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Another “Call to Arms”

CHRIS WHATMAN

In taking over the role of editor I would like to keep with the tradition of previous editors and pay tribute to the great work of Bruce Hamilton in leading the journal over the last 5 years. Bruce always impressed with his high editorial standards (my grammar was certainly found wanting on occasion!) and he brought a fresh look to the journal, adding sections including; “How I Treat” and “Postgrad Ponderings”. He also fostered various contributions from colleagues in High Performance Sport NZ which I am sure were always interesting to the wider membership of Sports Medicine NZ and others. In his first editorial when paying tribute to his immediate predecessor, Chris Milne, Bruce mentioned that he looked forward to Chris making a continued contribution to the journal – ditto to that with this editorial transition!

Taking on the editor role is a little daunting when I look at the list of names that have gone before me. Given my novice status and in the true traditions of a good academic I thought it best to consult the evidence as to the actual qualities needed to be a good editor. Acknowledging bias due to time constraints and the hand-picking of a couple of interesting looking sources, it does seem that I am at least part qualified. Experts suggest that editors need to be strategists, opportunists, collaborators, mediators, jugglers and gatekeepers.¹ Reads like the key qualities needed to be a parent to me, and having two young boys who tell me I’m one of the best jugglers they’ve seen gives me growing confidence! Should my juggling abilities let me down it is a pleasure to also welcome Stuart Armstrong to the editorial team and thank Stuart for his willingness to contribute. For those of you not overly familiar with my background and/or Stuart’s, we have included a brief bio in

this edition of the journal (thanks for the suggestion Brenda!).

The journal has a great history and Stuart and I believe it can still be relevant today. There are obvious challenges with the number journals in this space and unprecedented access to digital content across a variety of platforms. These challenges are not new however, and we believe the journal can still serve a role in informing and connecting local practitioners across the various disciplines that work in exercise and sports medicine. For me a key for the journal is to try and remain as practitioner centred as possible. In keeping with the definition of evidence based practice, the content should include appropriate research evidence but also the likes of case studies and expert commentaries highlighting advanced clinical practice. We have to acknowledge that we will always struggle to attract large quantities of original research given our place in the journal “pecking order”, however New Zealand has many advanced practitioners in the field of exercise and sports medicine and sharing of their knowledge and experiences needs to remain a primary focus. So in the words of previous editor Peter Milburn, this is another “Call to Arms”.

To all those experienced practitioners across the various disciplines please consider contributing – we want to hear your stories! Additionally a note to the academics (and others) that if you are publishing research in other publications please consider a brief commentary style version for the journal – preferably with a local flavour.

Stuart and I have been in discussion with the National Executive as to the future direction of the journal and they are very supportive of the journal and boosting the local flavour. We are also keen to try and enhance the journal’s

visibility via the current upgrade to the Sports Medicine NZ website. As I noted above, continuing to attract original research remains a goal but we are also keen for those local contributions from experienced practitioners via any of the following contribution formats (or any others that members would like to suggest); “How I Treat”, “Commentary Corner”, “Postgrad Ponderings”, conference reports, journal highlights (thanks to Chris Milne for continuing to provide the always informative “Best of British” section highlighting articles from the BJSM), branch updates, book reviews and of course letters to the editor!

I hope that you continue to enjoy reading the journal and also consider taking time out from what I am sure is a very busy clinical life to make a small (or large!) contribution.

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Fad diets in athletes

STUART ARMSTRONG

With every new Olympic cycle there seems to be a new “fad” diet going around. Of recent times there has been the paleo diet, the gluten free diet (in non-coeliac persons) and the intermittent fasting diet. These diets come and go over time, and there has been a great deal of interest recently around the low carbohydrate high fat diet (LCHF).

This diet is very polarising, with some controversy surrounding strong proponents of this diet such as Tim Noakes especially after a tweet he sent to a Mother of an infant. The subject of “tweeting” medical advice may be a good topic for another editorial! Despite this he has published a good review of this diet.¹

Looking at the core issue of a LCHF diet there are a few benefits and a few issues with this diet in athletes. There seems to be no debate that this diet is incredibly good at helping you lose weight if needed.² This is thought to be due to the appetite suppressive effect of the high fat and protein component of the diet, I have a few separate thoughts on this.

It is also proposed that the diet can help with ultra endurance events to teach your body to burn fat and increase rates of fat oxidation.³ Ironmen athletes have been shown to be “off the scale” on their fat burning ability after being on this diet for prolonged periods.⁴ Whether this actually helps race performance is another matter.

Shorter events and elite athletes are a different story. It has been shown to be detrimental to power sports.⁵ Studies on elite athletes have generally shown disappointing results.⁶

There is a possible benefit in ultra endurance athletes, but it shows negative performance for short events. So where is the cut off? There is no good data for that, but it is likely to be a sliding scale with impaired performance in events less than 1 hour, no significant change in events from 1 -10 hours and possible benefit in events over 10 hours and likely benefit to multi-day events.⁷

The other factor to take into account is energy availability. This is an incredibly important factor when we are thinking about reduced energy availability in sport and all the consequences involved with that condition.

So now to my personal experience. I was first made aware of this diet being used by athletes when one of my rowers started on it. He had always struggled to lose weight as a lightweight rower and decided to try this diet. In short it didn't work for him. As shown above it is not a diet for short events and he may have controlled his weight, but he lost his power and ultimately became a less capable rower.

In the spirit of physicians throughout the ages I felt a bout of self experimentation was in order. Although not to the extremes of previous medical colleagues⁸ I decided to try a LCHF diet for a few months.

My background is in ultra endurance events and I have transitioned from being around a 10 hour Ironman athlete to an ultra marathon runner now. After a 5 year break from hard training I had put on a few kilos and was struggling to lose this despite running up to 120km per week. I was also struggling with a number of overuse issues and had a weekly standing appointment with my physiotherapist.

