms, compared with 44% of those not using OC.

Discussion: The prevalence of OC use in active females was similar to previously reported use in Australian population surveys. Preliminary results suggest that women using an OC are less likely to avoid or reduce PA due to menstrual symptoms or menstrual bleeding compared to those not using an OC. Females not using an OC were more likely to perceive reduced capacity to exercise with menstruation or menstrual symptoms than OC users.

Conclusion: OC use potentially reduces the negative impact of female hormone-related barriers to PA.

161 Effects of menstrual cycle phase on skin conditions following intermittent exercise training

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Introduction: A better understanding of potential effects of menstrual cycle phase on skin conditions can provide appropriate strategies to prevent skin problems in advance. However, whether skin conditions following intermittent exercise training can be influenced by the menstrual cycle phase still remains unclear. The purpose of this study was to determine the effects of menstrual cycle phase on skin conditions following intermittent exercise training.

Methods: Eleven female nationally ranked collegiate basketball players (age: 19.0±1.1 year, height: 169.0±7.1 cm; body weight: 64.4±8.4 kg; BMI: 22.5±1.7 kg/m², body fat: 24.9±2.4 %) served as the subjects. Basketball training consisted of routine ball handling, shooting and other specialized drills. Each training session lasted 3 hours. All subjects performed identical training sessions between two menstrual phases.

Before and after (Pre and Post) basketball training sessions during the follicular (F: 6~10 days after the onset of the menses) and luteal (L: 5~9 days before the menses) phase, skin conditions of moisture balance, sebum (oiliness), and elasticity for all subjects were measured using the Triplesense® device (electrical capacitance) from Moritex USA (Blomeke et al. *Proceedings of the IEEE 3rd International Conference on Biometrics: Theory, Applications, and Systems: 375–378*, 2009). All results are expressed as mean values of the measurements (two consecutive days during each menstrual phase) conducted on three different sites (forehead, cheek, and chin).

Results: A two-way ANOVA showed a significant main effect of time was observed [(Skin moisture: Pre=65.3±13.0, Post=76.5±20.8 for forehead in F, Pre=61.2±24.2, Post=79.3±24.5 for forehead in L; Pre=67.2±20.3, Post=85.4±12.7 for cheek in F, Pre=70.7±19.7, Post=84.6±22.9 for cheek in L; Pre=67.6±19.1, Post=84.3±15.8 for chin in F, Pre=71.4±27.1, Post=83.3±19.1 for chin in L), (Sebum: Pre=20.4±17.7, Post=17.5±18.8 for forehead in F, Pre=15.4±11.8, Post=24.3±10.8 for forehead in L; Pre=18.6±10.2, Post=15.4±6.1 for cheek in F, Pre=18.2±8.7, Post=14.9±8.8 for cheek in L; Pre=25.6±13.3, Post=21.2±10.7 for chin in F, Pre=27.8±15.8, Post=17.4±9.1 for chin in L), (Elasticity: Pre=89.0±8.0, Post=87.9±7.3 for forehead in F, Pre=83.5±7.4, Post=82.2±12.2 for forehead in L; Pre=68.0±8.9, Post=53.7±22.1 for cheek in F, Pre=61.0±17.8, Post=61.4±19.3 for cheek in L; Pre=69.2±15.2, Post=60.2±17.7 for chin in F, Pre=68.1±16.8, Post=60.5±18.9 for chin in L, p<0.05)] before and after the basketball training session, but no difference across phase.

Discussion and Conclusions: Previous studies have shown the effects of menstrual cycle phase on skin conditions. The findings of the present study suggest that skin conditions such as skin moisture balance, sebum, and elasticity following intermittent exercise training appears not to be directly influenced by menstrual cycle phase.

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Introduction: There is limited information about how menstruation affects women's athletic/exercise performance. Cyclic hormone changes such as estrogen and progesterone can affect physical and psychological potentials including premenstrual syndrome, which may influence the performance. In this regard, the successfulness of free throw shooting as athletic performance in basketball may be influenced by menstrual cycle phase. However, whether menstrual cycle phase influences successfulness of free throw shooting is still unclear. The purpose of this study was to determine the effects of menstrual cycle phase on athletic performance based on successfulness of free throw shooting.

Methods: Thirteen eumenorrhoeic nationally ranked female basketball players (age: 19.6±1.0 year; height: 167.5±6.1 cm; body mass: 60.9±7.2 kg; body fat: 24.7±2.9 %; BMI: 21.6±1.4 kg/m²) served as the subjects. The free throws were taken from standard distance and to a hoop set at standard height from the ground. Free throw shooting trials were performed during the follicular (F: 6~10 days after the onset of the menses) and luteal (L: 5~9 days before the menses) phase. Each subject performed 10 free throw shots during four consecutive days for each menstrual cycle phase (10 shots x 4 successive days). A representative value of succeeded shots per day during each menstrual cycle phase was expressed as a mean value based on the calculation of 10 shots multiply 4 successive days divided by 4. Consequently, percentage of successfulness of free throw shooting was also calculated.

Results: Concerning succeeded shots, there were no significant differences (8.1±1.0 for F; 7.7±1.1 succeeded shots/10 shots for L). Similarly, no significant differences were also observed between two menstrual phases in terms of percent successfulness (79.7±8.6 for F; 77.2±10.5 % for L).

Discussion and Conclusions: Previous studies have argued the effects of menstrual cycle phase on athletic/exercise performance. Alterations in exercise performance during the menstrual cycle can be fluctuated. These results of the present study suggest that menstrual cycle phase may not directly influence successfulness of free throw shooting by trained basketball players.

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Introduction: Evaluating how the menstrual cycle phase influences various aspects of immune responses is necessary to understand comprehensive human responses to mentally and physically stressful conditions in women. Although previous studies have argued effects of menstrual cycle phase on mucosal immune function, exercise-induced immunosuppression (e.g., upper respiratory tract infection: URTI) over follicular and luteal phases still remain unclear. The purpose of this study was to determine the effects of menstrual cycle phases on the levels of salivary immunoglobulin A (S-IgA) and α -amylase in female basketball players.

Methods: Eleven eumenorrhoeic nationally ranked female basketball players (age: 19.0±1.1 year; height: 169.0±7.1 cm; body mass: 64.4±8.4 kg; body fat: 24.9±2.4 %; BMI: 22.5±1.7 kg/m²) served as the subjects. All subjects had no major medical problems, a normal menstrual history and no intake of any steroid contraceptives at the time of the study. Basketball training consisted of routine ball handling, shooting and other specialized drills. Unstimulated saliva samples were collected within 10 minutes before and after (Pre and Post) basketball training sessions during the follicular (F: 6~10 days after the onset of the menses) and luteal (L: 5~9 days before the menses) phase for analysis of S-IgA (a marker for the incidence of URTI) and α -amylase levels. Each training session lasted 3 hours. A representative result for each menstrual cycle phase was expressed as a mean value of two measurements (two consecutive days during each menstrual phase).

Results: In terms of S-IgA concentration, two-way analysis of variance (ANOVA) showed no significant main effects or interactions (Pre=8.7±4.9, Post=8.2±3.4 for F; Pre=8.1±3.5, Post=7.7±3.2 mg/dL for L) before and after the basketball training session. In contrast, ANOVA for salivary α -amylase activity demonstrated significant main effects of time (Pre=190.3±125.5, Post=319.0±148.4 for F; Pre=168.9±83.2, Post=297.3±149.2 U/mL for L, $p<0.05$). However, no differences across phase were apparent.

Discussion and Conclusions: Previous studies have reported exercise-induced immunosuppression affected by ovarian hormones such as estrogen and progesterone. The findings of the present study indicate that mucosal immune function may not directly be affected by menstrual cycle phase independent of salivary α -amylase activity reflecting sympathetic nervous function.

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Introduction: Synchronized swimming is a sport in which swimmers perform with high artistry and dynamism in a special environment both in and above water. For example, in a split movement, swimmers in an upside-down position vertically thrust their closed legs out of the water at a high speed, split their legs to an angle of $\geq 180^\circ$, close them instantaneously, and go underwater in a vertical direction. To accurately understand the physical functions of synchronized swimmers, the standard range of motion (ROM) and muscle power measurements alone don't appropriately consider the characteristics of the sport. Therefore, we conducted a study that aimed at establishing an alternative evaluation method unique to synchronized swimmers to evaluate the physical function typical of synchronized swimmers.

Method: We measured ROM and tightness in 21 synchronized swimmers. For ROM, movements of the shoulder, hip, and ankle joints were measured; in addition, the lengths of the pubic bone submerged movements unique to synchronized swimming including a split of the legs and shoulder girdle muscle were comprehensively measured. Tightness was evaluated by the straight leg raise test. The results were statistically analyzed with a significance level of 5%.

Results and Discussion: All ROM values were greater than the normal ROM of Japanese people. The items showing a left to right difference in flexion were horizontal adduction and external rotation of the shoulder joint and hip joint flexion (R 141.9°±13.5, L 138.9°±10.6), with the right leg SLR test showing greater (R 152.6°±13.7, L 145.0°±10.8). In a front split, the lengths of the pubic bone submerged movements in a right front split showed a significantly greater value than that in a left front split (R 6.0 cm±5.9, L 0.5 cm±5.7). In general, in sports involving a left to right symmetry, difference in the left to right ROM of the hip joint in female athletes could result in major disability such as congenital dysplasia of the hip joint; therefore, continuous evaluation is required. The left to right difference observed in a front split movement typical of synchronized swimming involved a hip flexion on one side and extension on the other side. Although a left to right difference in flexion was observed in this study, no left to right difference was observed in extension. To appropriately determine and evaluate the physical functions of synchronized swimmers for performance improvement and disability prevention, a method specifically evaluating movements unique to synchronized swimming needs to be established.

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The reliability of a linear position transducer to quantify measures of force and power during resistance exercise

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Introduction: Muscular force and power are recognised as important contributors to performance in many sport-specific actions. As such, coaches need to employ reliable monitoring tools during testing and training to quantify measures of force and power. Further, this also allows gains in strength and changes in the load-power relationship to be quantified. The current study aimed to investigate the reliability of a linear position transducer (LPT) to measure force and power during high-intensity resistance exercise.

Methods: Well-trained male strength athletes (N=10; age: 24.1 yr range 18–27; height: 179.4±6.8 cm; body mass: 86.0±12.8 kg) participated in the study. Prior to testing, subjects' 1-repetition maximum (1RM) values were quantified using a modified harness back squat (HBS) exercise in a Smith Machine. Subjects then visited the laboratory on two occasions, each separated by one week, to perform two sets of one repetition at 90%, 80% and 70% of 1RM, using the HBS. Subjects were instructed to complete each lift as explosively as possible, with force and power output being continuously recorded by a LPT. The first set was used to familiarize subjects with the load, and reliability analysis was only performed on the second set. Reliability measures of peak and mean force and power were represented by the coefficient of variation (CV) and intraclass correlation coefficient (ICC) between the corresponding sets across the two testing sessions.

Results: Measures of force and power across all intensities demonstrated high levels of reliability, with CV values of between 0.92–11.79% and ICC values between 0.80–1.00. More specifically, peak force and power at each exercise intensity demonstrated CV values of between 3.92–11.79% and ICC values ranging from 0.84–0.96. Separately, mean force and power values demonstrated CV values between 0.92–9.41% and ICC between 0.80–1.00. No notable differences were evident in the level of reliability across different exercise intensities.

Discussion: The current data demonstrates that LPTs are highly reliable in quantifying both peak and mean measure of force and power across various intensities of resistance exercise. These findings are in agreement with previous investigations that have demonstrated high levels of reliability using LPTs during explosive and jumping exercises. As such, the current findings demonstrate that LPT technology is capable of reliably monitoring measures of force and power during resistance training exercises, such as a controlled back squat.

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Forearm muscular activation: An indicator of archers' performance level

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Introduction: Earlier studies have defined a specific forearm muscular activation patterns during archery release. Estimation of the performance level of an archer by using forearm surface EMG data may be a method in experience evaluation in archery. The aim of the current study was to create some archery skill indexes that could be used in estimation of archers' performance levels by using forearm surface EMG data.

Methods: Three groups, i) elite (n=7, FITA score=1303.4±26.2), ii) beginners (n=6, FITA score=1152±9.0) and iii) non-archers (n=10, assumed FITA score=250±0), were involved in the study. Electromyographic (EMG) activity of the M. flexor digitorum superficialis and the M. extensor digitorum were quantified. Two-second periods –1 s before and 1 s after the fall of the clicker – were used to obtain averaged and rectified EMG data. The averaged and rectified EMG data were filtered by averaging finite impulse response filter with 80 ms time window and then normalized. EMG amplitudes were normalized with respect to Maximum Voluntary Contraction.

Results: To estimate FITA scores from EMG data, the following skill indexes that based on mean area under some parts of processed EMG waveforms was offered for archery: Pre-clicker Archery Skill Index (PreCASI), Post-clicker Archery Skill Index (PostCASI), Archery Skill Index (ASI) and Post-clicker Archery Skill Index 2 (PostCASI2). The correlations between rank of FITA scores and natural logarithms of archery skill indexes were significant for log (PreCASI): $r=-0.66$, $p<0.0008$; for log (PostCASI): $r=-0.70$, $p<0.0003$; for log (ASI): $r=-0.74$, $p<0.0001$; for log (PostCASI2): $r=-0.63$, $p<0.002$.

Discussion/Conclusions: It is concluded that archery skill indexes may be used for a) evaluation of archers' progress, b) selection of talented archers and c) improvement of archers' progress. Naturally, future researches will determine the application of archery skill indexes into practice.

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Is the contextual interference effect supported when practicing several skills in combination?

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Introduction: Previous studies addressing the contextual interference effect in applied sport settings have focused on multiple skills practiced independent of one another. However, in a typical game setting, several skills often need to be executed one after another in order to achieve a particular outcome. As such, the purpose of the study was to investigate the effects of three practice schedules located along the contextual interference continuum on the learning of combination skills.

Methods: A total of 68 undergraduate students with no prior experience in field hockey practiced three basic field hockey skills in combination for six practice sessions. Participants were assigned into either a low interference (blocked) or one of two high interference (random or game-based) practice schedules. Participants completed a pre-test, one acquisition tests and two retention tests and these tests consisted of a dribbling control test and push speed and accuracy tests. Data from the tests were analysed using a Split Plot ANOVA.

Results: Overall, all practice schedule groups improved dribble, push speed and push accuracy performance from pre-test to acquisition. In the retention phase, the results revealed that there were no differences between the high and low interference groups for all three measures.

Discussion: The results indicated that the amount of time spent on practice was sufficient for all groups to improve dribbling and pushing skills. However, practicing combination skills following a random or game-based schedule did not facilitate learning any more than practicing in blocked order. It is possible that the intra task difficulty of the field hockey skills provided the necessary interference to enhance learning. At the same time, the inter task difficulty coupled with a high interference practice schedule was too high for the random and game-based groups despite practicing the skills in combination in order to reduce inter task difficulty by chunking skills as one and to create a functional skill that resembled actual game situations. Therefore, the results suggested that when practicing skills from different motor programs in the field setting, the contextual interference effect was not supported, even when the skills were practiced in combination.

168 Effect of jumping coordination exercises on physical fitness and motor ability of nursery school children

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The decline in the physical strength and motor skills of children has become an issue of public concern in Japan. An approach to this problem receiving much attention is the use of coordination exercises designed to promote motor skill development. These exercises, involving dynamic motions using muscles of all parts of the body and providing various stimuli to sensory receptors, are important for toddlers and schoolchildren who are undergoing dramatic development of the nervous system, and are considered to be more effective when started at younger ages. This study, in a test-case program for introducing coordination exercises at a nursery school, evaluated 45 five-year-old nursery school children divided into two groups, one group performing conventional coordination exercises aiming at improving motor skills and the other group performing a new set of coordination exercises mainly consisting of jumping actions to produce more dynamic movements, and compared the improvement of motor skills between these groups. The results showed a higher rate of improvement in the group performing coordination exercises with more jumping actions. Analysis using a t-test demonstrated a significant difference at $P < 0.05$, and the inter-group differences in 20-meter dash (speed) and side step test (agility) were significant at $P < 0.01$. The results of our study support the effectiveness of these exercises in improving the physical fitness and motor skills of nursery school children.

169 Individual segment contribution towards ball velocity in elite ten pin bowlers

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Introduction: Research in segment contribution towards implement velocity and sequentiality has generated many findings that have contributed immensely to the knowledge base of a particular sport in terms of performance enhancement, training specificity and injury risk management. Among others, proximal to distal sequence patterns have been detected in a variety of throwing sports, including those with underarm movement but not as yet in ten pin bowling. The purpose of the study was to determine the individual segment contribution towards ball velocity and their sequence patterns in ten pin bowling.

Methods: A total of 18 elite bowlers (male=10, female=8; average score 213.2 ± 6.80 pin falls; ball velocity at release 8.00 ± 0.42 m/s) participated in the study. Kinematic data were derived from Kwon3D system with four 100Hz Basler cameras. Markers were placed at the hip, shoulder, elbow, wrist, hand and fingers. Peak velocities of the segment endpoints were recorded and reported as percentage of the ball velocity at release.

Results: The segment contribution towards the velocity of the bowling ball at release was described cumulatively as 37.4% from the lower body, 1.6% from the trunk, 46.8% from upper and lower arm, and 13.9% from the hand and fingers. There were no significant differences in terms of percentage of individual segment contributions between male and female bowlers. Qualitative assessment of segment linear velocity-time graphs showed a pattern of sequentiality, with the peak of the more distal segment occurring following the deceleration of the preceding proximal segment.

Discussion: It was summarised that a the majority of the final linear ball velocity in ten pin bowling stemmed from contributions of the walk during approach (37.4%) and the upper limbs (61.7%). However, unlike the findings of trunk contributions in the underarm and overarm throwing patterns of other sports, the trunk contribution in this study was negligible. It is possible that this difference was because bowling involves the use of an extremely heavy ball and the underarm pattern allows a preparatory phase for the ball to be lifted at heights and being allowed to freefall akin to a pendulum. From the potential-kinetic energy relationship and utilising the means of the elite bowlers, it was found that nearly the entire 61.7% upper limb contribution was attributed to gravity as opposed to being muscle driven.

170 Biomechanical analysis of the gliding and dolphin kick movement in competitive swimmers

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Introduction: The improvement of swimming performance is related not only to the effect of stroking but also dolphin kick movement after the start and the turn phase. The dolphin kick movement after the start and turn phases are important for the total race time in modern swimming. We hypothesized that acceleration by dolphin kick movement would assist to increase the swim speeds, consequently, swimmers need to keep a better body position and higher speed after optimal dolphin kick movement. The purpose of this study was to biomechanical analysis of the gliding and dolphin kick movement in competitive swimmers.

Methods: Six healthy male collegiate swimmers (age 19.7 ± 1.1 yrs, height 174.2 ± 5.2 cm, body weight 68.3 ± 3.6 kg, BMI 22.9 ± 1.8) volunteered to participate in this study. The subjects performed underwater gliding movement as fast as possible after the start wall kicking. During the underwater phase of gliding movement, the swimmers were to hold the streamlined position. In addition, dolphin kick movement performed by maximum effort. The subjects were monitored with an underwater video camera (SK-2130, SONY, Japan) with a sampling frequency of 60Hz in the sagittal plane to measure the angular displacement of their different joints. The wireless electromyography system (Biolog DL-5000, S&ME, Japan) was used to collect the muscle activities. All subjects received a written and verbal explanation of the study and gave their written informed consent for participation. Approval was granted from the institutional human ethics committee and the study was conducted in conformity with the Declaration of Helsinki for medical research involving human subjects. A motion analysis system (Frame-DIAS4, DKH, Japan) was used to digitize ten body landmarks. Results and Discussion: The swimming speed of the subjects showed that the highest speed was maintained during the gliding movement when the knee and the hip joint angles of 180 degrees were maintained from the push-off the wall to 0.8sec. On the other hand, the lower limb joints of the non-elite swimmer did not become straight. The main aim of this study was to analyse the gliding and dolphin kick movement in competitive swimmer and investigate whether the streamline of body could maintain the knee and the hip joint angles of 180 degree. During these phases, reducing underwater resistance force leads to the improvement of the swimming performance. The swimmer who maintained a superior streamline maintained the high velocity in the phase that the dolphin kick was performed.

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Biomechanical and neuromuscular impairments in FAI patients: A systematic review

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Introduction: Femoroacetabular impingement (FAI) is a common condition that can cause hip and/or groin pain in young active adults, plus give rise to stiffness, muscle weakness, reduced physical function and lower quality of life. It has also been proposed as a risk factor for early onset of hip osteoarthritis. Understanding the musculoskeletal impairments associated with FAI is critical in improving conservative management strategies. The purpose of the present study was to systematically review the literature to establish whether people with FAI demonstrate impairments and/or activity limitations compared to people without FAI.

Methods: Three electronic databases (Pubmed, CINAHL and SportDISCUS) were searched until the end of January 2013. Studies were included if: the population had symptomatic FAI diagnosed by clinical and imaging features; the comparison was either healthy controls, the asymptomatic contralateral limb of participants with symptomatic FAI, or the study group post-intervention; and the reported outcomes included a measure of impairment and/or activity limitation. Methodological quality was assessed by two raters using the Newcastle-Ottawa Scale.

Results: Eleven studies of moderate to high methodological quality fulfilled the eligibility criteria. Sample sizes varied between 10–37 participants. Seven studies were cross sectional with five of these including a comparison group of age and gender-matched controls and two using the contralateral hip in patients following total hip replacement. The remaining four studies used a pre/post design comparing the same group post-operative or post treatment. Follow up varied between 8–32 months. Outcome measures included biomechanical and neuromuscular factors assessed during various activities. Five studies evaluated hip range of motion (ROM) – two via computed tomography, three examined gait and two evaluated squatting – both via 3-D motion analysis, and one calculated maximum strength of the rectus femoris and tensor fasciae latae. Decreased frontal plane range of motion (adduction/abduction) at the hip was reported during the gait cycle. Other outcomes included a significant decrease in hip ROM in positions targeting impingement (flexion/ internal rotation), and decreased strength in the hip adductor and flexor muscles. Discussion: Results reported were inconsistent and limited due to the paucity of studies in this area. The scarcity of other outcome measures suggests that further research is needed to better characterise the range of impairments in individuals with FAI. Understanding these potential deficiencies will assist in the development of novel conservative management programs, such as targeted muscle rehabilitation, in order to better manage the condition.

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The biomechanical effects of cutting decision making on the lower extremity during a drop-landing

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Introduction: Female athletes' anterior cruciate ligament (ACL) injury rates are two to eight times higher than male. Investigations into non-contact ACL injuries suggest that many ruptures occur during a landing or side-cutting motion. The act of decision making is often present in most athletic competition. This decision making process during landing may alter the biomechanical procedures of the lower extremity which can possibly increase the risk of ACL injury. The purpose of this study was to determine the biomechanical effects of cutting-decision making in a female athletic during a drop landing.

Methods: Fourteen collegiate female recreational athletes (age: 21.4 years, range 19–24; height= 170 ± 4.1 cm, mass= 64.9 ± 5.4 kg) performed a drop landing (ht=0.5 m) with an anticipated right and left directional cuts (ADC). Next, the participants performed trials of unanticipated directional cut (UDC) in both directions as generated by random order. Three trials of all conditions were collected and the biomechanics of the dominant side were examined during cuts to the left. The lower body biomechanics of the dominant side were examined and compared between ADC and UDC. Three dimensional biomechanics data were recorded with 6 Vicon cameras (240 Hz) and two AMTI force plates (960 Hz). We compared UDC–ADC differences scores ($p < 0.05$) for lower-extremity joint kinematics and ground reaction forces (GRFs) using one sample t-tests. Confidence intervals (CI) at 95% level also were generated. Results: Less maximum knee flexion angle (4.42 ± 7.59) and displacement (4.51 ± 6.0) were exhibited by UDC, compared with ADC. Furthermore, at initial contact (IC), less hip and knee abduction angles (2.34 ± 2.84 , and 1.03 ± 1.22 , respectively) were exhibited during UDC. However, we found no significant difference in GRF.

Discussion: The unanticipated directional cut restricted knee maximum flexion and displacement. Furthermore, the frontal lower extremity alignments were restricted at IC. Consequently, the more extended knee and hip landing position may associate with ACL injury risk. However, the GRFs showed non-significant differences among the variables (Peak vertical GRF, time to peak vertical GRF, and medial GRF).

Conclusions: The kinematic changes displayed during UDC may cause an increase in stress on the knee joint. However, the examined GRFs data does not show any significant difference between conditions. We see that a reactive decision making process may put the ACL at greater risk based on our kinematic results.

173 The drugs in sport project: A comprehensive educational approach

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Drug use is not a new thing in sport, be it for enhancing performance or in social settings outside the competitive environment. While the use of performance enhancing drugs was previously considered the domain of elite sport it is now an issue across all levels of sport including junior competition. Similarly the use of illicit and social drugs has digressed from its amateur sport boundaries and is now problematic at elite level. Sports Medicine Australia (WA Branch) and the Department of Sport and Recreation of Western Australia have developed the Drugs in Sport Project. The principle aim of the Drugs in Sport Project is to raise awareness, provide information and address drugs in sport issues for the active community in Western Australia. The project provides education to the general sporting community including education institutions, club athletes and support personnel through to the elite sporting community at both State and National levels. The Drugs in Sport Project incorporates a comprehensive approach and addresses all categories of drug use from legal social drugs (particularly alcohol) through to the illicit and performance enhancing drugs. Sports Medicine Australia (WA Branch) has a close working relationship with the Australian Sports Anti-Doping Association (ASADA) and uses ASADA information to implement the anti-doping education component of the Drugs in Sport Project. The project utilises a range of strategies including face to face presentations to both the elite and community level sporting groups, development of educational resources and the formation of the Be Drug Free website. Other strategies include e-newsletters, development of an online education module and specialised school workshops mapped to current Health & Physical Education K-10 drug education curriculum. The project also aims to facilitate the implementation of appropriate drugs in sport policies at all levels of sport.

174 The effects of a physical warm-up on cognitive performance

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Introduction: The relationship between cognitive performance and exercise intensity has previously been shown to follow an inverted-U trend. Previous research has highlighted the relationship between cognitive performance and exercise, however no studies have examined the benefits of a physical warm-up on cognitive function. The purpose of this research was to compare cognitive performance during the Eriksen Flanker task, prior to and following a physical warm-up.

Methods: Seven team-sport officials (mean age: 33.9 years, range 29–42 years, height: 179.3 cm±7.6 cm, weight: 79.1±8.2 kg) participated in the current study. The Eriksen Flanker task consists of three coloured circles horizontally displayed on a screen in front of the participant. Participants are required to give either a left (blue [B], green [G]) or right (red [R], yellow [Y]) hand response according to the colour of the middle circle. The visual stimuli were categorised according to the level of difficulty, being either congruent ([CO]: all circles identical [eg. BBB]); stimulus-incongruent ([SI]: flanker circles different colour but same response to middle circle [eg. GBG]) or response-incongruent ([RI]: flanker circles different colour and different response to middle circle [eg. RBR]). The test lasted 1 min, consisting of 15 images, each which was presented for 1.5 s. The physical warm-up protocol lasted 10 min and consisted of 5 min of running (7 km·h⁻¹), followed by 3 min of dynamic exercises and 8x30 m efforts at increasing intensities (2x70%, 2x80%, 2x90%, 2x100% of maximal sprint speed), with a 30 m walk between repetitions. All running was completed on a non-motorised treadmill. Paired sample T-tests examined differences in the Eriksen Flanker response times across the warm-up.

Results: Response time significantly improved ($P<0.001$) following the physical warm-up protocol by 8±6% (pre: 672±197 ms; post: 617±157 ms). Specifically, the response time of the more difficult tasks showed significant improvements post warm-up (SI: 11±10%, $P<0.01$; RI: 12±7%, $P<0.01$). No significant improvements in response time were identified in CO stimuli (3±1%, $P>0.05$). Accuracy was 100% in all tests.

Discussion: The use of a physical warm up is typically used by team-sport officials in preparation for match-play, however the current data demonstrates surprisingly significant cognitive benefits. More difficult stimuli demonstrated greater improvements following the warm-up protocol. Whilst there were no changes in response accuracy between tests, there was significant improvement in the response time, which further supports the relationship between cognitive functioning and exercise-induced arousal.

175 Figuring sport

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Introduction: The world of exercise and sport is filled with interesting information, some simple and some quite complex. A large amount of this information is numerical, and it has been said that “if you cannot measure it, you don’t know the half of it”. My underlying theme therefore is that the numbers can and do tell a story, and my task will be to improve your “reading age” (i.e. your analytic numeracy level) through selected illustrative examples.

Methods: To get you figuring I will begin with a very simple question: “Is the standard triathlon fair between the three disciplines involved?” This isn’t simply a “Yes” or “No” question. You could say the obvious answer is “No” and that to make it fair, since you cycle 40km, you should logically also run 40km and swim 40km! Though undeniably logical, you may not accept this suggestion. The real question therefore is obviously about how you measure “fairness”. I will move on through several other numerical issues, like how little some so-called experts really appear to know. For example I recently heard a well-known international rugby commentator say last season that he expected the Stormers to win their Super14 match in Cape Town that weekend as they had such a large home advantage. The facts of the matter are that an analysis of the preceding six years of all games played by the Stormers reveals that they actually exhibit a negative home advantage! I will conclude with two illustrations of more informative and scientific substance, like modelling processes in exercise physiology and sport performance. For example if we make some simple hypotheses about energy delivery to the working muscles, can we accurately predict an athlete’s performance?

More interestingly, and with some other assumptions, if we know how much training an athlete undertakes over a training schedule, can these numbers be used to predict future performance? It turns out that the answer to both these issues is “Yes; reasonably well”.

Conclusion: The thrust here is that appropriate measurements well interpreted, together with a good model, inform us about how the real system may work, and once we know that, we can start manipulating the system to our advantage.

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Introduction: Determination of a young person's aerobic fitness is important to monitor training or interventions and to identify those at increased health risk. Direct measurement of maximal oxygen uptake (VO_{2max}) requiring exercise to volitional exhaustion is considered most accurate, but the protocols are complicated and expensive, making it less feasible for large population-based testing (e.g. school environment) and poorly tolerated by some individuals. Because of these limitations, many equations to predict maximal oxygen uptake from submaximal exercise tests have been proposed for young people, but the composition and accuracy of these equations vary greatly.

Methods: A systematic review of the literature was undertaken. MEDLINE, Embase, CINAHL, SportDiscus and Scopus electronic databases were searched for peer-reviewed English language papers which reported the accuracy of submaximal exercise-based equations to predict the VO_{2max} validated against VO_{2max} measured directly using gas analysis via a maximal exercise test in apparently healthy young people (<18 yrs).

Results: A total of 18 articles were retained from the systematic search strategy, resulting in 22 different predictive equations. The accuracy of the equations to predict maximal oxygen uptake ranged from $r=0.65-0.93$. The studies used different submaximal exercise tests to develop the equations: eleven used walking/running tests; three used bicycle ergometer tests; three used step tests; and one used a combination of all three test types. Nineteen predictive equations included socio-demographic (e.g. age and gender) and/or anthropometric (e.g. height, weight, sum of skin folds) variables in addition to variables derived from the submaximal exercise test.

Discussion: Various equations to predict maximal oxygen uptake from the results of submaximal exercise tests have been validated for use on young people. Submaximal exercise-based VO_{2max} prediction is potentially safer and better tolerated by clinical populations such as obese young people, and cheaper and more feasible for large-scale testing. When selecting the most appropriate predictive equation, the accuracy of the predictive equation, the type of submaximal test used and the additional variables required should all be considered.

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Introduction: In the areas of sport and rehabilitation sciences, 3D motion analysis is recognized as a useful tool to analyze complex movements and to compare the outcomes of different interventions. Hip joint centre (HJC) localization plays an essential role in human gait analysis. Inaccuracies in HJC location affect calculated hip and knee joint moments, force- and moment-generating capacity of muscles and hip contact forces, which can lead to incorrect interpretations and recommendations. The purpose of the current review was to evaluate the evidence describing the accuracy of different approaches to estimate the HJC.

Methods: A systematic search was undertaken of computerized databases, including Medline, CINAHL, EMBASE, Web of Science, and the Cochrane Library. Papers were included if they were related to 1) 3D motion analysis with 2) any report of accuracy, reliability or validity in the context of the estimation or calculation of human HJC, 3) full papers and 4) published in English. Quality of literature was evaluated based on a previously established customised quality assessment tool.

Results and Discussion: Following the application of inclusion/exclusion criteria, 33 full manuscripts were identified for inclusion in the systematic review. Meta-analysis of the results was not considered to be appropriate due to diversity of studies (*in vivo*, cadaver, simulation, mechanical linkage, and theoretical studies) and the large number of different functional and predictive methods. The geometric sphere fit (GSF) method and Harrington equation were the most accurate functional and predictive approach respectively. Multi-plane movement trials with at least 60° of flexion-extension and 30° of ab-adduction range of motion are suggested when using functional methods. Predictive or functional methods localize the HJC to within 25 mm error. Three dimensional ultrasound (3DUS) is a new approach to estimate the HJC and has an accuracy of 7 mm error. Computed tomography (CT) and magnetic resonance imaging (MRI) are the current used gold standard and locate the HJC to within 2 mm error. **Conclusions:** CT and MRI techniques are the most accurate methods for the estimation of the HJC. However, these methods are not used in routine gait analysis due to high costs, exposure of radiation and long post-processing time. 3DUS has the potential to become the new gold standard for the estimation of the HJC. If no 3DUS device is available, the GSF method should be used in people with sufficient hip ROM and the Harrington equation should be used in individuals without sufficient hip ROM.

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Introduction: It is generally accepted that there is a correlation between swimming velocity and physiological responses such as oxygen uptake (VO_2) and blood lactate concentration (Bla). Previous studies suggested that stroke parameters such as stroke length (SL) and stroke rate (SR) could be a good indication of swimming efficiency. The purpose of the present study was to investigate the effect of swimming velocity on physiological responses and stroke parameters in competitive swimmers.

Methods: All experimental measurements were conducted in a swimming flume using crawl stroke. The highly trained competitive swimmers performed an intermittent progressive test, which consisted of a 4 minutes swimming trial and a 5 minutes rest period. The swimming velocity was started at 50 % of each swimmer's 200 m personal best. The velocities were increased by 5 % at each trial up to exhaustion. SL and SR were measured from 30 seconds for the last 2 minutes of each trial using a video camera. Bla was taken from a fingertip immediately after completion of each trial. An automatic breath gas analyzer with a 10 seconds sampling rate was used to examine the expired gas continuously during the intermittent progressive test to measure VO_2 at each trial and VO_{2peak} at exhaustion.

Results and Discussion: Associated with an incremental swimming velocity, SR increased exponentially. On the other hand, SL increased and decreased with an incremental swimming velocity, there was SL peak point (SLPP) for all subjects. There were significant correlations between velocity at SLPP and velocity at OBLA (blood lactate concentration at 4 mmol/L), and between velocity at SLPP and VO_{2peak} . However, there was no significant correlation between velocity at SLPP and velocity of 200 m personal best. These results suggested that velocity at SLPP were highly corresponded to the endurance capacity. Consequently, the velocity at SLPP would be an effective index of endurance training intensity.

179 Force measurement of sweeping on ice in Curling

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Introduction: Curling is a game where two teams of four players each slide stones down a sheet of ice toward a target circle at the far end. Curlers often strongly sweep the ice in front of the sliding stone in order to correct the speed or the trajectory of the stone thrown in the games of curling. So far we have advanced development of a device for measuring the forces exerted on the brush during the sweeping. In this study, we attempted to measure the force during the sweeping on the sheet of ice using a wireless system and to confirm whether individual differences can be clarified in sweeping performance.

Methods: Eight subjects volunteered to participate in the study. They were two female and six male varsity curlers with one to ten years of curling experience. A commercially available curling brush was used to develop the device in the study. It consists of a head and a shaft with a joint combined to it. A Load cell was built in the brush shaft to detect the forces in the direction of the shaft axis and the direction perpendicular to it. The signals from the load cell were transmitted through the wireless system and digitized and sampled by the A/D converter at the rate of 200 Hz. Resultant force was calculated from the forces in the two directions as the force exerted on the ice. Subjects swept the ice in front of the sliding stone using the brush three times. They were instructed to sweep with maximum efforts for approximately 10 sec at a time. Force data for each trial were averaged for 10 sec. One-way ANOVA was used to determine significant differences between the subjects. The p-value was considered significant when it was found to be less than the usual level of significance 0.05.

Results: Mean values and SD of the 10-sec averaged force exerted during the sweeping were 205 (63) N in total. There were significant differences in the averaged force between the subjects ($p < 0.01$).