I decided to try a very low carbohydrate diet (under 50g of carbohydrate per day). The initial couple of weeks were hard as I have a sweet tooth and had a marked craving for sugar. There was a spectacular weight loss and in 8 weeks I lost 8kg. Going from 82kg – 74kg. My running improved massively and I'm now back under 39minutes for a 10km run and my injuries all seem to have abated, there may be a place for some research on weight loss and running injuries. I had to modify the diet at this point as it was likely I was going to get into a situation of low energy availability and would likely start to pickup a whole set of new injuries secondary to this. To be fair I don't think it is the low carbohydrate diet that has improved my running times or my injuries, but purely the

weight loss. Whether it will help me come race day (11th November) remains to be seen.

In conclusion, it seems to be an acceptable weight loss tool, it is debatable if there is an effect above and beyond this and should be recommended with great caution in elite athletes. You also have to be careful about reduced energy availability, and it should not be recommended for power or short distance sports in a normal weight athlete.... Some food for thought.

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Risky business in Monaco: Implementation, prediction and a reductionist approach are all contributory factors in the future challenge of sports injury prevention

FIONA MATHER

More akin to a James bond movie set than the scene for a sports medicine conference, it was somewhat absurd to find so many eminent international specialists in sports medicine together with 1200 delegates, all travelling to the tiny principality of Monaco in attendance of the 2017 International Olympic Committee (IOC) world conference on prevention of injury and illness in sport. This triennial conference has progressively established its place as the premier conference for our sports medicine community and this one did not disappoint!

Injury and illness prevention over the last 25 years has been a prominent theme and who better to open this conference than the inimitable Willem Van Mechelen, presenting a critical review of our progress in the last three decades. His classic 4 step model was initially inspired from primary healthcare, where we now see “inactivity” as the 4th major cause of death from non-communicable disease. It is no surprise that sport and exercise, in the guise of illness prevention is high on political and socioeconomic agendas. Moreover, in elite sporting environments the promotion of athlete health has been an area where we can impact directly upon performance, delivering athletes to the start line in optimal health. Indeed, the IOC has identified athlete health as one of its major objectives.

Despite considerable research and improved understanding of aetiology and scientific approaches to injury surveillance, our ability to deliver comprehensive injury prevention strategies has been limited.¹ A major objective of this 2017 conference, was to consider some of the barriers to injury prevention in sport, specifically considering implementation, injury prediction and the reductionist approach.

Van Mechelen's classic model of injury prevention, taught us to quantify a specific

issue, ensure a consistent and robust approach to defining injury such that an intervention could be applied and its efficacy assessed.² The vast amount of literature amassed in the last two decades supports the fact that establishing the incidence, prevalence and severity of an injury are necessary hallmarks of robust injury surveillance. By his own admission, Van Mechelen identified that steps 3 and 4 of his model lack specific guidance in relation to the implementation and design to ensure a successful outcome. Subsequently, whilst significant progress has been made in quantifying injuries, in many instances the same rigor in approach to accepting, adopting and complying with the interventions has not been comprehensively applied.³ Thus, many injury prevention programmes have been ineffective in achieving their goals in sporting environments.

Van Mechelen promoted the work of Caroline Finch and the team at ACRISP, nominating the TRIPP (Translating Research into Injury Prevention Practice) framework as a successor to his own classic model. This framework highlights the importance of robust implementation methods within injury prevention. He advocated that more research in this area will guide effective implementation and sustainable outcomes for injury prevention and will raise awareness of the need to fully understand the sport, their attitudes and beliefs which shape behaviours towards health and safety of athletes.

Roald Bahr, highlighted that another contributory factor is our inability to predict an injury based on the outcome of current screening methods in an athlete population group. Methods for evaluating screening tests have been translated from public health (eg, cervical and breast screening) where the cohorts are large and the statistical evaluation is based on a binary outcome; sick or healthy. Sports Injury is more often a continuum of intrinsic and extrinsic risk factors which

collide when the injury is sustained.⁴ It is not uncommon for an athlete to perform well in a screening test yet sustain an injury anyway because the assessment was not specific or sensitive enough.⁵ Despite this, physical movement tests have been used extensively to provide qualitative and quantitative information with the aim of predicting the risk for an individual of sustaining an injury. Bahr, a stalwart in this field of injury prevention, outlined common flaws in this popular approach to pre-participation screening.⁶

He states that many have placed a blind faith in screening tests which have shown an association with injury, but explains that the presence of an associated risk factor does not improve our ability to predict an injury.⁷

Bahr concluded with a cautionary note stating that while the Periodic Health Evaluation, remains a valuable resource in athlete monitoring particularly when carried out regularly in-season, in its current form cannot be used to screen out or predict injury. Given the complexity of predicting an injury a more appropriate approach for practitioners working in sports medicine would be to consider the likelihood of an event occurring using an odds ratio.⁸ The difficulty with this requirement is that it relies upon a series of past injuries to predict future injuries, and with small cohorts and a drive towards primary prevention this is challenging for elite sporting environments.

The series of conference workshops proposed an alternative approach to screening in its traditional form. Several research groups presented how in-season benchmarking evaluates an athletes' “state of readiness” to perform and concluded that perhaps the aim of injury prevention is a by-product of this testing rather than the primary focus. Regularly monitoring an athlete's response to training over time has never been easier

with recent advances in technology, and the conference provided a platform to showcase how research institutes are beginning to recognise the strength of merging data streams across multiple disciplines to enhance our understanding of the multifactorial nature of injury risk.⁹

Meeuwisse's model for injury risk, was another popular go-to at the conference and brings some clarity to the conundrum of injury prevention in athletes. His frequently cited model moves from the linear stepwise approach and recognises the recursive pattern of injury risk creating a continuum of susceptibility to injury. Distinguishing the association from the prediction of injury he considers the former and encourages us to evaluate the interactions between the associated risk factors.¹⁰

In most sports, there exists an element of physical risk and our role in sports medicine is not to remove all risk but instead to ascertain the degree of susceptibility to injury which can then provide relevant, timely and accurate information to influence performance decisions and optimise an athletes' ability to adapt to training.^{11,12} Reviewing the last 25 years, we should not underestimate the complexity of predicting injury. Understanding the recursive nature of risk when considering the challenge of predicting future injury was a fitting finale to this conference and one which will undoubtedly be central to the next IOC conference in March 2020. There was just enough time to re-consider our fundamental approach to healthcare in sports medicine and this conference confirmed that our approach to injury prevention has thus far been viewed using a narrow lens. Some drew conclusions that the emphasis on a diagnosis driven, reductionist approach has limited our critical thinking into injury prevention and proposed a move towards more holistic athlete management. A paradigm shift towards promoting health in athletes may bring about the necessary behaviours, attitudes and integrated approach required to address compliance issues seen in traditional isolated approaches to injury prevention.¹³

To date, the threat of injury has not been enough to motivate the masses into changing daily practices and complying with injury prevention strategies. Injury risk is

multifactorial, with local and central effects on athletes. This conference suggested that such a complex problem requires consideration from a multi-disciplinary perspective, a view that will be welcomed by our coaching colleagues.¹⁴

Former US President Obama recently endorsed French presidential candidate Macron in the French presidential race stating "he appeals to people's hopes and not their fears". Perhaps we in sports medicine might consider this approach in the future as one would like to think that promoting athlete health and optimising training will have a better impact on performance than continuing to wield the threat of injury for another quarter of a century.

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Rugby, risk and rhetoric: The trivialisation of injury data must end

JOE PIGGIN

Immediate change is needed to injury risk reporting in the sport of rugby union. Players, potential participants and the public are currently subjected to a wide range of inaccurate and misleading claims about risk in rugby which fall unacceptably short of rugby organisations' ethical and legal obligations.

Rugby has recently had a successful reintroduction to the Olympic Games in both the men's and women's game and is experiencing significant growth around the world. Concurrently, the sport's governing body, World Rugby, claims that player welfare is of paramount importance and are also making rule changes to the sport, such as with a 'zero-tolerance approach to reckless and accidental head contact'.¹

Unfortunately, pronouncements about the likelihood of injury in rugby are influenced too much by expansionist visions and too little by the actual data on injury risk. Numerous recent and ongoing instances show that rugby organisations inappropriately downplay the risk of injury in rugby.

First, after World Rugby was alerted to their own press release's erroneous claims of a relatively low injury risk, they acknowledged this and retracted the claims.² However, their retraction was incomplete. To date, the press release still claims that the 'benefits of the game far outweigh the relatively low risk of injury', despite this claim being erroneous.³

Second, in a video linked on World Rugby's site entitled 'The Medical View', a physician claims that 'It's really difficult comparing rugby with other sports, and to be honest from a paediatric end I don't think we have the data. Clearly rugby does generate a different sort of set of injuries to horse riding or to water polo but there are still injuries in all sports ... and I think to compare these is really hard'.⁴ This is very troubling because there are many data available.⁵

(World Rugby had cited from a report which stated rugby has a 'high participation-based [hospitalisation] rate'.⁵

Third, the opaqueness surrounding articulations of risk has also been present in England Rugby's so-called 'Rugby Safe' booklet.⁶ The booklet, ostensibly written for parents and players, was particularly troubling due to its distinct downplaying and false representation of injury rates in rugby. The booklet stated 'One of the reasons players love rugby is that it is a physical sport. That does not mean that we accept that injuries are inevitable'.⁶ On the contrary, an array of studies on rugby injury rates shows that at a population level, injuries are inevitable. Another quote on the same page attributed to CW Fuller from the Centre for Sports Medicine, University of Nottingham stated that 'There is no evidence to show that rugby poses a specifically greater risk than other sports'.⁶ However, Fuller's own research contradicts this claim. In 2008 CW Fuller wrote that 'Rugby union is a full contact sport with a relatively high overall risk of injury ...'.⁷ Also, in 2005 Brooks, Fuller, Kemp and Reddin found that 'Rugby union is one of the most popular professional team sports in the world, but it also has one of the highest reported incidences of injury, irrespective of the injury definition used'.⁸ England Rugby has very recently retracted the misleading Rugby Safe booklet but clearly more needs to be done in order for the organisation to display the variety of injury risks in the sport.

Fourth, England Rugby's current policies are inhibiting the collection of even more comprehensive injury data. Currently England Rugby does not mandate the collation of injury data by clubs and schools, and instead only recommends it. England Rugby only requires that injuries are reported when a player is kept in hospital.⁹ Therefore, concussions where a player does not attend

hospital are not necessarily recorded anywhere.

It is simply unacceptable that high impact collision sports do not clearly articulate injury risk on their websites. While pronouncements about lowering injury rates are useful, participants and potential participants deserve to understand the specific risks of playing the sport. For example, recent research in New Zealand indicates that community and elite former rugby union players reported a substantially higher number of concussions (76.8% and 84.5% respectively) than non-contact-sport players (23.1%).¹⁰

Removing misleading official claims about the lack of injury data and replacing these with existing data about the risk of injury is both ethically and legally pertinent. These data should be displayed prominently in the 'Injuries' section of the sports' websites. England Rugby CEO Ian Ritchie recently claimed 'It's about the proportionality of risk. There's still a risk if you try and cross the road or go on a car trip up the M1 [motorway]; that's another important message we need to get out'.¹¹ Proportionality of risk is indeed important, but the public must have access to such information instead of dismissive remarks that 'there are no data' or that 'all sports have risk'. The obfuscation of actual injury rates by rugby organisations must end now.