Discussion: The results demonstrated that the device in the study enables the force measurement during the sweeping on the sheet of ice in curling. It was confirmed that the data obtained from the device shows the individual difference in sweeping performance. The device may provide useful information for evaluating curlers' sweeping performance and for their physical training.

180 Evaluation of mucosal immune function following habitual handball training in female collegiate players

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Introduction: The measurements of salivary parameters can provide a simple and non-invasive means of evaluating the physiological responses during intense training of elite athletes in various sports during intense training, competition and recovery periods. Although handball is one of the most intense intermittent sports, whether there are cumulative effects of long-term intense training on mucosal immune function (e.g., upper respiratory tract infection: URTI) still remains to be clarified. The purpose of this study was to investigate the cumulative effects of the initial stage of training programs on mucosal immune function in female collegiate handball players.

Methods: Twelve female collegiate handball players served as the subjects [age: 20.2 ± 0.9 year, height: 159.5 ± 6.4 cm, body weight: 59.5 ± 8.7 kg, BMI: 23.3 ± 2.6 kg/m², Body fat: 25.1 ± 3.9 % (mean \pm SD)]. Within the overall annual training period, the initial stage of training was chosen to clarify the cumulative effects of S-IgA concentration. Daily handball training lasted a total of three hours per day and each day of training was consistent. The details of the training program consisted of 30 minutes of warm-up exercise (stretching, footwork, passing and shooting) and two hours of skill training and games with 10 minutes of rest, followed by 20 minutes of cooling down exercises. On Days 1 (the beginning of training program), 5, 10, 13 and 17, unstimulated salivary samples were collected at the 10-minute period before and after the daily training. Consequently, salivary immunoglobulin A (S-IgA), a marker for the incidence of URTI was analyzed by turbidimetric immunoassay.

Results: In light of S-IgA, two-way (time \times phase) analysis of variances (ANOVA) revealed no significant main effects or interactions (Pre: 7.2 ± 4.5 , Post: 7.0 ± 3.7 for Day 1; Pre: 6.6 ± 1.9 , Post: 7.9 ± 2.4 for Day 5; Pre: 7.9 ± 2.9 , Post: 10.7 ± 3.8 for Day 10; Pre: 9.1 ± 3.5 , Post: 9.8 ± 3.9 for Day 13; 9.4 ± 3.3 , Post: 9.4 ± 3.3 mg/dL for Day 17).

Discussion and Conclusions: Previous studies have argued the effects of long-term intense exercise on mucosal immune function in variety kinds of sports events. However, whether habitual training programs in female handball players induce cumulative effects has not yet been examined. The results of the present study suggest that there appears to be low incidence of URTI on the initial stage of the training regimen. In addition, these findings regarding S-IgA levels can provide information to assess exercise intensity and overtraining.

181 Effects of habitual handball training on urinary albumin excretion in female collegiate players

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Introduction: Handball is considered a vigorous intermittent sport that places a psychological and physiological stress on players. The findings of the previous studies with regard to exercise-induced albuminuria draw attention to its usefulness as a biomarker in assessing exercise intensity and overtraining. The purpose of this study was to investigate the cumulative effects of the initial stage of training programs on urinary albumin levels in female collegiate handball players.

Methods: Twelve female collegiate handball players served as the subjects [age: 20.2±0.9 year, height: 159.5±6.4 cm, body weight: 59.5±8.7 kg, BMI: 23.3±2.6 kg/m², Body fat: 25.1±3.9 % (mean±SD)]. The initial stage of training was chosen to examine the cumulative effects of urinary albumin excretion within the overall annual training period. Daily handball training lasted a total of three hours per day and each day of training was consistent. The details of the training program consisted of 30 minutes of warm-up exercise (stretching, footwork, passing and shooting) and two hours of skill training and games with 10 minutes of rest, followed by 20 minutes of cooling down exercises. On Days 1 (the beginning of training program), 5, 10, 13 and 17, spot urinary samples were taken at the 10-min period before and after the daily training for the later analysis of urinary albumin and total protein levels. The urinary albumin and total protein levels were analyzed by turbidimetric immunoassay and a pyrogallol red method, respectively. Results: Concerning urinary albumin levels, two-way (time x phase) analysis of variances (ANOVA) revealed significant main effects of time (Pre: 8.6±5.2, Post: 41.9±37.5 for Day 1; Pre: 7.7±6.3, Post: 38.5±66.7 for Day 5; Pre: 12.4±22.0, Post: 46.9±52.7 for Day 10; Pre: 7.8±6.4, Post: 52.1±34.3 for Day 13; Pre: 13.8±20.1, Post: 53.4±52.0 mg/g creatinine for Day 17, p<0.05), whereas no significant effects of phase or interactions were observed. Urinary total protein levels also demonstrated similar significances to urinary albumin excretion. Discussion and Conclusions: Previous studies have shown the elevated urinary albumin excretion following different kinds of sports events. However, whether habitual training programs in female handball players induce cumulative effects of urinary albumin excretion has not yet been elucidated. These findings of the present study indicate that there would be no cumulative effects of urinary albumin excretion influenced by the initial stage of the training regimen.

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Effects of repeated short-term futsal practice games on urinary catecholamine levels

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Introduction: Catecholamines have been known as an index of sympathetic nervous function, usually acting as a trigger for the adaptation of physical systems to the demands of exercise. A futsal game has high physical demands, which are known to act on stress hormone levels such as catecholamines. The non-invasive measurement of urinary catecholamines may offer a more suitable index than altered plasma catecholamines in sympathetic-adrenal activity during vigorous intermittent exercise in futsal-specific condition. The purpose of this study was to determine the effects of repeated bouts of short-term futsal games on urinary catecholamine levels.

Methods: Nine recreationally active male futsal players served as the subjects (age: 19.4±0.7 year; height: 170.0±4.4 cm; body mass: 61.7±7.6 kg; body fat: 15.5±5.1 %; BMI: 21.3±2.1 kg/m²). The protocol was composed of 5 minutes of warm-up, six 7-minute periods of game with 1 minute of rest, and cool-down. Spot urinary samples were obtained before (Pre) and after (Post) overall session for the later analysis of the urinary catecholamine levels (epinephrine, norepinephrine and dopamine). The urinary catecholamine levels were analyzed by high-performance liquid chromatography.

Results: A Student's t-test represented a significant elevation at the levels of urinary free norepinephrine (Pre: 97.7±57.7; Post: 432.9±190.0 µg/L, p<0.05) and epinephrine (Pre: 18.1±9.8; Post: 65.9±29.0 µg/L, p<0.05) except for dopamine (Pre: 572.9±245.4; Post: 1341.6±639.2 µg/L) after exercise. Significant changes were found at the levels of urinary total protein after exercise compared to the baseline (Pre: 6.0±8.2; Post: 26.9±27.9 mg/dL, p<0.05).

Discussion and Conclusions: Previous research has reported augmentation of urinary catecholamine levels following intermittent exercise. Thus, the concentration of urinary catecholamine may provide information about the psychological and physiological stress levels of athletes during training and competition. The results of the present study indicate that elevated urinary catecholamine levels may be useful to comprehensively understand exercise intensity during repeated bouts of futsal-specific intermittent exercise.

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Evaluation of hydration status based on urine specific gravity and urine osmolality in male collegiate players following soccer training

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Introduction: Attempts to assess hydration status have been conducted in a variety of situations for a number of years. In the later stages of a soccer game, dehydration has often been suggested as a factor responsible for the development of fatigue. However, it remains to be clarified whether game-induced dehydration is a cause of fatigue, or merely a single characteristic outcome of exercise controlled by a complex metabolic system. The purpose of this study was to determine the effects of habitual soccer training on hydration status in male collegiate players based on two types of non-invasive methods.

Methods: Fifteen male collegiate soccer players (age: 19.5±1.4 year, height: 173.2±5.9 cm; body weight: 67.0±7.6 kg; BMI: 22.6±1.8 kg/m², body fat: 11.6±3.6 %) served as the subjects. The soccer training consisted of routine ball handling, shooting and other specialized drills. Spot urine was collected within 10 minutes before (Pre) and after (Post) each training session over three consecutive days (Day 1, Day 3, and Day 5). For analysis of hydration status, urine specific gravity (Usg) and osmolality (Uosm) were determined with a handheld refractometer and osmometer, respectively. Each training session lasted approximately 3 hours.

Results: A two-way analysis of variances (ANOVA) showed significant main effects for time before and after the soccer training session (Usg: Pre=1.020±0.007, Post=1.025±0.006 for Day 1; Pre=1.022±0.005, Post=1.023±0.006 for Day 3; Pre=1.020±0.009, Post=1.023±0.006 g/mL for Day 5, p<0.05; Uosm: Pre=774.0±198.8, Post=872.5±161.3 for Day 1; Pre=826.7±155.7, Post=798.3±197.6 for Day 3; Pre=720.9±268.3, Post=789.0±167.6 mOsm/kg H₂O for Day 5, p<0.05), but no difference across days in Usg or Uosm. Moreover, linear regression analysis of the present data demonstrated a significant correlation between Usg and Uosm.

Discussion and Conclusions: Measurement of urinary markers to evaluate hydration status is considered to be inexpensive and requires minimal expertise from the technician. In line with that, measurement of Uosm can be used interchangeably with Usg, opening this as another potential marker to evaluate hydration status. These findings indicate that non-invasive measurements of Uosm as well as Usg could be applicable to the soccer-specific field conditions with regard to hydration status over three consecutive days of intermittent soccer training.

Can urinary 5-hydroxyindoleacetic acid (5-HIAA) levels following endurance exercise be a potential biomarker for brain glycogenolysis in humans?

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Introduction: Brain glucose has been known as a critical energy source for brain activity. The 5-Hydroxyindoleacetic acid (5-HIAA) levels are metabolites of tryptophan-derived 5-hydroxytryptamine (5-HT), which increases in the cortex during exercise. In this regard, 5-HIAA has been proposed as a biomarker involved in degradation of the brain glycogen levels in animal models (Matsui et al., *J Physiol*, 589: 3383–3393, 2011). However, whether prolonged exercise with and without carbohydrate-electrolyte solution influences the urinary 5-HIAA levels in humans still remains to be elucidated. The purpose of this study was to examine the effects of 2 hours of prolonged cycling exercise with and without carbohydrate-electrolyte solution on urinary 5-Hydroxyindoleacetic acid (5-HIAA) levels in moderately trained individuals.

Methods: Eleven moderately trained male collegiate cyclists (age: 19.5±1.3 year; height: 171.1±3.9 cm; body mass: 68.2±13.5 kg; body fat: 23.2±3.9 %; BMI: 23.2±3.9 kg/m²) served as the subjects. On two different occasions, each subject performed 2 hours of cycling exercise corresponding to a constant power output at 60%VO_{2peak}. After an overnight fast, all subjects drank either carbohydrate-electrolyte solution (CHO) (glucose: 62 g/L, Na⁺: 49 mg/dL; K⁺: 20 mg/dL; Ca²⁺: 2 mg/dL; Mg²⁺: 0.6 mg/dL) or water placebo (WP)(Na⁺: 0.53 mg/dL; K⁺: 0.05 mg/dL; Ca²⁺: 1.20 mg/dL; Mg²⁺: 0.28 mg/dL, pH: 6.8) immediately before cycling and every twenty minutes thereafter (2 ml/kg body weight). Spot urinary samples were obtained at the 10-min period before (Pre) and after (Post) 2 hours of cycling exercise corresponding to constant power output at 60% VO_{2peak} for the later analysis of the urinary 5-HIAA levels. The urinary 5-HIAA levels were analyzed by high-performance liquid chromatography.

Results: A two-way (time x treatment) analysis of variances (ANOVA) showed no significant main effects or interactions (Pre: 7.4±2.7, Post: 10.6±6.6 for CHO; Pre: 6.5±2.2, Post: 10.1±5.5 mg/L for WP), whereas there was a trend for CHO to be lower than WP in terms of the percent increase related to urinary 5-HIAA levels before and after exercise.

Discussion and Conclusions: Previous studies have demonstrated that increased 5-HT and 5-HIAA levels in the brain could serve as indicators of central fatigue during exercise. These results of the present study indicate that the urinary 5-HIAA levels following endurance exercise may be a potential biomarker for brain glycogenolysis in moderately trained cyclists.

Effects of continuous ascending steps on salivary α-amylase and IgA levels

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Introduction: Climbing stairs is an ideal physical activity to augment additional energy expenditure throughout the day as it is easy for people to find opportunities for climbing. Although previous studies have shown physiological responses of stair climbing, there was limited data concerning climbing-induced immunosuppression.

The purpose of this study was to explore the effects of climbing ascending steps on salivary α-amylase (a potential marker for psychological and physiological stress) and immunoglobulin A (IgA; a marker for upper respiratory tract infection: URTI) levels.

Methods: Twelve recreationally active men (age: 21.1±0.9 year; height: 166.4±5.6 cm; body weight: 61.0±7.3 kg; body mass index: 22.0±2.3 kg/m²; body fat: 17.4±6.1 %) served as the subjects. Stair climb trials were completed on a shrine access stairway (leading up to a Japanese famous shrine called Kotohira-gu) consisting of 786 steps (each step averaged approximately 15 cm in height). A stair climb trial was undertaken based on a single step ascent (ascending one stair step per stride). All subjects were accompanied by the investigator to assure compliance with outlined protocol and to record ascent duration. Each subject was fitted with a heart rate monitor and instructed to ascend at a constant pace of their choice so long as it was not too quick to elicit bounding. Moreover, they were instructed not to use handrails or place their hands on their thighs. The duration of ascent of the stairway used for the present study averaged 26.9±0.8 minutes. Unstimulated saliva samples were obtained at the 10-min period before (Pre) and after (Post) ascent for the later analysis of salivary α-amylase and IgA levels. Salivary α-amylase and IgA levels were determined by an enzymatic assay and turbidimetric immunoassay, respectively.

Results: Regarding salivary α-amylase activity, a Student's t-test demonstrated a significant increase (Pre=96.1±38.5, Post=175.1±108.0 U/mL, p<0.05) before and after climbing ascending. In contrast, salivary IgA concentration were similar before and after the exercise (Pre=10.3±5.3, Post=13.0±11.8 mg/dL).

Discussion and Conclusions: Previous studies have demonstrated exercise-induced immunosuppression in various sports and physical activity. However, there was few data regarding salivary α-amylase and IgA levels following climbing ascending steps. These findings indicate that increased salivary α-amylase activity appears to lead to improvement of the protective effect of saliva and no alterations of salivary IgA concentration may contribute to a low incidence of URTI following endurance ascending.

Psychological and social benefits of sport participation: The development of health through sport conceptual model

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Introduction: There are specific guidelines regarding the level of physical activity (PA) required to provide health benefits. However, the research underpinning these PA guidelines does not address the element of social health. Furthermore, there is insufficient evidence about the levels or types of PA associated specifically with psychological health. This presentation first presents the results of a systematic review of the psychological and social health benefits of participation in sport by children and adolescents. Secondly, the information arising from the systematic review has been used to develop a conceptual model.

Methods: A systematic review of 14 electronic databases was conducted in June 2012, and studies published since 1990 were considered for inclusion. Results: Thirty publications were identified that investigated the relationship between participation in sport and psychological and social health benefits. There were many different psychological and social health benefits reported, with the most commonly being psychosocial functioning and emotional wellbeing, followed by decreased risk of depression and mental ill health. Sport may be associated with improved psychosocial health above and beyond improvements attributable to participation in PA. Specifically, team sport seems to be associated with improved health outcomes compared to individual activities, due to the social nature of the participation. A conceptual model, Health through Sport, is proposed. The model depicts the relationship between psychological, psychosocial and social health domains, and their positive associations with sport participation, as reported in the literature. However, it is acknowledged that the capacity to determine the existence and direction of causal links between participation and health is limited by the fact that the majority of studies identified ($n=21$) were cross-sectional. Discussion: It is recommended that community sport participation is advocated as a form of leisure time PA for children and adolescents, in an effort to not only improve physical health in relation to such matters as the obesity crisis, but also to enhance psychological and social health outcomes. It is also recommended that the causal link between participation in sport and psycho-social health be further investigated and the conceptual model of Health through Sport be tested.

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Limited value of international physical activity questionnaire – short form (IPAQ-SF) for use in university students

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Introduction: IPAQ is the most widely used physical activities assessment questionnaire. Its correlation with various other fitness and physical activity measurements remains a subject of conflict among researchers. This study was to investigate, the correlation of the IPAQ-SF scores with cardiorespiratory fitness (VO_{2peak}) among university students.

Method: A sample of 81 university students, male=24 and female=57, aged 20–23 (median 22, interquartile range 20–22) participated in this study. Participants were required to attend 2 sessions of testing one week apart. Each of them answered the IPAQ-SF and, after adequate rest, they were subjected to Astrand 6 minute submaximal cycling protocol to determine their VO_{2peak} . Metabolic equivalent from IPAQ-SF were reported as MET min-week⁻¹ and VO_{2peak} values as ml/min/kg. Questionnaire scoring and use conformed to the IPAQ manual. Spearman correlation (r_s) of total IPAQ score (S) and the relevant IPAQ subsection scores (vigorous-v, moderate- m, walking-w) with VO_{2peak} were analysed. Significant level was set at $p < 0.05$.

Results: On the first visit, 45 out of 81 subjects were included for analysis and the remainder 36 were excluded (missing VO_2 results: 2/81; incomplete IPAQ: 34/81). On the subsequent visit, 42 of the 79 subjects were included and 37 were excluded from analysis (missing VO_2 results: 1/79, incomplete IPAQ: 36/79). The values of r_{ss} , r_{sv} , r_{sm} and r_{sw} were respectively 0.19, 0.23, -0.10 and 0.13 with $p > 0.05$ for all variables at the first testing. The correlation remained statistically insignificant on the repeated visit, $p > 0.05$ for each of the values of r_{ss} (0.30), r_{sv} (0.19), r_{sm} (0.22) and r_{sw} (0.15).

Discussion: On both occasions, none of the IPAQ total score or its subsection score showed statistically significant correlation with VO_{2peak} . However, correlation of total IPAQ score with the VO_{2peak} did improve on subsequent testing. This result challenged the practice of using IPAQ as an indirect measurement of cardiorespiratory fitness for first time respondents and implied that study outcome from experienced respondents should be given more weightage. Also, in light of the consistently high proportion of missing data (>40% of collected questionnaires), administration of IPAQ-SF in research should be more meticulously examined with regards to sample size calculation and missing data interpretation. In conclusion, IPAQ-SF is not a valid tool for fitness measure among university students who are first time respondents but its validity may improve as the respondents familiarize themselves with its use.