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CHRIS MILNE

HIGHLIGHTS FROM THE BJSM JANUARY TO JUNE 2017

Issue 1, supported by the IOC started with an article on The Ethics of Genetic Testing and Research in Sport. This was a position statement from the Australian Institute of Sport. Genetic testing has proven of value in the practice of clinical medicine. However, these authors conclude that there are currently no scientific grounds for the use of genetic testing for athlete performance improvement, sport selection or talent identification. They make the point that athletes and coaches should be discouraged from using direct to consumer genetic testing, as it lacks validation and replicability. There is no involvement of a medical practitioner in the process. Gene doping i.e. the transfer of genetic material or genetic modification of cells for performance enhancement should not be used on athletes. This is a laudable position statement, however even as I write this, I suspect there are organisations in some countries that are actively exploring gene doping as a means of performance enhancement.

Golf is an activity that is popular amongst health professionals. A scoping review was carried out by Murray and associates and concluded that golf can provide moderate intensity physical activity and is associated with physical health benefits that include improved cardiovascular, respiratory and metabolic profiles plus improved wellness. The article was accompanied by an infographic which may be applicable for use in a treatment room.

Meldonium is a substance that was much in the news as Maria Sharapova incurred a doping violation after using it. Schobersberger and colleagues provide a narrative review regarding the substance. Athletes use Meldonium for the purpose of increasing recovery rate or exercise performance. However, these authors conclude that the benefits of taking

Meldonium for this purpose is quite speculative. At this stage, they conclude that there is no scientific evidence of performance enhancement properties of Meldonium.

Rugby is our national sport. Fuller and colleagues conducted an injury surveillance study during the 2015 Rugby World Cup and they found an incidence of injury of 90.1 match injuries per 1000 player match hours with backs being at slightly higher risk. By contrast, training was a much more benign activity with only one training injury per 1000 player training

hours. The most common and citing event for injury during matches and contact training was being tackled which contributed approximately 25% of injuries. The authors note an overall increase in injury severity compared with the previous Rugby World Cup and I suspect this is due to the players being bigger and faster in recent years. Concussion is a significant problem in rugby, and Fuller and colleagues evaluated World Rugby's concussion management

process. This involves an initial on-pitch and/or pitch side assessment of the injury, a follow-up assessment within three hours and a further assessment at 36 – 48 hours. This strategy would be regarded as world best practice when implemented as the authors describe. However, there were a couple of high profile incidents during the recent Lions Tour which cast doubt on its universal application.

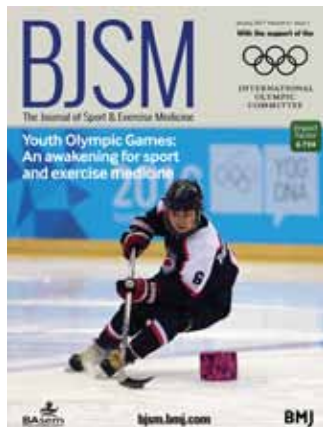
Issue 2 included an article on conservative treatment for Greater Trochanteric Pain Syndrome. Barratt et al reviewed eight studies containing 696 subjects based on pain, corticosteroid injection demonstrated superior outcomes for up to three months compared with home training, radial shockwave therapy and usual care. Fluoroscopy guided injections failed to show additional benefit. They concluded that there was a paucity of high quality research for the conservative treatments of Greater Trochanteric Pain Syndrome. Since this represents a tendinopathy, it follows that treatment should include a concentric then eccentric strengthening regime for the

muscle tendon unit.

Chronic ankle instability is a common complication of ankle sprain. Kosik and colleagues conducted a systematic review of therapeutic interventions including balance training, multimodal rehabilitation, joint mobilisation, resistive training, soft tissue mobilisation, passive calf stretching and orthotics. They concluded that balance training i.e. proprioception training provided the most consistent improvements. This would be in accord with my clinical experience over the past 30 years. Following on from this article, Doherty and colleagues conducted an overview of treatment and prevention of acute and recurrent ankle sprains. They reviewed 46 papers and concluded that there was strong evidence for NSAIDs and early mobilisation, with moderate evidence supporting exercise and manual therapy for reduction of pain, swelling and improved function. With regard to prevention of chronic ankle instability, exercise therapy and bracing were found to have the most benefit.

Low carbohydrate high fat diets are a controversial issue in sports nutrition. Tim Noakes has been a strong proponent of these diets and whilst there is a variable, highly individual response in terms of total cholesterol and LDL cholesterol, these low carbohydrate high fat diets improve other markers of cardiovascular risk e.g. lowering elevated blood glucose, insulin triglyceride, Apo B and saturated fat, glycosylated haemoglobin, blood pressure and body weight. Certainly, fat is not quite the ogre that it was painted to be a couple of decades ago. In recent years, populations in many countries have become progressively fatter by adhering to a high carbohydrate low fat diet. I suspect this is because fat in the diet does induce satiety much more effectively than carbohydrate. Nevertheless, I have reservations about these diets for competitive athletes in most sport, particularly those of less than three hours duration. Biochemistry 101 teaches us that a higher workload can be sustained for this time by burning carbohydrate rather than fat.

Issue 3 was published in association with the American Medical Society of Sports Medicine and was sub-titled Key Issues



in the Care of Young Athletes. One of the most useful articles was by John di Fiori and colleagues entitled *Debunking Early Single Sports Specialisation & Reshaping the Youth Sport Experience: An NBA Perspective*. The common wisdom amongst many parents and coaches is that early single sports specialisation is essential for future competitive sports success. As a consequence, many promising young athletes are advised to specialise early in their life. di Fiori et al contend from their research that many elite performers across virtually all types of sports do not engage exclusively in one sport. They encourage early sport sampling as a way of broadening the experiences that young athletes are exposed to. This information should be disseminated by health care professionals to parents, coaches and physical education teachers.