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Motivation and physical activity in children and adolescents: A systematic review and meta-analysis of evidence from studies framed by self-determination theory

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Introduction: Self-determination theory is a popular framework for examining the relationship between motivation and physical activity. The purpose of this study was to systematically review studies that assessed the relationship between motivation and physical activity levels in children and adolescents.

Methods: Electronic databases were searched in May 2012. Included studies assessed the relationship between motivation (as outlined in self-determination theory) and physical activity in children and adolescents.

Results: 36 studies ($n=13,392$ participants) met the inclusion criteria. Meta-analysis indicated that overall levels of self-determined motivation were moderately and positively correlated with physical activity ($r=.28$). Autonomous forms of motivation were moderately and positively associated with physical activity. Controlled forms of motivation showed no association or weak positive correlations with physical activity, while amotivation showed a weak negative correlation.

Discussions: Evidence supports the tenets of self-determination theory. However, methodological shortcomings and gaps in the evidence base are currently present in the literature.

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Introduction: This presentation attempts to determine the influence of selected social and economic factors on physical development of children and adolescents.

Methods: It is based on the results of a long term project (1992–2010). 1008 infants born in 1985 have been examined. 482 children (172 boys and 250 girls) have been chosen and examined during selected ontogenetic periods (when aged 6,10, 14 and 18). The research included the study of height and body mass (these are sensitive barometers of changes in social and economic conditions). Differences in physical development of children and adolescents may serve as indicators of social stratification. The influence of the socio-economic environment on physical development of children was assessed on the basis of analysis of the following factors: mother's occupation at the time of birth, the social background of the examined child, education and occupation of the parents, the number of family members and siblings of the examined child. Obtained data has been verified and analysed. Arithmetical mean, standard deviation, standard deviation of arithmetical mean, and coefficient of variation have been calculated and the importance of differences between arithmetical means of investigated features has been described through Student's t-test.

Results: 1. Selected socio-economic factors heavily influenced the development of certain somatic features of the examined children aged 0–18 in the Świętokrzyskie region. 2. An Intelligentsia social background, a higher level of education (especially of the mother), fewer children in the family and the fact that both parents are intellectual workers relate to greater body mass, easily noticeable in groups of boys. 3. The highest body mass mean is characteristic for working class boys and girls of peasant origin, a higher level of education of mothers may be correlated with greater body mass of boys. Furthermore, children from families where both parents are manual workers or from single-child families are usually heavier than their peers.

Discussion: The obtained results regarding ontogenetic development have consequences in the preferred lifestyle, which in turn will decide the health of not only the present but also future generations. These results confirm the developmental tendencies presented by other authors.

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Introduction: Despite the health benefits associated with participation in sport and physical activity across the lifespan, factors relating to dropout from sport and physical activity are not well understood. This paper investigated the major determinants of youth and adult dropout from organised sport and physical activity.

Methods: The paper applied a socio-ecological perspective, in terms of intrapersonal, interpersonal, organisational/environmental factors, to the findings of a systematic review of post 1990 international academic literature concerning youth, adult and elderly cohort dropout from organised sport and physical activity.

Results: Dropout from organised sport or physical activity was mostly linked to intrapersonal factors such as perceived competency, competing priorities, lack of enjoyment or interest, or a change to another sport or activity. Interpersonal determinants of dropout mainly included a negative relationship with a sport or physical activity coach, a lack of social support from others within the sport or activity, or a strained team relationship or atmosphere. Environmental determinants on dropout concerned program suitability in relation to individual requirements and the quality of related sport or physical activity organisations. There was an apparent evenness of total male and female cohorts across the study. However, whilst most of the studies related to the under-twenty five age group, several studies concerned elderly cohorts, hence presenting a mid-age range adult cohort research gap and skewing the findings towards those relating to younger people. Notable reasons for dropout across the ages concerned: youth having self competency doubts, competing priorities, concerns over a perceived lack of social and/or coach support, or changing to another sport; mid twenty to mid-thirty year old dropouts having competing priorities or switching to another activity; and older adult dropouts over fifty having a lack of motivation and/or individual coaching support, switching away from overly vigorous programs, or being single.

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Introduction: The purpose of the study is to evaluate the relationship between exercise dependence and exercise age, exercise frequency, exercise type, duration of the exercise and gender.

Methods: The sample group of the study has limited within Eskişehir and consisted of 242 participants who exercise regularly. Subjects have been reached with handy, judgmental and snowball sampling mixed methods. In the current study, the subjects have been applied personal information form and exercise dependence scale 21 (EDS) for exercise attitudes and habits. EDS-21 has been developed by Hausenblas, HA and Downs, DS (2002) and Yeltepe and İkizler (2007) have performed its Turkish validity and reliability studies. In order to see the data's decomposed homogenously got from the samples skewness and kurtosis means are considered. According to skewness and kurtosis results (± 2), Parametric T-test was applied in order to investigate if there's a difference between male and female subjects exercise dependency.

Results: It can be expressed that EDS-21 is reliable because (Cronbach) $\alpha=0,782$ has been found related to the items on EDS-21. After the analysis there is a significant difference between male and female subjects according to "tolerance, time and intention effect" criteria ($p \leq 0,05$). According to "withdrawal, continuance, lack of control, reductions in other activities" criteria is no significant difference between male and female subjects ($p \geq 0,05$). 91 (%37,6) women and 151(%62,4) men totally 242 subjects took part in the study. One of the participants was from primary school, 33 of the participants were high school graduates, 180 of them are university graduates and 28 of them and post graduate. As of exercise type %40,5 of the participants deal with bodybuilding, %30,2 of them deal with cardio and %29,3 of the subjects perform fitness. %48,8 of the participants in the study have 7 or more years, %25,6 of them have 1–2 years, %21,1 of them have 3–4 years and %4,5 of them have 5 or 6 years of exercise age.

Discussion: At least 3 of 7 criteria which Hausenblas and Downs have used to determine exercise dependence has been seen on the subjects in the study. It has been considered that there is a positive relation between exercise dependence and exercise type, training age, exercise frequency and exercise duration. Findings obtained from this study have a similarity with the results of the researches made by Hausenblas and Downs, Kagan, Flynn and Yeltepe and Ikizler.

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The morphological characteristic of the overweight seven year-olds

M. Markowska^{1*} ▪ G. Nowak-Starz¹ ▪ E. Ciesla¹ ▪ A. Przychodni¹ ▪ E. Zieba¹ ▪ ¹Jan Kochanowski University in Kielce

Introduction: The high biological value of the youngest population depends on the assurance of the proper conditions for a comprehensive, harmonious development which is the base for comfort during the period of childhood and adolescence, as well as maturity. Morphological structure and body composition are the subject of the studies of many specialists owing to constantly changing conditions of physical development. An increasing interest in overweight extent in the population of the youngest derives from the fact, that in many research more and more often a significant percentage of children with high values of BMI indicator is noted down and prognoses indicate further increase. The aim of the paper is the morphological characteristic of the six-year-olds with overweight against a background of the same aged with the proper weight and height proportions.

Methods: In the paper the results of the research of the six-year-old children from randomly chosen nursery schools and primary schools in Poland.

The studies were done in 2006 and they comprised 37 340 seven-year-old children. The researched were divided into two groups. The first constituted overweight children, the second comparative group with proper weight and height proportions). The division criterion was the value 85 centyla of BMI indicator of all the researched in the separated in this way groups the basic statistic characteristics were estimated (\bar{x} , s). The importance of differences between the arithmetic means was evaluated by t-Student test. In the paper the following were taken into account: body height and mass, circumferences: chest, shoulder and waist, fatness elements: thickness of adipose skin folds at the front and back of a shoulder, on the side of a trunk, under the scapula and on the gastrocnemius muscle.

Results: The overweight boys were characterized by considerably bigger general body measurements than the comparative group, which confirms the commonly quoted statement about many times higher advancement of the development of the children which reveal higher proportion of fat in the body mass. Among girls the differentiation in the level of the development of the basic morphological parameters was similar to boys. All the differences were statistically significant.

Discussion: Our's research is similar like reilly's research on representative probation of 2630 English children shows that stated on the basis of BMI indicator overweight occurred in 22% of the six-seven-year-olds and obesity in 10% of this age group.

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Physical activity and surgery in mid-aged women

T. Pavey^{1*} ▪ T. Kolbe-Alexander¹ ▪ G. Peeters¹ ▪ W. Brown¹ ▪ ¹University of Queensland

Introduction: Physical activity has been previously associated with a decreased risk in gynecological surgeries (e.g. ovary removal, endometrial ablation) cholecystectomy (gall bladder) and breast surgery (e.g mastectomy, lumpectomy). However, there is currently a lack of research assessing the concurrent association of these surgeries and physical activity, using data gathered from a large representative sample of mid-aged women. The aim of this study is to assess the concurrent longitudinal association between physical activity and cholecystectomy, gynaecological and breast surgeries in mid-aged women.

Methods: The study involved 9688 participants in the Australian Longitudinal Study on Women's Health, who completed triennial surveys from 1998 to 2010. Baseline age in 1998 was 47–52 years. Physical activity was assessed as time spent in walking, moderate and vigorous activity in the previous week, and an index of MET.mins/week was derived and categorized into one of four levels (none, low activity, meeting guidelines, high activity). Surgery was assessed by the question "In the past three years, have you had any of the following operations". Generalised estimating equation models (with 3-year time lag), with adjustment for sociodemographic, behavioural and health-related variables, were used to examine the relationship between physical activity level and surgery risk, with no activity as the referent. Odds ratios and 95% confidence intervals are reported.

Results: Compared to no physical activity, unadjusted models showed a reduced risk of gynecological surgery for low activity (0.82, 0.70–0.96), meeting guidelines (0.74, 0.63–0.87) and high activity (0.74, 0.64–0.86), with adjusted models showing similar results. Only high levels of physical activity showed a reduced risk of cholecystectomy (0.66, 0.53–0.84) compared to no physical activity. This became borderline significant (0.67, 0.61–1.02) for the adjusted model. There was no significant risk reduction across physical activity levels with breast surgery.

Conclusions: For this age group, even low levels of physical activity appear protective against gynecological surgery, with optimal benefits for those meeting physical activity guidelines. For protection against cholecystectomy, higher levels of physical activity are needed. Our results support the continued promotion of physical activity guidelines for the adult population.

B. Zboina^{1*} ▪ H. Krol² ▪ G. Nowak-Starz² ▪ M. Markowska² ▪ E. Ciesla² ▪ M. Biskup² ▪ ¹John Paul II Catholic University, Lublin, Poland
²Jan Kochanowski University, Kielce, Poland

Introduction: The definition of the quality of life perceived as an individual's personal perception of their position in life in the context of culture and value systems in which they live, and in relation to their goals, expectations, standards, and concerns gives a new outlook on four spheres and perspectives of people's life which are exceptionally important at old age. The analysis of academic sources shows the complexity of the problems connected with the quality of life, the process of aging within societies, the organization of health care and welfare for elderly people. The aim of the present dissertation is to present the biopsychological factors which shape the sense of the quality of life among the elderly people in long-term welfare institutions

Research methodology: The research was conducted by means of an interviewing questionnaire technique with the usage of WHOQOL-BREF which is an international instrument enabling a reception of a profile of the quality of life within four spheres (physical, social, psychological, and environmental). The scale also includes questions which are analysed separately and which refer to: individual general perception of the quality of life and general perception of one's own health. The examined community consisted of elderly people having many common features such as – being over sixty years old, being a resident of the above mentioned institutions for at least a month, main source of maintenance – pension or constant benefit. The analysed community consisted of 243 persons. The average age was 72,3.

Results: As for life efficiency, a better quality of life is observable among people of better physical fitness. It turned out that the most important factor determining the quality of life was physical strength and life energy, ability to lead a normal life, mobility, and lack of limitations caused by pain. Taking sex into account in case of motor efficiency, a better quality of life is noticeable among men and people under 70.

The recognition of the results of the research is an important circumstance for practical solutions of problems within geriatric care. This care which holistically involves an elderly person might become a new model for integrated cooperation of multidisciplinary team, contributing to the increase of the quality of life.

Y. Maharmeh^{1,2*} ▪ ¹Jordan Football Association Medical Committee ▪ ²Member, AFC Medical Committee

The beautiful game of Football is not just a game but also a powerful tool to make a change. Millions of people around the world play football including countless children and teenagers. Football provides positive outlook in life and promotes peaceful approach to conflict resolution. It is a tool to ensure that young people grow up healthy, fit and full of self-esteem.

FIFA, AFC, National Football Association and Non-governmental organization are working hand-in-hand to use the game of football in many ways to provide opportunity to enjoy the game and improve the emotional development. Children from war afflicted country and those in the refugee camps will likely benefit from football in recovering from trauma.

The Zaatari campsite, in northern Jordan, is currently the second-largest refugee camp in the world. According to the United Nations, it is equivalent to the fifth city in the country. More than 160,000 refugees have left their homes in Syria to flee the conflict, and a considerable majority of these are minors. Admirable efforts are being made to improve the quality of these young people's lives – both boys and girls – by using the power of football to stimulate them.

Jordan Football Association through the leadership of his President HRH Prince Ali has conducted visits at the Zaatari Camp with FIFA and Special Adviser to the UN Secretary General on Sport for Development and Peace Wilfried Lemke. The tour was an effort to raise awareness in the international community on the severity of the Syrian refugee crisis in Jordan and the role of sport in rehabilitation and building resilience amongst refugee communities.

Various football activities have been held in conjunction with the World Refugees Day such as football festival amongst Syrian and Jordan children affected by the Syrian Refugees crisis as well as visit of UEFA President Michel Platini as part of UEFA's effort to support the Asian Football Development Project (AFDP) to help Syrian refugees in Jordan. Brazilian coaches also provided tactical and technical training for 80 children and 20 coaches. FIFA has implemented a project to help Syrian refugees cope with their living conditions, providing them with facility to play football and other sports as well as sports kits and other assistance. The camp is currently organizing a football league and hosts a variety of sports centres. Football's power to alleviate the lives of refugees is limitless.

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FRIDAY 25 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
0800 – 0900	Workshop	Examination and management considerations in the chronic, recurrent hamstring strain	Craig Purdam	Arcadia Hall 1	196
0800 – 0900	Workshop	Practical aspects of examination and management of hip and groin injuries	Neville Blomeley Gavan White	Arcadia Hall 2	197
0800 – 0900	Workshop	Foot and ankle taping for a purpose	Chris Bishop Kent Sweeting	Lagoon Hall A	198
0800 – 0900	Workshop	When pictures tell more than a thousand words: The clinical role of imaging for tendinopathy and emergence of UTC	Sean Docking Jill Cook Ebonie Rio	Lagoon Hall B	199
0930 – 1030	Keynote	Football for health – a global health initiative of FIFA	Jiri Dvorak	Ballroom B	200
1100 – 1230	Free papers: Clinical and cutting edge			Ballroom B	
		The role of ultrasound tissue characterisation in the management and prevention of tendinopathy in athletes	Sean Docking		201
		Clinical experience using isometric exercise for immediate pain reduction in tendinopathy	Ebonie Rio		202
		Objective measurement of intra-pelvic instability using motion sensors	Bruce Mitchell		203
		Use of ultrasound-guided polidocanol injections (using Colour Doppler) to arrest acute bleeding from intramuscular haematomas	John Orchard		204
		Adipose derived stem cell therapies for treatment of musculoskeletal conditions	Diana Robinson		205
		Reliability of in-vivo human Achilles tendon stiffness assessed using acoustoelastography	Michael Ryan		206
		An evaluation of Tandem Gait as a measure of dynamic balance and coordination in the assessment of individuals with medical diagnosed sports-related concussion	Anthony Schneiders		207
1100 – 1230	Free papers: Knee			Arcadia Hall 1	
		Higher knee load, not knee extensor strength predicts medial cartilage degradation over 2 years following partial meniscectomy	Michelle Hall		208
		Comparison of hamstring and patellar tendon autografts for ACL reconstruction: 15 year follow up of a randomized controlled trial	Kate Webster		209
		Type of exercise and presence of varus thrust influences pain outcomes in people with medial knee osteoarthritis	Kim Bennell		210
		The psychological responses of athletes before, and early after recovery from ACL reconstruction predict returning to the pre-injury level sport	Clare Ardern		211
		Intra-articular injection of platelet-rich plasma in patients with knee osteoarthritis: A randomised controlled pilot study	Kade Paterson		212
		Physiotherapist-delivered exercise and pain coping skills training is more effective than either intervention alone in knee osteoarthritis	Kim Bennell		213
		Quadriceps muscle force control is related to knee function 12 months after anterior cruciate ligament reconstruction	Luke Perraton		214

FRIDAY 25 OCTOBER PAPERS AT A GLANCE

Time	Session	Title	Presenter	Room	Paper
1100 – 1230	Free papers: Sport studies			Arcadia Hall 2	
		Anterior and posterior gluteus minimus are functionally distinct from anterior and posterior gluteus medius	Adam Semciw		215
		Does hypoxic and thermal stress enhance the training response and performance for AFL footballers?	Ian Gillam		216
		Decrements in strength comparing high- and moderate-volume sprints between the wickets in batsmen	David Goble		217
		Energy cost and metabolic power of Australian football	Adrian Gray		218
		Impact of a simulated one day international century on batting performance in cricket	Lee Pote		219
		Mental effort ratio and perceived exertion in sub-maximal bicycle ergometry	Eugene Aidman		220
		Training characteristics of elite Australian rowers: Training volume, loading patterns, and training variety	Jacqueline Tran		221
1100 – 1230	Free papers: Sport specific injury			Lagoon Hall A	
		Changes in muscle recruitment of the lower limb musculature following repeated sprints between the wickets	Candice Christie		222
		Physical demands and injury outcomes of shoulder charge tackles within elite Rugby League	Cloe Cummins		223
		Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers	Billy Hulin		224
		The influence of soccer-specific fatigue on the risk of thigh injuries in amateur Black African players	Robert Jones		225
		Injury characteristics in Australian elite junior rugby league players	Rhonda Orr		226
1100 – 1230	Symposium	Choose your own intensity: Advantages for and mechanisms underpinning self-regulated exercise		Lagoon Hall B	227
		Maximal exercise testing: Making it feel better	Harrison Evans		228
		Does a submaximal perceptually-regulated exercise test work with older adults?	Ashleigh Smith		229
		A 'hard' training program only works for some	Roger Eston		230
		What intensity do old and young choose: How hard, how do they feel and so what?	Gaynor Parfitt		231
		Why we feel how we feel: Investigating cerebral blood flow during exercise	Gavin Tempest		232
1330 – 1430	Best of the Best	Best paper winners represent to determine the Asics Medal winner for Best Conference Paper		Ballroom B	

196 Examination and management considerations in the chronic, recurrent hamstring strain

WORKSHOP

Australian Sports Medicine Federation Fellows Supported Speaker

C. Purdam^{1*} ▪ ¹Australian Institute of Sport



Chronic hamstring injuries are widely acknowledged as requiring a multi-factorial approach to their management. This practical workshop will explore both common and unusual clinical presentations that have been shared with other practitioners in a high performance setting. This has highlighted the need for an individualised approach to management approaches. Emerging awareness of anatomical deficits as well as varied clinical presentations of motor patterning anomalies will be explored, along with the more common muscle strength issues and kinetic chain considerations. In a workshop setting, a history and examination structure as well as intervention options will be discussed and demonstrated.