Cognitive rest following concussion is regarded by many as one of the corner stones of concussion management. Halstead and colleagues have challenged this shibboleth and conclude that the research as to the benefit or harm of cognitive rest is lagging behind most other aspects of concussion management. They conclude we should take a more liberal approach to adolescents continuing with text messaging, watching television, playing video games and returning to school at an early stage after sustaining a concussion.

The AMSSM has recently published a position statement on cardiovascular preparticipation screening in athletes. As readers will be aware, American medicine is fraught with issues of litigation, and this has influenced their approach to preparticipation screening. Jonathan Drezner and colleagues provide an American perspective and conclude that the decision to implement a cardiovascular screening programme with or without the addition of a resting ECG necessitates careful consideration of the risk of sudden cardiac arrest or death in the targeted population and the availability of cardiology resources and infrastructure. The article is accompanied by a useful infographic summarising the key points.

Shoulder instability in young athletes is a common occurrence. Zaremski and colleagues conducted a review and meta analysis of 17 studies comprising 654 shoulder instability events with over

90% of cases being traumatic rather than atraumatic. They concluded that primary operative treatment for shoulder instability should be considered in youth athletes aged over 14 years. I would add a caution that for atraumatic i.e. multi-directional instability, a non-operative approach is the one we would use in virtually all cases in this country.

Issue 4 was published in conjunction with the IOC World Conference on The Prevention of Injury & Illness in Sport held in Monaco in March 2017. Pelliccia and colleagues asked the question “Are Olympic Athletes Free from Cardiovascular Diseases?” They evaluated 2352 participants from the Athens Games in 2004 to the Sochi Winter Games in 2014. They found a subset of 92 athletes (3.9%) showing abnormal cardiovascular findings. These included four inherited cardiomyopathies, four pericarditis, two myocardial bridges, 45 valvular and congenital diseases, ten with systemic hypertension, 14 with SVT, seven with complex ventricular tachyarrhythmia and one with coronary artery disease. The mean age was 25 years with 64% of the sample being men, competing in 31 Summer or 15 Winter Olympic sports. The data presented are not surprising to me, and I have seen several of these conditions in our high level athletes over my 30 years in sports medicine.

Many sporting competitions are held in the heat. Periard and colleague examines strategies associated with preparing for competing in the heat at the 2015 IAAF World Athletics Championship. They found that less than 1/5th of athletes heat acclimatised, half had a pre-cooling strategy and almost all athletes had a hydration plan. Athletes with a history of exertional heat illness and female athletes were more likely to use a complete heat stress prevention strategy. They conclude that more information regarding heat acclimatisation should be provided to protect athlete health and optimise performance at major athletics competitions in the heat. The second half of this large 412 page issue includes 326 abstracts from the IOC Conference and

these cover a wide range of sports medicine topics.

Issue 5 was published in association with Sports Physiotherapy New Zealand. One of the editorials was entitled “It is Time to Stop Causing Harm with Inappropriate Imaging for Low Back Pain”. Darlow and colleague make the point that the contents of imaging reports can strongly influence clinicians’ beliefs and the clinical management decisions they make. In addition, misinterpretation of results

by patients can result in catastrophisation, fear and avoidance of movement and activity plus low expectations of recovery. Whilst the observations have merit, in the sports medicine setting, particularly with elite athletes, there are characteristic presentations which require imaging to document them appropriately. One example would be imaging for

lumbar stress fracture in fast bowling. Also for those patients who present with radiculopathy, imaging is usually appropriate.

Player welfare is an issue which has assumed progressively greater importance in recent years. Ken Quarrie of New Zealand Rugby and colleague provide a review of current knowledge and practices with regard to managing player load in professional rugby union. The match injury rate is about 27 times higher than that in training. The working group observed that players entering a new level of play, those with unresolved previous injuries, or who are older or subject to rapid increases in load are probably at increased risk of injury. Collaboration between team staff and players was held to be the best approach to monitor and manage player load. Following on from that article was one by Windt & Tim Gabbett outlining the workload injury aetiology model. Implications of their model include the following:

- 1 High work loads increase exposure, thereby increasing injury risk.
- 2 Work loads which induce high levels of negative changes i.e. fatigue increase injury risk.
- 3 Work loads that maximise positive



adaptations whilst minimising fatigue will help make athletes more robust and thereby reduce subsequent injury risk.

Groin pain is common in multidirectional sports. Franklyn-Miller and colleague studied 322 athletes with chronic groin pain. They identified three distinct movement strategies amongst athletes during a maximum effort change of direction task. Partial meniscectomy is a commonly performed surgical procedure. However, in the middle-aged person with associated chondral damage, it may not necessarily advantage the patient. Ross & Thorlin advise that patients and clinicians engage in shared decision making and consider non-operative treatments such as exercise therapy plus weight loss.

High intensity interval training (HIIT) has been advocated in recent years. This describes exercise

bouts of ten seconds to four minutes with all out maximal effort at intensities of around 90% maximum heart rate, interspersed by periods of low activity or rest for 30 seconds to four minutes. George Nassis observes that despite the evidence that this type of training can improve fitness and reduce risk factors, implementation

is patchy. He observes that in individuals who are sedentary or of low fitness, as exercise intensity increases, pleasure reduces and this in turn leads to reduced compliance and increased drop-out. I would agree and these factors go a long way to explaining why HIIT has had lesser impact in the community than one might suppose, given its theoretical benefit.

Ankle sprains are common and it is difficult to identify those patients with a probable ankle fracture. Therefore the Ottawa ankle rules were introduced about three decades ago. Beckenkamp and colleagues conducted a systematic review including 66 studies. They concluded that the ankle rules had high sensitivity (around 95%) but only modest specificity at 35%. Despite these rules, the low prevalence of fracture means that many people without fracture will still undergo imaging and exposure to radiation, but that figure is considerably less than if the rules

were not applied.

Lateral hip pain is very common in the sporting and also non-athletic communities. Grimaldi and colleagues assessed the utility of clinical tests to diagnose MRI confirmed gluteal tendinopathy in patients presenting with lateral hip pain. They found that pain reported within 30 seconds of standing is a strong positive feature whereas no tenderness on palpation tends to rule out the presence of gluteal tendinopathy. These findings are in accord with what most of us see in our rooms every day.

In Issue 7, Forsdyke and colleagues examined the issue of psychological readiness to return to sport. This is often overlooked, but the authors embrace the notion of “knowing your athlete”. The athlete’s confidence is a key feature in deciding whether they are psychologically ready to return to sport.

Predicting injury risk is a problematic business. In recent years, movement quality screening has been advocated. Whittaker and colleagues conducted a systematic review of 17 studies with 15 of these involving the functional movement screen. They found inconsistent evidence that poor movement quality is associated with increased risk of lower extremity injury in sport. However, at this stage

other than previous lower extremity injury, there are relatively few reliable predictors for future injury.

Falls are a common problem in older adults and many interventions are proposed to reduce the risk. Okubo and colleagues conducted a systematic review of step training and found that this could reduce falls among older adults by approximately 50%. They postulate that this reduction may be due to improvements in reaction time, gait, balance and balance recovery but not in strength.

Issue 8 was published in association with the Canadian Academy of Sport & Exercise Medicine. This issue contains an editorial on exercise medicine education commenting that tomorrow’s doctors want more teaching and training on physical activity for health. This is linked to an infographic on page 629, and medical

educators should be made aware of these findings.

C-reactive protein is a marker of chronic low grade inflammation that has been associated with increased risk of cardiovascular disease. Fedewa and colleagues examined the effect of exercise training on C-reactive protein. They reviewed 83 trials including 3769 participants. The pooled results indicated a decrease in C-reactive protein following exercise training, and this was independent of a decrease in Body Mass Index and percent body fat.

The gut microbiota includes about one hundred trillion microbes, with the majority of these residing in the colon. In recent years, its role has been examined in more detail. The gut microbiota can influence general health and with exercise, there may be an increase in gut wall permeability that permits systemic migration of bacterial material. This in turn can influence both musculoskeletal and general health. Athletes need to know that when they eat and drink, they are feeding themselves as well as their microbes. There is poor understanding of how supplements influence gut microbial health and performance and the same is true for sports drinks. There is much research going on in this area so stay tuned.

Sudden cardiac death is the leading cause of mortality in athletes during sport. Recently the International criteria for ECG interpretation in athletes has been updated. Drezner and colleagues from over a dozen countries have collaborated in this latest consensus statement. They identify normal ECG findings, borderline ECG findings and abnormal ECG findings. Any abnormal ECG findings, or two or more borderline ECG findings lead to the recommendation for further evaluation. Usually this will be an echocardiogram. This article should be available as a reference to all of those who provide periodic health evaluations to elite athletes. An ECG is not routinely recommended for preparticipation screening in recreational athletes, unless there are symptoms.

Oral health in elite health is known to be suboptimal in many cases. Needleman and colleague have produced a useful infographic which briefly details the consequences of poor oral health in the short and longer term, plus their causes and effects on performance. This infographic is clear and concise, and would be appropriate for use



in a locker room or similar setting, where athletes can read it at their leisure.

In Issue 10, infographics were produced explaining the benefits of physical activity for adults and children. With today's emphasis on instant messaging, these may be a more appropriate way to get the physical activity message disseminated in the wider community.

Is being overweight associated with patellofemoral pain and patellofemoral osteoarthritis? Hart and colleagues conducted a systematic review of 52 studies and concluded that higher BMI is present in patellofemoral pain and patellofemoral OA, but not in adolescents with patellofemoral pain. Their pain may be more developmental in origin and related to developing kinaesthetic sense with physical maturity.

Achilles tendon pain is common in clinical practice. Alfredson, one of the giants in the field, has written a brief paper on persistent pain in the mid-portion of the Achilles tendon. He advises us to consider the plantaris tendon as a possible culprit. Pain is typically on the medial side of the tendon and the initial advice is an eccentric loading regime or isometric exercise plus minimising pronation through the mid-stance phase of gait. If that is not successful, then ultrasound guided injection with local anaesthetic to separate the plantaris from the Achilles tendon may be attempted. If that is unsuccessful, then he recommends surgical removal. Certainly something to consider when we see people with recalcitrant Achilles tendon pain.

Issue 11 contains the long awaited report from the Fifth International Consensus Conference on Concussion in Sport held in Berlin in late 2016. A full paper spans 12 pages and is a state of the art review of the topic. To my mind, the major change appears to be allowing people to adopt a graduated return to activity about 48 hours after the injury. They propose routine ADL, then moving on to light aerobic exercise then sports specific exercise then non-contact training drills before undertaking full contact practice. The authors advocate at least 24 hours before progressing to the

next level, and if symptoms worsen during exercise, the athlete should go back to the previous step. For children with concussion, they advocate an early return to school, possibly starting with a partial school day or with increased breaks. They allow the child to read and text and have other screen time providing these do not increase their symptoms.

The Sport Concussion Assessment Tool was also updated at the Berlin consensus meeting and we now have a SCAT 5 for those who have followed previous iterations there was no SCAT 4. One change from the previous SCAT 3 is using ten words per trial to assess immediate memory. However, early experience would tend to indicate that most people have trouble remembering the ten words, and in my view use of the traditional five words is preferable. There is also a separate child SCAT 5, measuring parameters that are relevant to children in a language they can understand.

Finally, in this issue there was a systematic review of definition of sports related concussion. For the record, the authors state that sports related concussion is a traumatic brain injury that is defined "as a complex pathophysiological process affecting the brain, induced by biomechanical forces with several common features that help define its nature". They point out that there is no gold standard to assess the diagnostic properties of the clinical criteria. Whilst this may seem rather wordy, it is the best definition we have at present.