197 Practical aspects of examination and management of hip and groin injuries

WORKSHOP

N. Blomeley^{1*} ▪ G. White^{1*} ▪ ¹Sports Doctors Australia

Diagnosis and management of hip and groin injuries in sports medicine can seem complex and overwhelming because of the complex anatomy and wide range of injuries that occur. The aim of this workshop is to simplify the process for primary care physicians. The main causes of hip and groin pain will be discussed initially, looking at acute and chronic causes in both adults and the paediatric /adolescent population. The main part of the workshop will focus on examination techniques for this lower limb pathology and participants will be given the opportunity to practise these techniques. The final part of the workshop will look at radiology of the area.

198 Foot and ankle taping for a purpose

WORKSHOP

C. Bishop^{1*} ▪ K. Sweeting^{2*} ▪ ¹School of Health Sciences, University of South Australia ▪ ²Performance Podiatry and Physiotherapy, QLD

This workshop will provide attendees with a structured and systematic approach to the taping of common foot and ankle pathologies. The focus of the workshop will involve appreciating the complex anatomy of the region of interest and determining the responsible muscle and soft tissue function of the impaired rotations and/or translations of a joint which caused the injury. The concept of rigid taping will then be employed to investigate how we can rectify the cause of common clinical presentations in each region of the foot, which, through an understanding of tapings various mechanisms of action, may help predict which treatments individuals are likely to respond to.

199 When pictures tell more than a thousand words: The clinical role of imaging for tendinopathy and emergence of UTC

WORKSHOP

S. Docking^{1*} ▪ E. Rio^{1*} ▪ J. Cook^{1*} ▪ ¹Department of Physiotherapy, Monash University

This workshop will discuss the importance and relevance of imaging modalities in the diagnosis and management of lower limb tendinopathy. Included is a practical demonstration of ultrasound tissue characterisation (UTC) in imaging the Achilles and patellar tendon with detailed input from Prof Jill Cook and Ebonie Rio on the conservative and intervention management directed by findings on UTC. UTC utilises conventional ultrasound to render a 3-dimensional image of the tendon and allows semi-quantitative analysis of tendon structure and detection of subtle changes in tendon structure in response to load. Previous research utilising conventional ultrasound and MRI will be discussed as well as the emergence of UTC in the clinical setting.

200 Football for health – a global health initiative of FIFA

KEYNOTE

J. Dvorak^{1,2,3*} ▪ ¹University of Zurich ▪ ²Schulthess Spine Centre ▪ ³Fédération Internationale de Football Association

The main objectives of the FIFA Medical Assessment and Research Centre (F-MARC) are to protect players' health, ensure the respect of the FIFA Anti-Doping Regulations and use the potential of the game to improve public health.

During pre-competition medical assessment and medical services at competitions, FIFA engages with all participating teams to ensure that players are not subject to any avoidable medical risks.

F-MARC has developed a standardised pre-competition medical assessment (PCMA), which is mandatory prior to all competitions. FIFA also issues detailed requirements, including staff and infrastructure, for the provision of medical services to the participating teams and delegations.

Furthermore, the medical teams on the touchline must be fully trained in emergency medicine and be equipped with an automated external defibrillator (AED). FIFA provided each member association with one FMEB (Football Medicine Emergency Bag) together with an educational package.

In order to minimise any further potential risks, FIFA has issued several recommendations with regard to environmental factors such as heat, and, in collaboration with other international federations, FIFA has also developed a touchline assessment for players with head injuries to identify potential concussions.

Fight against doping: In a significant move in the continued battle to eradicate those who seek to gain an advantage through doping, FIFA adopted the so-called "biological passport" profiling at the FIFA Confederations Cup Brazil 2013 and the procedure will again form part of our wide-ranging anti-doping strategy when we return for the 2014 FIFA World Cup Brazil.

The FIFA 11+: The FIFA 11+ injury prevention programme is a simple, time-efficient warm-up programme for players. Scientific evidence has shown that overall injuries decreased by a third and serious injuries by half in teams using the FIFA 11+.

The FIFA 11 for Health: FIFA's 11 for Health Programme is a series of football-based sessions aimed at encouraging physical activity while educating children about healthy behaviour. Consisting of 11 simple messages to reduce communicable and non-communicable diseases, all supported by prominent footballers working as one team. The programme, which started in Africa in 2009, is now spreading its positive message around the globe and a pilot project was launched in Brazil in 2013.

201 The role of ultrasound tissue characterisation in the management and prevention of tendinopathy in athletes

S. Docking^{1*} ▪ S. Rosengarten² ▪ J. Daffy³ ▪ H. Van Schie^{1,4} ▪ J. Cook¹ ▪ ¹Monash University ▪ ²Carlton Football Club ▪ ³St. Vincent's Hospital ▪ ⁴UTC Imaging

Tendinopathy is a prevalent and frustrating condition in athletes and its management is complex for clinicians. At present, sports medicine practitioners are reactionary to the onset of, or changes in, pain to indicate tendinopathy as standard imaging modalities are reliant on subjective interpretation and are not sensitive enough to detect subtle fluctuations in structure. As symptoms are not directly linked to pathology, an athlete may develop substantial tendon disorganisation without symptoms.

Ultrasound tissue characterisation (UTC) is a novel development in the field of ultrasound that may advance diagnosis and management of tendinopathy. UTC captures 600-contiguous transverse US images and has three clear advantages; first, UTC standardises parameters and removes user-dependency allowing direct comparison between scans. Second, it quantifies tendon structure removing the subjective interpretation of other imaging modalities. Third, it is able to detect small changes in structure, making it an ideal tool to clinically monitor tendon structure in response to overload in athletes. Previously, UTC has been used as a research tool for monitoring the progression of tendon lesions and for objective evaluation of various treatments such as intra-tendinous platelet-rich plasma. Our research group has shown changes in Achilles tendon structure despite the absence of symptoms in patients with patellar tendinopathy, and in the asymptomatic tendon in unilateral Achilles tendinopathy. Clinically, UTC has been used to quantify the amount of tendinopathic change, allowing clinicians and patients the confidence to embrace load as part of their clinical management. UTC identifies reactive tendinopathy, that has been previously undetectable using conventional imaging modalities. In addition, research showing changes in tendon structure in response to load athletes has allowed proactive clinical management before the presence of symptoms. The ability to quantify and detect subtle changes in tendon structure will potentially allow for early management and reduce the impact of tendinopathy.

202 Clinical experience using isometric exercise for immediate pain reduction in tendinopathy

E. Rio^{1*} ▪ J. Cook¹ ▪ ¹Monash University

Tendinopathy is debilitating and impacts negatively on participation in physical activity, occupational ability and sporting performance, predominantly due to pain. Eccentric exercise is used commonly in tendinopathy rehabilitation but it has been shown that eccentric exercise increased pain during the first few weeks and was not effective during the competitive season. Furthermore, pain during eccentric exercise results in poor compliance in athletes, leaving many clinicians without options for managing this condition. Eccentric exercise is also known to cause muscle fatigue and therefore may not be appropriate to use pre-activity due to the potential for impact on performance and injury risk. There is evidence that isometric exercise reduces pain in other conditions such as osteoarthritis and patellofemoral joint syndrome and research underway suggests it may also be useful in common clinical presentations such as recent onset or an acute flare up of longstanding tendinopathy. This clinically based presentation will focus on the use of isometric exercise for immediate reduction in tendon pain. This type of exercise has important clinical implications; people are able to complete high loads that reduce pain immediately and for sustained periods, as measured by tendon pain provocation tests and twenty four hour pain response but without reductions in muscle strength as measured by maximal voluntary isometric contraction post exercise. Examples of exercises will be provided for clinicians as well as a clinical discussion around utilising this type of intervention as a pre-activity or post activity tool for pain reduction. Exercises that not only reduce pain, but are not extremely painful to complete are likely to result in improved compliance and reduce the need for invasive interventions.

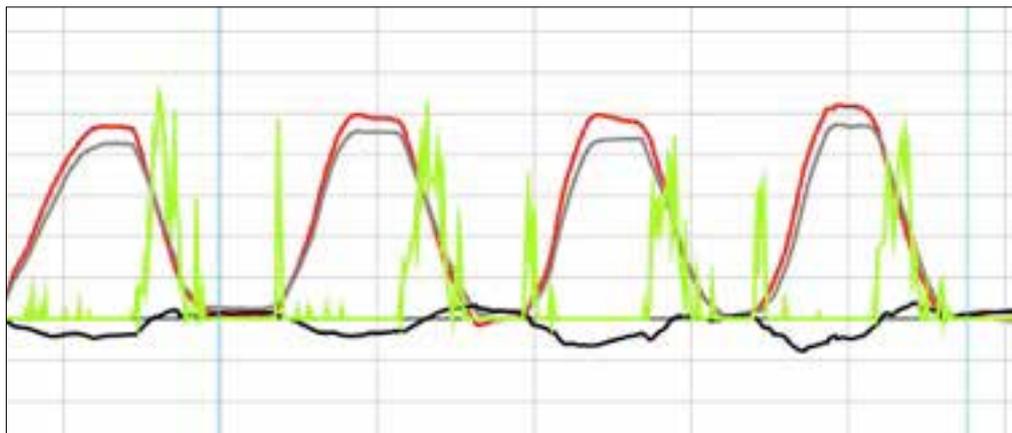
203 Objective measurement of intra-pelvic instability using motion sensors

B. Mitchell^{1*} ▪ D. Vivian¹ ▪ P. Verrills¹ ▪ A. Barnard¹ ▪ ¹Metro Pain Clinic

Introduction: Intra-pelvic (pelvic girdle) instability has been associated with lumbo-pelvic pain but there is controversy about identifying and linking aberrant movement to pain. Current examination for intra-pelvic stability uses palpation of bony landmarks as the patient moves but currently has controversial reliability and therefore utility. New technology using small, wireless motion sensors that can be used in a typical clinical setting provide increased accuracy of pelvic movement. The technology was designed to measure lumbar motion relative to the sacrum. We have adapted the positioning of the sensors to measure relative innominate motion. This study demonstrates the usefulness of measuring intra-pelvic stability with motion sensor technology pre and post prolotherapy intervention.

Methods: A case series (n=6) (full follow up data on 30 will be available at the conference) people with lumbopelvic pain and clinical intra-pelvic instability were selected. Motion testing for left versus right symmetry of innominate bone movement was performed by skin-surface placement of inertial sensors (ViMove, DorsaVi) over right and left PSIS during a trunk flexion movement. A series of three movements were repeated. Movement was assessed pre and post prolotherapy to ilio-lumbar and posterior sacro-iliac ligaments. Motion sensor data was recorded independent to tester observation. Patient outcome data was collected using the Clinical Intelligence data collection system

Results: The below graph shows the maximum flexion for the left innominate (in red) and the right innominate (in grey). The black line shows the difference between the two innominates measured. The green line is the EMG activity. Note the increased range of motion of the left innominate (red line) and the consistency of this across four repetitions.



Discussion: Despite widespread acceptance amongst experienced clinicians, the concept of intra-pelvic instability remains controversial in the wider medical community. Indeed, rheumatologists still argue it does not exist. Hence, lack of a validated objective outcome measure for intra-pelvic instability has major impacts on access to treatments for these patients and has made research in the area difficult. While our numbers are small, these early results indicate that we may, finally, have a tool that simply and reliably measures intra-pelvic instability. This early data also indicates that prolotherapy to the pelvic ligaments may correct this instability.

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Use of ultrasound-guided polidocanol injections (using Colour Doppler) to arrest acute bleeding from intramuscular haematomas

J. Orchard^{1,2*} ▪ L. Cutler² ▪ P. Williams² ▪ T. Touma² ▪ P. Farhart³ ▪ A. Ibrahim² ▪ ¹University of Sydney ▪ ²Sydney Roosters RLFC ▪ ³City Edge Physiotherapy

This series of three cases presents a novel medical intervention for uncontrolled bleeding in traumatic intramuscular haematomas. The vast majority of traumatic haematomas in a sporting setting resolve rapidly and cause minimal missed playing time. However a small minority lead to progressive bleeding which continues after rest and can cause the player to miss many weeks. In the worst scenarios uncontrolled bleeding can lead to acute compartment syndrome for which emergency surgery is the only management. Ultrasound-guided injections of polidocanol in sports medicine have been popularised by Scandinavian researchers for sclerosing of neovessels in chronic tendinopathies. In general medicine the major use of polidocanol is as a sclerosant for varicose veins. The mechanism of action is endothelial damage, causing platelets to accumulate and ligate the vessel. It is recommended for intravenous use only in the lowest possible dose with caution to be used in peripheral locations. In this case series, athletes who had suffered massive haematomas secondary to trauma were examined using Colour Doppler US (Sonosite M Turbo). In all cases a suspected vessel with high flow in the haematoma, which was presumed to be the source of the excessive bleeding, was seen. In all cases the vessel was able to be accessed with a needle and polidocanol sclerosant injected. The case in which the sclerosant was injected immediately (30 mins) after the injury gave the most dramatic clinical improvement, although the net effect in the other (subacute) cases was considered neutral to helpful. Although it is impossible to know the clinical outcome of these cases without sclerosant usage, the cases do provide a novel medical (non-surgical) acute treatment for massive haematoma. This novel management could certainly be attempted in similar future cases of severe haematoma prior to consideration of acute surgical intervention.

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Adipose derived stem cell therapies for treatment of musculoskeletal conditions

D. Robinson^{1*} ▪ ¹Sydney Sportsmed Specialists

Sydney Sports Medicine Specialists have been using an autologous adipose derived stem cell procedure known as HiQCell for the treatment of musculoskeletal conditions. The half-day procedure, which complies with the Australian TGA's Biological Framework legislation, is undertaken in a hospital setting and involves harvesting adipose (fat) tissue from a patient's abdomen, which is then processed to extract a combination of adult mesenchymal stem cells, adipocytes and stromal vascular fraction cells, which are then injected into affected joints or tendons.

Adipose tissue provides a rich source of these cell types without the need for culturing and is easily harvested via a minor liposuction procedure. It is thought that the injected cells help to repair and regenerate affected sites by replacing lost or damaged cells, reducing inflammation, improving the function of cells at the site and recruiting cells from other parts of the body to assist in these processes.

The HiQCell procedure has been used to treat over 500 joints in approximately 270 patients during the last 18 months; bilateral knee osteoarthritis (OA) being the most common indication. Cell numbers harvested from adipose tissue averaged 36 400 000 and ranged from 1 650 000 to 277 000 000. In patient follow-up data collected to date, HiQCell has achieved a 73% response rate, with an average reduction in pain of 79%. Median VAS pain scores have been observed to decrease from 5.0 at pre-treatment to 1.5 at 6 months post-treatment. All grades of OA across a broad age profile have shown to benefit from the treatment.

Since April 2013 an added step in the HiQCell protocol provides the option for patients to cryopreserve (freeze) excess cells from their tissue harvest procedure for future treatment of their musculoskeletal condition. The stored cells are held at a specialist TGA approved facility under liquid nitrogen for an indefinite period of time until required for future injections.

Early clinical results indicate that HiQCell is a safe treatment option that bridges the gap in the current OA treatment continuum and offers meaningful clinical benefit for patients. A number of case histories will be presented in support.

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Introduction: Current ultrasound-based sonoelastography methods, such as shear-wave elastography, are constrained to assessing tissue properties under minimal deformation (~1%). Human tendons, such as the Achilles tendon, undergo relative large deformation (~8%) during physiological loading, such as with running and jumping. A new post-processing method, acoustoelastography (AE), uses a tissue's acoustic properties to estimate stiffness under forces resulting in large nonlinear deformation. AE may be particularly well-suited for estimating in-vivo tendon biomechanics in humans due to its comparative ease of use (requires only ultrasound) and potential for examining tendon mechanical behavior under high-load conditions. However, AE methodology remains untested in humans; therefore, the purpose of the current study is to evaluate the reliability of AE in a selected region of interest (ROI) within a human Achilles tendon.

Methods: Four male participants performed five maximal voluntary isometric contractions in an ankle dynamometer (Futek, USA), while a linear array ultrasound probe (14–5 MHz, Ultrasonix, Richmond, Canada) was secured to the posterior ankle above the Achilles tendon. B-mode ultrasound video-images of the Achilles tendon were recorded (30 Hz) and post-processed with specially designed software (Echosoftware, Madison, USA) that estimates tissue stiffness as a function of mean pixel luminosity within the selected ROI. Stiffness values were normalised to peak ankle plantarflexion torque. Intraclass correlation coefficients (2,1) were performed with an analysis of variance approach used to test significance at an alpha of 0.5. **Results:** Normalised stiffness measures from AE were highly reliable within a testing session (ICC: 0.975–0.992)($p < .001$). High reliability was also achieved between days (ICC: 0.761–0.894)($p < .05$) and between raters (ICC: 0.904–0.776)($p < .05$).

Discussion: AE appears to be a reliable method for assessing stiffness of the human Achilles tendon in vivo. Additional validation comparing AE stiffness to dynamometer/ultrasound based measures, in combination with reliability testing with a larger sample, are currently underway. Clinically, AE represents the potential to serve as a biomarker of tendon function that can assist the evaluation of regeneration-based treatments for chronic tendinosis.

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Introduction: The third edition of the Sports Concussion Assessment Tool (SCAT3) was released in March 2013 following the 4th International Conference on Concussion in Sport held in Zurich. A new inclusion in the SCAT3 is the timed Tandem Gait Test (TGT) which is suggested to differentiate athletes who have sustained a concussion by evaluating deficits in gait, speed, dynamic balance, and coordination. The test requires an athlete suspected of being concussed to walk 3m along a straight line using an alternate heel-to-toe gait, turn, and return to the starting position as quickly as possible. Calculations from normative reference values (+2SD) suggest that this test should usually be completed in less than 14 sec in non-concussed individuals. Despite the inclusion of this test in the SCAT3 and its face validity, the TGT has yet to be formally investigated in the literature for its ability to identify athletes who have sustained a concussion. Therefore, the purpose of this study was to investigate athletes with a medical diagnosis of concussion using the timed TGT and compare their scores with non-concussed age and gender matched controls in order to determine the TGT's continuing utility as a side-line screening measure of sports concussion.

Methods: Patients presenting to a provincial sports injury clinic during the winter sports season were triaged by a medical doctor and all athletes diagnosed with a sports-related concussion who consented to participate in the study were required to undergo a TGT. The concussed participants were subsequently age and gender matched to a cohort of athletes who had not sustained a concussion and their TGT scores compared using independent t-tests.

Results: Eighteen concussed athletes with a mean time from injury to TGT assessment of 95.39 min (SD 54.37) were matched with 18 controls with no recent history of concussion. There was no correlation between the time since injury and the corresponding TGT scores ($p > 0.05$). There was a statistically significant difference ($t_{34} = 2.8$, $p = 0.009$) between mean TGT scores of the concussed athletes ($M = 14.7$ s; SD 3.8) and the matched controls ($M = 11.6$ s; SD 2.8).

Discussion: This is the first study to investigate the TGT in sports injury setting with athletes who had been medically diagnosed as having sustained a concussion. The average TGT score of the concussed athletes exceeded the cut-off set within the SCAT3, however, a number of patients scored lower than this threshold suggesting either recovery or a limitation in the constructs of the TGT.

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Introduction: Patients following medial arthroscopic partial meniscectomy (APM) are at increased risk of developing knee osteoarthritis in the longer-term. Higher medial knee joint loading during gait and weak knee muscles post-APM may contribute to this increased risk. The external knee adduction moment (KAM) is often used as a proxy for dynamic medial knee joint loading and has been found to be higher in patients' 3-months post-APM surgery as compared to healthy controls. Knee muscle weakness is also widely reported following recent APM surgery. The aim of this study was to evaluate the hypothesis that higher medial knee joint load and knee extensor muscle weakness would predict greater medial cartilage degradation over 2-years in individuals with a medial APM.

Methods: This longitudinal cohort study included 73 participants 3-months following medial APM surgery (88% males; 41 ± 5.5 yrs; BMI 27.3 ± 4.0 kg/m²). Dynamic medial knee load measures including the peak KAM and the KAM impulse were assessed at baseline (3-months following-surgery) using three-dimensional gait analysis during walking (normal pace and fast pace). Maximal isokinetic knee extensor strength (concentric and eccentric at 60°/second) was also assessed at baseline. MRI was used to assess structural cartilage indices at baseline and 2-years later. Multiple linear regressions (adjusted for covariates) examined the relationship between the % annual change in medial tibial cartilage volume and a) medial knee joint load and b) isokinetic knee extensor strength. Binary logistic regression was used for the dichotomous variables of progression of medial tibiofemoral cartilage defects.

Results: A higher peak KAM during fast pace walking was significantly associated with greater progression of medial tibiofemoral cartilage defects (OR=2.055, 95%CI 1.0 to 4.1, p=0.042). No significant relationships were found for KAM impulse during fast or normal pace walking or for peak KAM during normal pace walking. There were also no significant relationships observed between knee extensor muscle strength and either parameter of structural change.

Discussion: These novel findings suggest that higher medial knee loading, as evidenced by the peak KAM during fast walking, may be a risk factor for medial tibiofemoral cartilage defect progression in an APM cohort 3-months post-surgery. Therapeutic rehabilitation interventions should explore and evaluate approaches to reduce knee load with the aim to slow osteoarthritis disease onset and progression in this patient group.

209 Comparison of hamstring and patellar tendon autografts for ACL reconstruction: 15 year follow up of a randomized controlled trial

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Introduction: Numerous studies have compared patellar tendon and hamstring tendon anterior cruciate ligament (ACL) reconstructions in the short to mid-term. There are inadequate long-term results. This prospective randomized controlled trial provides long term follow up data to compare between these two common graft types.

Methods: Sixty-five patients undergoing ACL reconstruction following ACL rupture were randomized to receive either a patellar tendon (PT) graft or a four strand hamstring tendon (HS) graft. Forty seven patients (22/31 PT and 25/34 HS) were reviewed at a mean of 15.2 years (range 14–16). They completed the IKDC Subjective Knee Score, VR-12 quality of life survey and Cincinnati Knee Rating and Sports Activity Scales, as well as reporting the incidence and severity of anterior knee pain and kneeling pain on visual analogue scales. Examination consisted of assessment of any effusion, range of motion and anterior knee laxity. Weight-bearing X-rays were also undertaken and assessed for osteoarthritis using the Kellgren-Lawrence (KG) classification.

Results: The mean age of the group was 42 years (30–56). There were 36 males and 11 females. Three graft ruptures (1 PT; 2HS), and six (2HS; 4PT) contralateral ACL injuries occurred in the followed up group. There was no statistically significant difference between the groups for any of the variables measured. There was a similar incidence of anterior knee pain and kneeling pain in both groups. The previously observed increased extension deficit in the PT group at three years had resolved and there was no significant between-group difference in knee laxity. Overall 60% were participating in sport on a weekly basis with a trend towards greater participation in the PT group (HS: 48%; PT 73%, p=0.08). There was no difference in the degree of osteoarthritis between the groups (HS: KG0/1 72%, KG2/3 28%; PT: KG0/1 70%, KG2/3 30%).

Discussion: This randomized controlled trial showed that HS and PT ACL reconstructions have comparable results at an average of 15 years follow-up. Both graft types provide good long term subjective and objective outcomes. One third of patients had definite changes of osteoarthritis, but for half of these patients the changes were only mild.

210 Type of exercise and presence of varus thrust influences pain outcomes in people with medial knee osteoarthritis

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Introduction: In people with knee osteoarthritis (OA), varus malalignment or an observable varus thrust during walking (dynamic bowing out of knee laterally during stance) increases the risk of structural disease progression. This may be partly due to higher knee loads. Different exercise may have differential effects on knee load and symptoms. This randomised controlled trial tested the hypothesis that a neuromuscular exercise program (NEXA) would lead to greater reductions in peak knee adduction moment (an indicator of medial knee load) and greater improvements in knee symptoms than a quadriceps strengthening program (QS) and that presence/absence of a varus thrust would influence these outcomes.

Methods: 100 people with medial knee pain, radiographic medial compartment OA and varus knee malalignment were randomly allocated to one of two 12-week exercise programs. Each involved 14 supervised exercise sessions with a physiotherapist plus home exercises 4 times weekly. NEXA comprised functional weight bearing exercises focusing on trunk and lower limb position and movement quality. The QS program involved 5 non-weight-bearing exercises (3 sets of 10 repetitions). Primary outcomes were peak external knee adduction moment (3D gait analysis), average knee pain (100 mm visual analogue scale) and self-reported physical function (WOMAC) measured at baseline and 12 weeks. Varus thrust was assessed at baseline via gait observation by a trained examiner. Data were analysed using a 2-way analysis of covariance (exercise group and varus thrust as factors) of the change in outcome adjusted for baseline values.

Results: 100 participants (50 NEXA, 50 QS) were randomised and 82 (38 (76%) NEXA, 44 (88%) QS) completed the trial. Forty three people had a varus thrust at baseline (19 NEXA). There was a significant interaction effect for pain (p=0.029) showing that NEXA resulted in greater pain reduction than QS in thrusters while effects were opposite for non thrusters (mean change: NEXA thrusters: 26, 95% CI: 16–36; NEXA non-thrusters 16, 8–24; QS thrusters 18, 8–27; QS non thrusters 27, 17–36). There was no significant effect of either exercise program on knee load while physical function was similarly improved by both exercise types

Discussion: These novel findings suggest that therapists should assess for the presence of a varus thrust during walking in order to prescribe the most appropriate exercise. If a varus thrust is visualised, neuromuscular exercise may be the best type of exercise for pain relief. As neither exercise program reduced indicators of knee load, they may not slow structural disease progression.

211 The psychological responses of athletes before, and early after recovery from ACL reconstruction predict returning to the pre-injury level sport

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Introduction: Athletes are expected to have returned to sport by 12 months after anterior cruciate ligament (ACL) reconstruction. However, up to two-thirds may not have returned to their pre-injury level sport by this time, despite being physically recovered. There is a suggestion that psychological factors may influence returning to sport.

Purpose: To determine whether psychological factors predicted returning to the pre-injury level sport by 12 months following ACL reconstruction.

Method: 187 athletes (133 competitive and 54 recreational) were recruited consecutively from a private orthopaedic clinic (122 men, mean age 27.3 years). The psychological factors, evaluated pre-operatively and at four months post-operatively, were: psychological readiness to return to sport, fear of re-injury, mood, emotions, sport rehabilitation locus of control, and recovery expectations. Subjective and objective knee function was evaluated as an indicator of the extent of physical recovery and physical capacity to return to sport. The primary outcome was returning to the pre-injury level sport at 12 months post-operative. Logistic regression was employed for data analysis.

Results: The return to pre-injury sport rate at 12 months was 32%. Satisfactory objective knee function (International Knee Documentation Committee (IKDC) classification category A or B, and hop test limb symmetry index $\geq 85\%$) was observed in 91% of participants. Psychological readiness to return to sport and the athlete's estimate of the number of months it would take to return to the pre-injury level (recovery expectations) measured pre-operatively predicted return to the pre-injury level sport with 70% accuracy. Psychological readiness to return to sport, the extent of fear of re-injury, sport locus of control and the estimate of the number of months it would take to return to any sport (recovery expectations) measured at four months after surgery predicted returning to the pre-injury level sport with 90% accuracy.

Conclusions: Based on current clinical guidelines, most athletes had sufficient physical capacity to cope with the demands of returning to sport. Psychological factors measured before surgery and in early recovery were predictive of returning to the pre-injury level sport at 12 months following surgery. This suggests psychological responses make a contribution to an athlete returning to sport. Therefore, there may be merit in undertaking more routine early assessment of psychological factors to help clinicians to identify athletes who may be at risk of not returning to sport, and enable targeted intervention to maximise the chances of returning to sport.

212 Intra-articular injection of platelet-rich plasma in patients with knee osteoarthritis: A randomised controlled pilot study

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Introduction: Osteoarthritis (OA) is a disabling condition affecting 15% of the Australian population, with the majority of cases occurring in the knee. Currently, there is no cure for knee OA hence the majority of treatment is aimed towards symptom reduction. In contrast, preliminary research suggests that intra-articular injection of platelet-rich plasma (PRP) may promote tissue regeneration and healing. Consequently, PRP could be developed as a minimally invasive, cost effective alternative to conventional medical and surgical treatment in knee OA. To date, there are no randomised controlled studies evaluating the effects of PRP on pain and function in knee OA. The aim of this pilot study was to assess changes in pain, symptoms and lower limb functional ability of patients with mild to moderate knee OA following injection of PRP compared to Synvisc[®].

Methods: Twenty one volunteers with knee OA were recruited for a single centre, double-blinded randomised controlled pilot study. Eligible participants were randomised to receive three injections of either PRP or Synvisc[®] in the affected knee joint at weekly intervals. The primary outcome was pain assessed by a 100 mm visual analogue scale (VAS) at four weeks following the final injection, with secondary outcomes of self-reported symptoms (KOOS and KQoL), and objective measures of functional ability (single leg hop distance and number of knee bends in 30 seconds).

Results: Significant reductions in the mean VAS pain score were reported for the PRP (28.45 mm, $p < 0.001$, $ES = 0.86$) and Synvisc[®] (26.80 mm, $p = 0.006$, $ES = 0.77$) groups at follow-up. Although no other improvements were found for the Synvisc[®] group, the PRP group demonstrated significant improvements ($p < 0.05$) in the KOOS pain and function subscales ($p < 0.05$), the KQoL physical, activity and emotional subscales, and hopping distance. After controlling for baseline values however, ANCOVA revealed no significant differences between the groups on any of the outcome measures at follow up.

Discussion: This study demonstrated significant clinical improvements in pain following both PRP and Synvisc[®] intra-articular injections in patients with knee OA. Although PRP was also found to improve self reported symptoms and lower limb function at one month, after controlling for differences in baseline symptoms and function, no between-group differences were found at follow up. These findings suggest that intra articular injection of PRP offers a safe and cost effective alternative to the existing medical management of knee OA.

213 Physiotherapist-delivered exercise and pain coping skills training is more effective than either intervention alone in knee osteoarthritis

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Introduction: Pain is the primary symptom in knee osteoarthritis (OA) and results from a complex interaction between structural changes, physical impairments and psychological factors. Evidence supports strengthening exercises and psychologist-delivered pain coping skills training (PCST), a form of cognitive behavioural therapy, to improve pain and physical function in this patient population. Though typically provided separately, there are symptom-, resource- and practical-advantages of exercise and PCST being delivered together by a single healthcare professional. This multi-site RCT primarily aimed to investigate whether an integrated 12-week exercise and PCST treatment program delivered by physiotherapists is more efficacious than either program alone.

Methods: Participants with symptomatic and radiographic knee OA were recruited from Melbourne and Brisbane, Australia and randomized to one of three groups (i) Exercise; (ii) PCST; and (iii) Exercise plus PCST. The intervention included 10 sessions with a physiotherapist over 12 weeks and participants performed home practice over the trial duration. Measurements were taken by a blinded assessor at baseline, 12, 32 and 52 weeks. Primary outcomes were overall average pain in the past week (VAS) and self-reported physical function (WOMAC) at all time points. Secondary outcomes included global rating of change, muscle strength, functional performance, physical activity levels, health-related quality-of-life and psychological factors.

Results: 222 participants were randomized and 184 (82%) completed the 12-month trial. All groups showed improved pain following treatment with no difference between groups. However, the integrated program resulted in significantly greater improvements in physical function compared to either intervention alone at all time points ($p < 0.05$). Benefits of the integrated program over both programs alone were also seen for self-efficacy and quality-of-life at all time points ($p < 0.05$). The integrated program generally showed greater improvements in psychological parameters compared to exercise alone and greater improvements in functional performance compared to PCST alone.

Discussion: Results of this novel study provide strong evidence of the benefits of an integrated exercise and PCST program for physical function and a range of physical and psychological outcomes in the short- and longer-term for people with knee OA. They highlight the potential for a new model of care involving physiotherapists. Advantages of using physiotherapists to deliver PCST may include better integration with exercise, increased availability of PCST treatment to those who may not have access to a psychologist, reduced time and cost for patients and reduced overall costs to the health care system.

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Quadriceps muscle force control is related to knee function 12 months after anterior cruciate ligament reconstruction

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Introduction: The capacity of the quadriceps muscles to produce steady and accurate force may be an important determinant of knee function after anterior cruciate ligament reconstruction (ACLR). Impairments in the steadiness and accuracy of quadriceps force production following ACLR have been previously reported but the relationship between these impairments and knee function is not well established.

Method: A novel testing protocol was developed to assess accuracy of quadriceps force production and muscle activation strategies after ACLR. Thirty participants (19 males, mean age 27, range 19–39) at 12–24 months post ACLR with a semitendinosus-gracilis graft and 30 physically active control participants (15 males, mean age 24, range 18–34) were recruited. Participants performed a sub-maximal isometric knee extension task while seated on an isokinetic dynamometer. Participants sat on a foam platform without thigh support, necessitating the recruitment of gluteal and trunk muscles to maintain stability. The task involved matching a target torque displayed on a computer monitor that varied between 5–30% of their previously-determined maximum voluntary contraction (MVC) at a speed of 0.25 Hz for one minute (7.5 cycles). Root mean square error (RMSE) of the torque output (normalised to MVC) was used to assess the accuracy of quadriceps force output. Electromyographic signals (RMSE) from the hamstring and quadriceps muscles were used to quantify muscle activation strategies. In the ACLR group, two sub-groups were created (high-error and low error groups) based on the median value of quadriceps RMSE to compare self-reported knee function, using the Cincinnati Knee Rating Scale (CKRS).

Results: Statistical analysis revealed ACLR participants demonstrated higher quadriceps force error ($p < 0.03$) and greater activation of medial hamstring ($p = 0.001$) and vastus medialis ($p = 0.04$) than healthy control participants. In the ACLR group, significant negative correlations were found between quadriceps force error and medial hamstring activation ($r = -0.45$, $p = 0.02$) and lateral hamstring activation ($r = -0.40$, $p = 0.03$). ACLR participants with higher quadriceps force error had significantly better knee function [CKRS=90.6%, 95% CI=86.5–94.7] than participants with lower error [CKRS=81.2%, 95% CI=73.0–89.4], (effect size 0.84).

Discussion: Although ACLR participants demonstrated higher quadriceps force error than control participants, ACLR individuals with lower error (reduced quadriceps force variability) had worse knee function. Contrary to our hypothesis, lower quadriceps force error was associated with greater hamstring co-contraction. Greater hamstring co-contraction and reduced quadriceps force variability were associated with worse knee function and are thought to reflect mal-adaptive neuromuscular strategies.

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Anterior and posterior gluteus minimus are functionally distinct from anterior and posterior gluteus medius

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Introduction: Gluteus minimus (GMin) and gluteus medius (GMed) are considered important hip joint and pelvic stabilisers. Despite having distinct anatomical attachments, the muscles have been functionally considered as one, or grouped together based on anterior and posterior regions (e.g. anterior GMin and anterior GMed are considered one functional unit). The purpose of this study was to determine whether anterior and posterior segments of GMin are functionally different from anterior and posterior segments of GMed respectively, during gait. The findings could help to determine whether each muscle has the potential for unique roles in hip health or dysfunction.

Methods: Bi-polar, fine wire electromyography (EMG) electrodes were inserted into anterior and posterior segments of GMin and GMed in 15 healthy volunteers (9 males, 6 females, mean age 22.5 years). Participants were asked to walk four times at a comfortable, self-selected walking speed along a 10 m walkway. Temporal (time to peak, TTP) and amplitude (Peak and Average, normalized to percent of maximum voluntary isometric contraction) EMG variables were collected from a total of 8 strides per participant. Data was processed and analysed separately within three phases of the gait cycle; 0% to 20% gait cycle (representing the first EMG burst), 20% to 60% gait cycle (representing the second EMG burst) and the whole stance phase (heel strike to toe off). Independent samples t-tests were used to compare the EMG characteristics between corresponding segments of the GMin and GMed ($p=0.05$).