Issue 12 contains systematic reviews of various issues concerning sports related concussion. These included the role of advanced neuro imaging, fluid biomarkers and genetic testing. At this stage, the expert group regarded these as research tools only but they may have wider application in future.

Rest has been the traditional advice regarding sport related concussion. However, recent evidence indicates that after 48 hours, the concussed athlete can be started on a progressive activity regime as indicated above. Schneider and colleague conducted a systematic review of 28 studies and

concluded that after 48 hours, patients should be encouraged to gradually increase activity, but should back off to the previous level if this activity provoke symptoms.

There are differences in concussion management and children compared with adults. Davis and colleagues examined this issue in detail and concluded that a brief period of cognitive and physical rest should be followed by gradual symptom limited physical and cognitive activity. They make the point that children and adolescents should not return to sport until they have successfully returned to all of their academic activities at school. If they are still symptomatic a month post-injury, they need to be reviewed by a doctor with expertise in concussion management.

Potential long term effects of sport related concussion have been much in the news recently. Manley and colleagues conducted a systematic review of 47 studies. They concluded that multiple concussions appear to be a risk factor for cognitive impairment and mental health problems in some individuals. However, they comment that more research is needed to better understand the prevalence of chronic traumatic encephalopathy plus other neurological conditions, and the extent to which they are related to concussions sustained in sport. From my perspective, the media has had rather a simplistic analysis of this problem and as with so many things in life, the reality is more complex.

My pick for the most valuable article in this six month sequence would be the Berlin consensus statement, as it provides a state of the art summary of our current knowledge regarding this important condition. All clinicians who treat concussed athletes should be familiar with its contents.

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Movement quality, physical performance and prevalence of overuse injuries in secondary school netball players

CHRIS WHATMAN, DUNCAN REID

ABSTRACT

Objectives

To investigate movement quality, physical performance and prevalence of overuse injuries in secondary school netballers.

Design

Cross-sectional observational study.

Methods

166 players were rated performing a modified netball movement competency (MC) screen consisting of five functional tasks. Maximum jump height and power during a vertical jump were also recorded as was dorsiflexion range of motion. Additionally, frontal plane knee angle (FPKA) and knee position relative to the foot during a single leg squat and drop jump were assessed. Finally players completed an overuse knee and ankle injury questionnaire based on the previous 12 months.

Results

The total MC score (maximum 32) ranged from 12 to 30. Across all tasks approximately 50% of players failed to meet the criteria for good movement competency and more than 50% of players landed with a knee position medial to the foot during the drop jump. Seventy three percent of players failed to reach the suggested minimum range of motion in the dorsiflexion assessment. Highest grade players had significantly better jump performance and total MC score than lowest grade players. The prevalence of all knee and ankle problems was 31% and 51% respectively. There were no significant differences in total MC score, jump performance or dorsiflexion ROM between players with a history of knee or ankle problems and those without.

Conclusion

Movement quality, physical performance and ankle range of motion are not associated with history of injury in youth netballers. Poor landing technique, poor movement quality and overuse knee/ankle problems remain issues for secondary school netballers and strategies to address this should continue to be a focus of coach and player development.

Keywords: Sports injury, Movement screening, Adolescents, Physical performance

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INTRODUCTION

Netball is one of the most common team sports played throughout Australia and New Zealand.¹ It is a physically demanding dynamic sport that requires a high degree of strength, flexibility, speed and fitness.² With an increasing number of young non-elite athletes engaging in high demand sports there is an increased risk of injury.² Injuries result in reduced playing time and potentially end the season early for sports participants. Additionally injury in youth may have longer term consequences that limit participation in sport and reduce general physical activity.³

Netball exposes the lower limb to high impact forces, particularly during jumping and landing. The lower leg, knee, ankle and foot are amongst the most common sites of injury.^{4,5} Knee injuries are highlighted as being the most severe in relation to

disability and ongoing healthcare related costs.² The New Zealand Accident Compensation Corporation (2013) reported 26,179 new netball related claims between July 2012 and June 2013, an increase on the previous year from 24,143. It also reported the cost of netball associated claims for the year 2012-2013 was approximately \$20 million.

Movement quality (neuromuscular control of multiple segments in a chain) may be related to injury risk and/or performance⁶ and improvements in movement quality may therefore result in a reduction in netball injury related cost. Sahrman⁷ has been a proponent of assessing the movement system for many years referring to the term movement quality, emphasising that assessment and treatment of musculoskeletal disorders should emphasise quality rather than quantity. Sahrman suggested poor movement

quality (faulty patterns and/or poor control) is the key risk factor for the development of injury as it leads to increased stress on the components of the musculoskeletal system resulting in cumulative microtrauma and musculoskeletal pain syndromes. Traditionally, pre-participation and performance assessments are used to assess athletes prior to activity. Results from these screens are often used to create functional or performance goals, however they may fail to address the individual's specific biomechanical needs.^{8,9} Performance tests often fail to evaluate the quality of movement in an individual's performance and little consideration is given to faulty movement patterns that may limit performance and predispose the athlete to injury.¹⁰ The way an athlete activates their muscles and moves influences how a joint is loaded and potentially the associated risk of injury.^{11,12} Several authors have

suggested the best time to test movement quality in landing tasks is in youth athletes¹³ as it represents the best opportunity for establishing good habits and maintaining good movement patterns throughout a playing career. It should however be noted that the current evidence linking assessments of movement quality to injury risk and/or athletic performance is somewhat unclear and depends on the movement task/assessment tool being investigated. For example a recent clinical commentary highlighted the lack of evidence supporting the use of the popular Functional Movement Screen for predicting injury risk¹⁴ and similarly a recent systematic review found inconsistent evidence for the link between movement quality and lower extremity injury¹⁵. In contrast popular neuromuscular warm-ups that have a focus on improving movement quality in youth athletes have been successful in reducing injury rates.¹⁶ From several perspectives including continued player development, appropriate coach development and financial cost there is a clear need to understand the movement quality and landing techniques of secondary school netball players. Thus the purpose of this study was to investigate the movement quality, physical performance and prevalence of overuse knee and ankle injuries in secondary school netballers. Additionally differences in movement quality and physical performance between players with and without a history of injury and between players from higher and lower grades was investigated.