Results: Analysis of the anterior segments indicated that anterior GMed had a higher EMG amplitude (Peak and Average) and earlier peak first burst, as well as an earlier peak within the stance phase compared with anterior GMin ($p<0.05$). Analysis of the posterior segments suggests that posterior GMin had a significantly later peak for the first and second burst, as-well as a larger amplitude (Peak and Average) for the second burst ($p<0.05$).

Discussion: The results of this study confirm that GMed and GMin should be considered as functionally independent muscles. When viewed together with morphological data from past research, anterior GMed likely contributes to pelvic stability, while anterior GMin is suited to stabilising the head of femur in the acetabulum, particularly in mid to late stance. Posterior GMed may facilitate hip joint stability in early stance, while posterior GMin may contribute to hip joint stability through-out stance. These proposed roles can assist with the development of targeted hip rehabilitation programs.

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Does hypoxic and thermal stress enhance the training response and performance for AFL footballers?

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Introduction: An increasing number of AFL Clubs are using altitude-training camps as part of their early season training, with one club, adding thermal stress to improve their on-field performance. What is the evidence that these additional environmental stressors provide adaptations that enhance the physical performance and this expense justified?

Research review: The traditional model for altitude training to improve sea level (SL) performance was based on a live high and train high (LHTH) model. In 1997, Stray-Gunderson and Levine's group compared the LHTH model to a new model of altitude training, where athletes lived-high (2500 m) while training at low (1250 m) altitude (LHTL). While both groups showed a significant increase in red cell mass (RCM) and VO_2 max in response to the hypoxia, only the LHTL group showed a significant improvement in 5000 m running performance at SL. This was attributed to the training speed specificity at SL. Many research studies show that only some athletes "respond" to hypoxia by increasing erythropoietin synthesis and RCM, with only some studies showing these haematological adaptations significantly correlate with increased VO_2 max. Any improvement in SL performance is limited to 1–2%. Indeed, some researchers attribute any improvements in SL performance to non-haematological adaptations. The maintenance of any physiological adaptations and performance improvements are limited to 3 weeks post-altitude exposure, so the physiological benefits of an early pre-season altitude training camp to an AFL player's on-field performance three months are questionable? McLean et al (2013) compared the effect of a 19-day LHTH training camp in Arizona on 21 Collingwood footballers compared to a "control" group who trained in Melbourne. RCM increased and SL 2000m running performance improved on return to SL in the LHTH group when compared to the control group, which was maintained for four weeks post-camp. In 2011, Carlton Football club (Buccheit et al, 2012) added thermal stress to hypoxic stress and compared this to a group that only trained in the heat. The altitude group increased their RCM, but both groups showed significant performance improvements, attributed to increased in blood volume induced by thermal stress. Interestingly, only the altitude group maintained this performance improvement for 3 weeks.

Conclusion: While there is a small performance benefit attributed to hypoxic training and the cost is at least \$750K, thermal stress might provide a more economical and relevant environmental stress for AFL footballers. AFL clubs might better use these savings on other areas of performance improvement?

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Decrements in strength comparing high- and moderate-volume sprints between the wickets in batsmen

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Introduction: The objective of the current investigation was to determine the strength changes within the lower limb musculature of specialised batsmen induced by two work bouts of differing intensities.

Methods: Twenty cricket batsmen (age 22.6 ± 4.74 years; stature 179.5 ± 6.38 cm; mass 80.7 ± 11.77 kg) were tested. Two experimental conditions, representative of a high- (HVR representing twelve sprints per over) and moderate-volume running (MVR representing six sprints per over) batting protocol were compared in a laboratory setting. Muscle strength measures were collected prior to, and following both protocols using the Cybex 6000 Isokinetic Dynamometer, and included; concentric and eccentric measures of both knee flexors and extensors. Peak torque, total work, average power and the hamstring to quadriceps ratio were the isokinetic strength parameters under study with sampling conducted at speeds of 60 and $270^\circ.s^{-1}$.

Results and Discussion: Both the HVR and MVR conditions resulted in significant ($p<0.05$) reductions in concentric and eccentric extensor and eccentric flexor peak torque at $60^\circ.s^{-1}$. However, expectedly, the largest changes were seen following the HVR condition. For example, peak concentric and eccentric knee extensor (EXT) (-17.17% and -16.07% respectively) and eccentric flexor (FLEX) (-17.49%) values decreased significantly ($p<0.05$) following the HVR condition at $60^\circ.s^{-1}$. In addition, concentric and eccentric total work produced by the flexors and eccentric extensors resulted in significantly ($p<0.05$) lower values due to the HVR condition. In contrast, the MVR condition elicited significant ($p<0.05$) reductions in concentric extensor average power values at speeds of $60^\circ.s^{-1}$, whereas the HVR protocol revealed no changes in average power for concentric or eccentric flexor and extensor values at both speeds. Thus, although strength was negatively compromised following both conditions, this was to a greater extent following the high volume sprinting condition. In conclusion, the isokinetic concentric strength decrement was particularly exaggerated following the HVR condition while eccentric strength decrements were evident following both conditions.

218 Energy cost and metabolic power of Australian football

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Recently, models based on running velocity and the rate of change in running velocity have been used to estimate the energetic demands of field-based team sports. Such analyses have provided greater insight into the intermittent physiological loads experienced during play, aiding the preparation of players for competition, potentially minimising the effects of fatigue and improving performance. The aim of this study was to describe the metabolic demands of different playing positions in elite Australian football competition; and to evaluate the utility of energy expenditure as a monitoring tool. A running based model was used to estimate energy expenditure and metabolic demands of 24 elite Australian football players tracked during the 2010 AFL season using 5 Hz GPS receivers. Players were allocated to 4 positional groups: midfielders (n=74 files), ruckmen (n=24 files), small forwards/backs (n=78 files) and key forwards/backs (n=76 files). The demands of each game were quantified by the duration (min:s), distance travelled (m), energy expenditure (J·kg⁻¹), anaerobic index and equivalent distance (m). Six metabolic power (W·kg⁻¹) zones were used to profile the intensity of play. One-way ANOVA with Bonferroni post hoc tests were performed to compare between positional groups using SPSS 19.0 (SPSS, Chicago). Total energy expenditure ranged from ~46–63 kJ·kg⁻¹ equivalent to running 11.5–15.7 km at a steady aerobic pace. Time on-field, distance travelled, total energy expenditure and the rates of energy expenditure varied between playing positions. Midfielders were found to expend the most energy between moderate aerobic and light anaerobic metabolic rates (10–35 W·kg⁻¹). Ruckmen expended the least energy overall, and ranked lower on energetic indices of running intensity. Key and small forwards/backs had more intermittent running profiles. Small forwards/backs expended the most energy at high exercise intensities (>55 W·kg⁻¹) followed by key forwards/backs. Key forwards/backs expended the most energy at low intensities (<10 W·kg⁻¹). Changing forward running velocity accounted for ~24%, of the total energy expenditure for all positions. The range of total energy expended compares well with recent estimates in soccer (~60 kJ·kg⁻¹). Energetic indices identified differing metabolic demands for midfielders, ruckmen, small forwards/backs and key forwards/backs. These profiles were consistent with previous findings, suggesting energy expenditure is sensitive to variation in running demands. GPS modelled energy expenditure is both a meaningful and practical option for coaches seeking a unifying index to monitor the physiological strain of competition and training.

219 Impact of a simulated one day international century on batting performance in cricket

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Introduction: Very few studies have examined the demands of a prolonged work-bout on batting performance in cricket. Of the studies that have been conducted, most have used short-duration work-bouts of high intensities and focused on simple performance responses. The purpose of this study therefore, was to determine how scoring a simulated one day international (ODI) century would impact batting performance; more specifically, sprint times and impact accuracy (impact of the ball on the face of the bat, relative to the 'sweet spot').

Methods: Seventeen male cricketers, performed a simulated batting innings (BATEX[®]), typical of scoring a ODI century. The BATEX[®] protocol consisted of six, five over stages (21 minutes each), with each stage matched to a specific phase of play where batsmen were encouraged to bat with the mindset of that phase. During stages one, three and five players ran at a "self-selected cruise pace" whereas during stages two, four and six players were required to run at maximum speed. Sprint times were recorded during the high intensity stages where batsmen were required to sprint a '2'. Times were recorded using a single-beam timing gate system. Impact accuracy was recorded using a bat fitted with specialised electronic wiring equipment and responses were recorded during the first over of each stage.

Results: Sprint times increased significantly (p<0.05) between stage 2 (5.61±0.41 s) and stage 6 (5.81±0.32 s). In contrast, impact accuracy improved significantly (p<0.05) after stage one (104.82±25.34 mm) and then stabilised for the remainder of the protocol (between 57.40±17.69 mm and 67.56±20.84 mm).

Discussion: The simulated batting protocol significantly impacted the performance responses of the batsmen. A slowing down in sprint times towards the end of the protocol may indicate the presence of physical fatigue. This physical fatigue did not however seem to impact the batsmen cognitively as accuracy improved after the first stage and then remained constant over time. It is therefore suggested that in addition to skills based training, that batsmen receive more specific repeated sprint training activities to prolong the onset of physical fatigue.

220 Mental effort ratio and perceived exertion in sub-maximal bicycle ergometry

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Background: Individual differences in subjective tolerance to fatigue and physical exhaustion can be estimated by the proportion of exercise sustained after the detection of first signs of perceived exertion (Borg, 1973, 1982). This proportion has been found to be relatively stable (Ilyin, 1980; Aidman 1995; Miotti, 1996) and was termed "mental effort ratio" (MER), with a psychometric procedure for its measurement developed using a modified hypoxemic (breath-holding) test. Current paper continues to examine the relationship between MER and endurance performance, following the studies with endurance athletes (Aidman, 2005) and military personnel (Aidman & Cramer, 2006).

Method: Thirty regular, non-competitive exercisers (14 females) performed the MER test and then rated their perceived exertion (Borg's RPE) at 90sec intervals while performing Incremental Bicycle Ergometry at their individually calibrated work intensity of 80% of PWC.

Results: Predictable negative correlations were observed between MER metrics and Borg's RPEs at 80% of Physical Working Capacity (PWC). Higher MER levels were predictive of lower RPEs at an individually normalised and hence, cross-individually comparable, level of work intensity (80% of PWC). MER was also shown to correlate with dispositional mental effort tolerance (MET; Dornic, Ekehammar & Laaksonen, 1991).

Conclusions: Results to date confirm the validity of MER measurement in predicting important performance parameters, such as aerobic capacity. This makes it an attractive practical addition to assessment protocols used for selection into physically demanding occupations. Potential applications and future development of the tool are discussed.

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Introduction: As training intervention studies are not often feasible in elite sport, observing the current strategies used by elite athletes is necessary to provide insight into current best practice and inform future training planning and prescription. However, there is paucity of research documenting recent practices in elite rowing, with the available data lacking details regarding training organisation (e.g., loading patterns, the structure of training specificity and variety). Therefore, the purpose of this study was to document the training volume and training patterns of elite rowers over six months of domestic preparations.

Methods: 19 elite Australian rowers (14 males, 5 females) participated. Training was monitored for six months, comprising a specific preparation phase (P1; 12 weeks) and a domestic competition phase (P2; 12 weeks). Training data were analysed for the whole sample and grouped by sex. Training load was quantified using external measures of volume (training duration and distance rowed), and a validated, in-house proprietary measure of internal load known as the T2minute method.

Results: In P1, external training volumes averaged 18.3 ± 1.9 h and 111.9 ± 43.7 km rowed per week. The average weekly internal training load was 1092 ± 150 T2minutes. In P2, 16.9 ± 3.4 h of training was completed, with 110.4 ± 24.2 km were rowed per week. Average weekly internal load in P2 was 1110 ± 222 T2minutes. The loading pattern typically fluctuated on a four-week cycle, with the highest training loads occurring in weeks 3 or 4 of a cycle. In P1, on-water rowing predominated ($54.1 \pm 17.9\%$ of total training duration), followed by non-rowing training ($37.8 \pm 16.8\%$), and ergometer rowing ($8.1 \pm 3.2\%$). In P2, the proportion of time spent in on-water training increased to $61.3 \pm 12.4\%$, with concomitant decreases in non-rowing training ($31.6 \pm 12.2\%$). Male rowers completed a greater relative proportion of rowing-specific training than female rowers (males $91.8 \pm 4.5\%$ vs. females $79.8 \pm 14.1\%$ of total T2minute load; males $71.7 \pm 5.9\%$ vs. females $51.7 \pm 17.6\%$ of total training duration).

Conclusion: Compared to previous reports, the rowers in this study completed similar or slightly lower training volumes and similar distances rowed. This research contributes new data that illustrates how prescribed fluctuations in training loads are realised. In addition, the data indicates that the training of elite Australian rowers is more varied, with greater distribution of training load to non-rowing modes, than what has been previously reported.

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Introduction: It is well known that overuse injuries of the lower limb musculature are a common occurrence in batsmen. The repeated sprint activity between the wickets in addition to the rapid accelerations and decelerations required when sprinting and turning have been proposed to be linked to these overuse injuries. Therefore, the purpose of this study was to determine whether muscle recruitment patterns and sprint times change over time during sprinting between the wickets comparing two conditions of varying intensity of effort.

Methods: Twenty cricket batsmen (age 22.60 ± 4.74 years; stature 179.51 ± 6.38 cm; mass 80.77 ± 11.77 kg) were tested. The exercise protocol involved two experimental conditions, representative of a high- (HVR) and moderate-volume running (MVR) batting protocol both of which were seven overs. The HVR condition required players to sprint twelve runs per over and the MVR condition required the players to sprint six runs per over. Dependent variables of interest were sprint times as well as muscle recruitment changes of the following muscles: vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF) and semitendinosus (ST).

Results: There was no change in sprint times during the MVR condition which was in contrast to the HVR condition where sprint times significantly ($p < 0.05$) slowed over time. More specifically, a significant ($p < 0.05$) increase in sprint time was measured from the first over compared to over's three to seven in this condition. Further, there was a lower variability in sprint times during the MVR condition. Reductions in BF and ST muscle recruitment levels were observed following the HVR condition. This was further supported by the significantly ($p < 0.05$) greater levels of ST activation following the MVR condition when compared to the HVR condition.

Conclusion: These results suggest elevated demands were placed on the hamstring musculature as a consequence of the HVR condition.

This suggests a greater degree of musculoskeletal strain and increased injury risk associated with running between the wickets at this intensity, representative of an aggressive batting scenario requiring a high volume of repeated sprints.

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Introduction: A tackle in Rugby League occurs when a defending player holds or seizes an attacking player to halt the progress. The shoulder charge (SC) is a recently adopted tackling technique whereby the defender charges or knocks down the ball-carrier without trying to grasp the player. Rugby Union research indicates collisions of this nature are 70% more likely to result in injury than a conventional tackle (CT); therefore, the study investigated the physical demands and injury outcomes of SC tackles within Rugby League.

Methods: Seventy-five players from the 2012 Australian National Rugby League (NRL) competition were recruited. Tackle characteristics and injury outcomes from video footage of 101 matches (30 NRL rounds and finals series) were examined. Where possible, data from Global Positioning System (GPS) units worn by players was linked to video footage for analysis. Tackles were classified as SC or CT. Outcome measures included impacts (G-force) sustained during SC and CT events, injury outcome, tackle characteristics and SC utilisation rate. Match play was linked to GPS data.

Results: From a total of 142,355 tackles, 68 SC events were identified. The SC incidence was 0.05% with an average rate of 0.33/game. No strategic trends were observed with SC being employed in general play situations (67%), kick returns (15%) and kick restarts (12%). Attackers were "blind sided" in 6.5% of SC incidents. Defenders successfully made contact with the shoulder in 80% of attempted SC. The point of SC contact on attackers was the head (17%) and shoulder (60%). SC resulted in no injury to the attacker or defender in 96% and 99% of tackles, respectively. Concussion injuries occurred in 2% of attackers and 1% of defenders. One attacker (1%) suffered a career-ending neck injury. In these cases, players were removed from the game due to injury. Data from six GPS files of SC tackles only were available. When compared with six CT files from the same games, the mean impact force of SC tackles (10.7 ± 2.5 G) was significantly higher than CT (6.06 ± 0.6) ($p = .004$).

Discussion: Preliminary findings show that SC incidents occur at collision forces 76% greater than conventional front-on tackles. The increased collision forces coupled with head contact resulted in concussion and neck injuries to both attacking and defending players. Although these results may be unique to individual players and teams' defensive strategies, they are indicative of the significant physical demands and injury outcomes of SC tackles in Rugby League.

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Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers

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Introduction: Compared to other positions in elite cricket, fast bowlers have a higher workload. This higher workload is coupled with greater injury prevalence. The purpose of this study was to determine the relationship between injury and acute and chronic workloads in elite cricket fast bowlers. Methods: Workloads for 28 fast bowlers (mean age 26 yrs., range 17.2–36.3 yrs.) were collected over 5 seasons, by summarising the total number of balls bowled per week (external workload), and by multiplying the session RPE (RPE, CR-10) by the session duration (internal workload). The 1-week data represented the acute workload, while the 4-week rolling average represented the chronic workload. The size of acute workload in relation to chronic workload provided either a negative or positive training-stress balance (TSB). Training-stress balances were then compared with the current and subsequent week's injury likelihood.

Results: A negative TSB was associated with an increased risk of injury in the subsequent week for internal workload (Relative risk (RR)=2.2 [Confidence interval (CI), 1.91–2.53], $p=0.01$), and external workload (RR=2.1 [CI, 1.81–2.44], $p=0.01$). Fast bowlers with an internal workload TSB of greater than 200% had a RR of injury of 4.5 (CI, 3.43–5.90, $p=0.01$), and 3.4 (CI, 1.56–7.43, $p=0.03$) compared to those with a TSB between 50 to 99%, and 0 to 49%, respectively. Fast bowlers with an external workload TSB of more than 200% in magnitude had a RR of injury of 3.3 (CI, 1.50–7.25, $p=0.03$) in comparison to fast bowlers with an external workload TSB between 50 to 99%.

Discussion: This is the first study to investigate the relationship between acute and chronic workloads and injury risk in elite cricket fast bowlers. Our results indicate that increases in acute workload relative to chronic workload increase injury risk in the following week. Furthermore, greater increases in acute workload relative to chronic workload, result in larger injury likelihoods in the subsequent week. This is highlighted by the 3- and 4-fold rises in injury risk for external and internal workloads, respectively when TSB exceeded 200%. These results suggest that increases in chronic workloads should be performed systematically, in an appropriate sequence and combination. In summary, it is clear that a negative internal and external TSB is associated with subsequent injury, which highlights the importance of monitoring both internal and external workloads, and acute and chronic workloads to minimise injury likelihoods in elite cricket fast bowlers.

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The influence of soccer-specific fatigue on the risk of thigh injuries in amateur Black African players

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Introduction: Epidemiological findings indicate a higher risk of muscular thigh strain injury during the latter stages of both halves of soccer match-play, with muscular fatigue highlighted as a key etiological factor in injury causation. Anthropometric, biomechanical and physiological differences present in the Black African population may elicit unique thigh injury risk profiles, different from those of European and American players. The purpose of the current research was to investigate the impact of soccer-specific fatigue on the risk of hamstring and quadriceps injury in amateur Black African soccer players, in both the dominant and non-dominant legs.

Methods: Participants ($n=20$) were required to perform a soccer match-play simulation (SAFT90), consisting of multidirectional and utility movements, as well as frequent acceleration and deceleration. Selected physical, physiological and psychophysical responses were collected at specific time intervals throughout fatigue protocol performance.

Results: Heart rate responses were observed to increase significantly ($p<0.05$) in response to the start of both halves, and remain elevated (but showing no further significant increase) during the performance of the remainder of the fatigue protocol. Significant ($p<0.05$) changes in both concentric and eccentric isokinetic variables of the knee flexors and extensors highlight the effect of muscular fatigue on performance in soccer match-play. Eccentric hamstring peak torque was observed to decrease significantly over time ($60^\circ.s^{-1}=17.34\%$, $180^\circ.s^{-1}=18.27\%$), with significant reductions observed during both halves. The functional H:Q ratio at $180^\circ.s^{-1}$ indicated a significant decrease over time (10.04%), with a significant decrease indicated during the second half of the SAFT90 protocol. The passive half time interval did not result in significant changes in isokinetic variables. Isokinetic strength, work and power indicated no significant effects of leg dominance.. 'Central' and 'Local' ratings of exertion were observed to increase significantly ($p<0.05$) as a function of exercise duration.

Discussion: The overall reduction in both the eccentric hamstring peak torque and the functional strength ratio was illustrated to be similar to that of other soccer-specific fatigue research. As a result, the risk of thigh strain injuries is suggested to be similar regardless of playing level and race. These time dependent changes may have implications for competitive performance and increased predisposition to hamstring strain injuries during the latter stages of both halves of match-play.

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Injury characteristics in Australian elite junior rugby league players

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Introduction: Rugby league (RL) players participate in physically demanding collisions and activities, and musculoskeletal injuries are common. Few studies describe injuries at the junior level. Currently no injury surveillance paradigm in the Junior RL Competition has been established, although Clubs record player injuries asystematically. Thus, the aim of this study was to characterise injuries sustained by junior players within the elite competition.

Methods: The study was a prospective cohort experimental design. We developed and implemented an injury surveillance mechanism in the 2012 NSW Junior Representative RL Competitions (Under 16 (U16) and Under 18 (U18)). Players' match and training injuries were recorded for nine rounds and five finals rounds.

Results: We recruited 385 players (U18: n=201, U16: n=184; mean age 15.8 years). Only 114 full data sets (U16: n=5; U18: n=2 teams) were available due to poor compliance from clubs with respect to form completion and data collection. Although 109 injuries (98 match, 11 training; 66% to forwards, 34% to backs) were reported, 38 injuries (35%), defined as missing >1 matches resulted in 70 matches missed and an injury incidence of 94/1000 playing hours. Injury severity was categorised as mild (83%, 0–1 matches lost), moderate (15%, 2–4 matches lost) or major (2%, >5 matches lost). Ankle injuries produced the greatest match losses (3–5 games). Knee injuries caused 3–4 lost matches; fractures and shoulder joint injuries resulted in 3 and 1–3 lost matches, respectively. The major injury types included bruise/cork/haematoma 48%; sprain/ligament injury 21%; concussion 7%; muscle tear/strain 7%. Injuries predominantly occurred to ankle 13%; head/face 12%; shoulder/clavicle 11%; sternum 11%; quadriceps 11%. Three-quarters of injuries were tackle-related: 43% from being tackled, 32% from effecting the tackle. Similarly, sternum injuries and corks/haematomas resulted in 1–2 lost matches.

Discussion: The injury incidence reflects use of exact player match duration where possible and underestimation of injuries. Most injuries sustained were mild and comparable to previous studies. The most commonly injured region is the ankle. Shoulder injuries have surpassed knee injuries (previously most prevalent) which may be attributed to changes in match rules of the 10m defensive line. There was limited adherence to documentation by teams. Whilst club personnel agreed that routine injury surveillance and supervision was important, only a minority persevered with recording throughout the season. Given the developing musculoskeletal system in juniors, the presence of larger Polynesian players, higher intensity of play and training regimes, injury incidence warrants rigorous documentation and careful monitoring. This study was supported by the NSW Sporting Injuries Committee

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Choose your own intensity: Advantages for and mechanisms underpinning self-regulated exercise

SYMPOSIUM

R. Eston^{1*} ▪ H. Evans^{1*} ▪ A. Smith^{1*} ▪ G. Parfitt^{1*} ▪ G. Tempest^{1*} ▪ ¹University of South Australia

Introduction: Despite the high saturation of recent public health campaigns to increase exercise and physical activity levels, the number of Australian adults failing to meet the recommendations remains high. Interventions to promote participation have yielded modest results at best, prompting an urgent need to better understand the factors associated with exercise behaviour change; factors such as individual choice and enjoyment. An exercise intensity to adherence hypothesis suggests a causal chain linking the intensity of physical activity, affective responses and adherence. The method of controlling exercise intensity also appears to be an important factor in this relationship.

Format: The symposium will begin with an overview of the exercise-adherence hypothesis and related theories, and the factors associated with exercise behaviour change. Following this, a series of four papers will be presented to demonstrate the advantages and applications of self-regulated exercise across the life course. Paper one describes the use of a perceptually-regulated exercise test (PRET) to measure cardiorespiratory fitness; paper two describes the use of a sub-maximal PRET to predict fitness in older adults; paper three describes the training effect of an 8-week PRET program, clamped at two levels of ratings perceived exertion (RPE) on fitness, and assesses the affective responses associated with PRET at the two RPE levels, and paper four describes the actual intensity and affective responses to a bout of self-selected intensity exercise in both youth and older adults. In each of these presentations, the focus will be on particular links in the exercise-intensity-adherence chain. The final paper will focus on the mechanisms underpinning the exercise intensity-affect relationship and will describe the relationships between cerebral blood flow and affective responses to exercise. Following these presentations, an interactive discussion with the audience will be led by Professor Roger Eston, a highly regarded researcher with a world class reputation in the study and utility of perceived exertion in a variety of clinical and healthy populations. The results from the first four studies presented will be discussed to highlight real-life application and implications for practice and policy. The final study will be discussed to shed light on the mechanism underpinning self-regulated exercise, and to stimulate discussion regarding other potential sources of influence.

Paper 1: Maximal exercise testing: Making it feel better

Paper 2: Does a submaximal perceptually-regulated exercise test work with older adults?

Paper 3: A 'hard' training program only works for some

Paper 4: What intensity do old and young choose: How hard, how do they feel and so what?

Paper 5: Why we feel how we feel: Investigating cerebral blood flow during exercise

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Maximal exercise testing: Making it feel better

H. Evans^{1*} ▪ G. Parfitt¹ ▪ R. Eston¹ ▪ ¹University of South Australia

Introduction: Often regarded as a criterion measure of aerobic fitness, the direct measurement of maximal oxygen uptake (VO_{2max}) requires the individual to exercise to volitional exhaustion. However, the decline in affective state (i.e. how good or bad one feels) throughout a maximal test is rarely considered. The autonomy given to the individual during a perceptually-regulated exercise test (PRET) whereby participants control the exercise intensity would likely induce a more positive affective response compared to a traditional 'experimenter controlled' graded exercise test (GXT). The aims of this study were to assess i) if a PRET could be used to elicit a VO_{2max} and ii) if the affective responses differed between the PRET and the GXT.

Methods: Sixteen participants (20.5, 18–22 yrs) completed three PRETs which required them to adjust the resistance on a recumbent cycle ergometer to correspond to prescribed Ratings of Perceived Exertion (RPE) levels 9, 11, 13, 15, 17 and 20 and one GXT using a ramp protocol; all tests ended with volitional exhaustion. Affect was recorded every minute throughout exercise using the Feeling Scale (FS). Physiological and performance parameters along with affective responses were compared between the third PRET and the GXT.

Results: There was no significant difference ($p > 0.05$) between the VO_{2max} measured from the PRET (43.5 ± 4.1 ml/kg/min) and the GXT (44.3 ± 4.9 ml/kg/min). Participants also reported feeling significantly less negative ($p < 0.05$) during the final phase (just prior to volitional exhaustion) of the PRET (FS -0.84 ± 3.0) compared to the GXT (FS -2.4 ± 2.7). When matched for the same submaximal level of perceived exertion (RPE 9, 11, 13, 15, 17) participants felt more positive ($p < 0.05$) when perceptually regulating the exercise intensity opposed to when the intensity was controlled by the experimenter during the GXT (average mean difference FS = 1.3 ± 4.9).

Discussion: A maximal PRET can be used to elicit a VO_{2max} in young healthy individuals. Participants felt more positive when controlling the exercise intensity via a PRET opposed to when the experimenter controlled the intensity via a traditional GXT. The PRET has application in situations where the direct measurement of VO_{2max} is required and potential negative affective responses of the individual are considered important.

229 Does a submaximal perceptually-regulated exercise test work with older adults?

A. Smith^{1*} ■ B. Norton¹ ■ R. Eston¹ ■ G. Parfitt¹ ■ ¹University of South Australia

Introduction: An accurate measure of peak oxygen uptake (VO_{2peak}) is an important indicator of cardiorespiratory fitness. In older adults significant concerns for safety are associated with using tests which push participants to volitional exhaustion to measure actual VO_{2peak} . There are a number of indirect methods to predict VO_{2max} although the validity and reliability of these methods are questionable. Recently, VO_{2peak} was reliably predicted in young adults using a submaximal perceptually-regulated exercise test (PRET). Whether older adults can use this same test to accurately predict VO_{2peak} is unknown.

Methods: We assessed the validity of a treadmill based PRET to predict VO_{2peak} on sufficiently active older adults ($n=9$, 65.5, 61–74, 3 males). Participants completed two PRETs (PRET 1 and PRET2), requiring a change in speed or incline corresponding to ratings of perceived exertion (RPE) 9, 11, 13 and 15. Extrapolation of RPE was obtained from VO_2 data to RPE 19 and 20 from the 9–15 ranges. This extrapolation was then used to estimate VO_{2peak} and compared to actual measured VO_{2peak} from a graded exercise test (GXT).

Results: Repeated measures analysis of variance (ANOVA) revealed no difference in VO_{2peak} between PRET 1 and 2 when extrapolated to RPE19 ($F_{[1,8]}=4.7$, $P=0.06$). There was no difference when VO_{2peak} from PRET 1 was extrapolated to 19 and compared to actual VO_{2peak} ($F_{[1,8]}=1.8$, $P=0.2$). Furthermore, predicted VO_{2peak} extrapolated to RPE 19 strongly correlated with actual VO_{2peak} ($d=0.7$, $P=0.03$).

Discussion: This demonstrates that a single PRET can be used to robustly predict VO_{2max} in older adults. Findings have particular relevance to healthy older populations and clinical populations where maximal exercise testing is not recommended.

230 A 'hard' training program only works for some

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Introduction: There may be a delicate balancing act between exercise at an intensity which is pleasant (and hence encourages adherence) and exercise at an intensity which optimises health-related benefits. We know that training at a rating of perceived exertion (RPE) of 13 ('somewhat hard') can improve fitness, is adhered to during training and is perceived as pleasant. We do not know if the same is true for training at RPE 15 ('Hard/Heavy'). The aim of this study was to examine the physiological and motivational process effects of perceptually-regulated training at RPE 13 and RPE 15.

Methods: Currently sedentary participants ($n=66$) were randomised to 8-weeks training at RPE 13 or 15, or a waiting list control group.

Participants completed baseline fitness and exercise motivation assessments prior to and following the training period. The training was guided to be 30 min, 3 times a week in a gym environment where staff monitored that participants were perceptually-regulating at the allocated RPE intensity. Compliance to training was recorded and physiological training intensity was monitored over the training period.

Results: Maximal aerobic capacity increased significantly from baseline to post-training ($p < 0.05$, 7 to 11% change) for the RPE 13 and 15 groups respectively. There was no change in the control group and no statistical difference between the RPE 13 and RPE 15 groups. Drop-out across the 8-week program was high in the RPE 15 group (48% versus 18%). For those who complied, training intensities ranged between 80 to 85% HRmax for the RPE 13 and RPE 15 groups, respectively, and motivational processes began to increase, relative to the control group. Affective responses (pleasure/displeasure) were more positive in the RPE 13 group ($P < 0.5$) over the 8-week program.

Discussion: Perceptually-regulated exercise training with the RPE scale makes sense and improves fitness. Drop-out was higher in the RPE 15 group and indicates that self-regulation alone will not address this issue. However, given that the fitness gains were not significantly lower in the RPE13 training group, but affective responses and compliance were higher, a case can be made to recommend the use of RPE13-regulated training in sedentary adults.

231 What intensity do old and young choose: How hard, how do they feel and so what?

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Introduction: When individuals are allowed to self-select exercise-intensity, their affective (pleasure/displeasure) responses are more positive and the intensity is typically within the 'moderate' exercise domain. This research evidence is based mainly upon young to middle-age adult populations (active and sedentary). Two studies are reported that extend this research: Study 1 with older adults (male and female) and Study 2 with adolescent females.

Methods: Participants (Study 1, $n=10$, age= 66.5 ± 4.8 ; Study 2, $n=27$, age= $14.6 \pm .8$) exercised at their preferred intensity for 20min on a motorised treadmill. Oxygen uptake was measured throughout and affect and ratings of perceived exertion (RPE) were recorded at 5 min intervals. Participants changed the exercise intensity throughout the 20 minutes if they wished. In Study 2, with a counterbalanced protocol, participants were also prescribed an exercise-intensity for 20 min, but were blinded to the fact that it matched their preferred session.

Results: During the self-selected exercise, participants chose to increase the exercise-intensity and averaged $62\% \text{VO}_{2\text{max}} \pm 5$ (Study 1) and $70\% \text{VO}_{2\text{max}} \pm 10$ (Study 2), this was close to their ventilatory threshold. Affect remained positive throughout exercise (2.8 ± 1.1 and 1.89 ± 0.33 , Study 1 and 2 respectively) and RPE ranged from 'light' (RPE 11) in the first 5 minutes to "somewhat hard" (RPE 13) in the last 5 min. In Study 2, affect was significantly higher in the self-selected exercise compared to prescribed condition, even though the actual intensities did not differ. Discussion: When allowed to self-select exercise intensity, older adults and adolescent females choose to work at an intensity that would be classified as within the 'moderate' domain for at least 15 of a 20 min exercise session. Affect remained positive. When compared to a prescribed session (Study 2) even though the intensities were identical, affect was significantly lower in the prescribed condition. Care therefore needs to be taken when prescribing exercise-intensity in this population as affective responses during exercise have been shown to impact future activity behaviour. Given data support that the exercise stimulus from the self-selected intensity would confer physiological benefits, it may be wise to allow self-selection in these populations to facilitate maintenance of exercise-behaviour.

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Why we feel how we feel: Investigating cerebral blood flow during exercise

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Introduction: The underlying mechanisms of why we feel how we feel during exercise remain unknown and until recently have been methodologically problematic to investigate. Local cerebral blood flow (which reflects activity of the frontal cortex [FC]) can be measured using Near Infrared Spectroscopy (NIRS), and is suitable for use during exercise. The objective of this study is to examine affective responses (i.e. feeling good or feeling bad) and activity in areas of the FC during exercise standardised to metabolic processes (i.e. gas exchange thresholds).

Methods: In a fully repeated measures design, participants ($n=25$, 25.6 years, range 21–34) completed an incremental exercise test to volitional exhaustion. Affective responses (using the Feeling Scale; range +5 [very good] to -5 [very bad]) and changes in cerebral oxygenation (O_2Hb), deoxygenation (HHb), blood volume (tHb) and haemoglobin difference ($\text{HbDiff}=\text{O}_2\text{Hb}-\text{HHb}$), were measured (micromolar; μm) from the right (Areas 1–4R) and left (Areas 5–8L) FC (corresponding to Brodmann's Areas 8, 10 and 46) using multi-channel NIRS. Averages were taken at ventilatory threshold (VT), respiratory compensation point (RCP) and exhaustion (END).

Results: A one-way Time (Pre-, VT, RCP, END) ANOVA indicated a significant ($p<0.05$) decline in affect (feeling good to bad) from Pre- ($M \pm \text{SD}$, 2.4 ± 1.1), to VT (1.5 ± 1.0), RCP (-0.8 ± 1.7), and END (-2 ± 1.8). A multivariate ANOVA revealed significant ($p<0.05$) Intensity (3; VT, RCP, END) by Area (8; 1-4R, 5-8L) interactions for O_2Hb , tHb and HbDiff. From VT to END, HbDiff increased in Area 6L ($+1.7 \pm 4.9$) compared to Area 1R (-1.3 ± 5.7). From RCP to END, O_2Hb declined in Area 1R (-0.8 ± 2.2) whereas O_2Hb and tHb increased in Area 4R ($+1.4 \pm 2.5$ and $+3.2 \pm 3.6$, respectively). At RCP, Areas 1R (O_2Hb , HbDiff) and 6L (HbDiff); and at END, Areas 4R (O_2Hb , tHb) and 6L (HbDiff) were associated with feeling bad (range $r = -0.44$, $p<0.02$ and -0.61 $p<0.01$).

Discussion: Differential patterns of activity and asymmetry in the FC at exercise intensities above VT are associated with how we feel during exercise. On-going research is exploring other potential sources of influence i.e. dispositional traits and the effect of intervention strategies on FC activity during exercise to further understand why we feel how we feel.



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