METHODS

Data was collected on 166 female players (mean \pm SD; age 16 ± 1 y, height 172 ± 7 cm, mass 68.5 ± 10.3 kg) during an annual national secondary school tournament in which teams competed in three grades A, B and C representing the 1st, 2nd and 3rd level of teams in the tournament. All players gave written informed consent and the study was approved by Auckland University of Technology Ethics Committee (AUTEC). All measures were collected by having players report to a designated testing area to complete anthropometric (height and weight), movement competency tasks (to assess movement quality), jump

height, dorsiflexion range of motion and an ankle/knee injury history questionnaire (Oslo Sports Trauma Research Centre [OSTRC] overuse Injury Questionnaire).¹⁷ This questionnaire is a validated method of recording overuse injuries (defined as those without a specific identifiable event responsible for their onset). Prior to all testing players had tape placed over their right and left anterior superior iliac spines (ASIS's) for use during measures of frontal plane knee angle (FPKA).

Dorsiflexion range of motion (DROM) was assessed by having participants face a wall ensuring their back leg was facing forward and their pelvis was parallel to the wall. They were asked to bend their front knee and establish how far back from the wall they could go for maximal dorsiflexion stretch, without lifting their heel and without any compensation (neutral pronation/supination). A distance was measured (cm) from the end of the great toe to the wall. Greater distance is indicative of greater dorsiflexion ROM and clinically 10 cm or more is considered adequate.¹⁸

All players were videoed performing five functional movement tasks (based on the previously reported netball movement screening tool 19 and a drop jump). Player movement competency rating was based on visual ratings of the five functional tasks (Squat/vertical jump, broad jump, single leg mini-squat, push-up, and lunge and twist). Three repetitions of each task were performed. All tasks were later visually rated and as the vertical jump task was performed on a portable force plate, peak jump height and power were also calculated. As netball is mostly a jumping and landing sport, the bend and pull component of the original netball movement screening tool was removed both to save time in rating a large number of players and also as it was deemed by

the research team not as an important a part of the screening tool as other movements.

Ratings of movement competency were based on previously reported criteria.²⁰ The reliability when rating movement competency based on these tasks has recently been reported.¹⁹ Good movement competency ratings were thought to reflect better movement patterns indicative of more effective and efficient biomechanics. The squat/vertical jump was based on a rating scale from one to five. For all other movements a three point scale was used where 1=poor movement competency, 2=moderate movement competency and 3=good movement competency. All players received a total score (0 to 32) and individual scores for each task. Additionally the knee position relative to the foot (at peak knee flexion) during the drop jump task was rated as over the foot or medial to the foot. Visual rating of knee position in young athletes during this task has been reported to show acceptable agreement between raters.²¹

During the single leg mini-squat and the drop jump the frontal plane knee angle (see figure 1) at the point of maximum knee flexion (for both left and right knee) was measured using Kinovea video analysis software (v 8.15). This angle is the angle created by the intersection of the line between the ASIS and the mid-point of the patella and the line from the mid-point of the patella to the mid-point of the ankle. A smaller angle (angle reducing from 180 degrees) represents worse performance



Figure 1: Frontal plane knee angle (FPKA) measured during the drop jump

(greater medial knee deviation relative to hip and ankle). The reliability of the frontal plane knee angle measure in the current study demonstrated good levels of inter-rater agreement (ICC 2,1 = 0.87).

A total knee injury score and ankle injury score was calculated for all players who completed the injury questionnaire. The questionnaire was designed to give an indication of overuse knee and ankle problems experienced by the player over the previous 12 months. Each of four questions for the knee and ankle was assigned a points total with a higher total score indicating more problems (score range 0-100).

The mean, standard deviation and range were calculated to describe the movement competency of the participants. The percentage of players performing at each level for the individual movement competency screen tasks was also calculated as was the percentage of players landing with a knee medial to foot position during the drop jump. An unpaired t-test was used to investigate differences in key outcome variables between players with and without a history of injury and between players from different grades ($p < 0.05$ was used as the threshold for significant differences). Effect sizes for these differences (outcomes in standardised Cohen units) were also calculated and the magnitudes of these effect sizes were interpreted based on the following thresholds: 0.2 (small), 0.6 (moderate), 1.2 (large), 2.0 (very large), ≥ 4.0 (extremely large) 22.

RESULTS

Approximately one third of players came from each of the A, B and C grades in the

tournament and there was an even distribution of players from all positions. Players in the A grade were significantly taller than players in the B grade (mean difference=5.8 cm; $p=0.03$) and C grade (mean difference=4 cm; $p=0.01$). There were no significant differences between grades in age, mass or BMI.

A summary of the total movement competency (MC) score, jump performance, dorsiflexion range of motion and FPKA is presented in Table 1. Seventy three percent of players failed to reach the suggested minimum of 10 cm in the dorsiflexion range of motion assessment. The total MC score (maximum 32) ranged from 12 to 30. If players were rated as moderately competent across all tests their total score would be 21. Just over 50% of players tested failed to reach this score. Additionally more than half the players landed with a knee position medial to the foot during the drop jump (right leg = 68%; left leg = 52%).

The distribution of scores for four of the individual tasks used to assess movement competency is shown in Figure 2. Across all tasks shown 50% or more of players failed to meet the criteria for good movement competency. Specifically less than 10% of players were rated as having good movement

Table 1: Summary descriptive statistics for all variables

	Minimum	Maximum	Mean (SD)
Total MC score	12.0	30.0	20.0 (3.4)
Jump height (cm)	16.9	40.0	26.1 (3.8)
Jump power (watts)	29.8	53.0	38.9 (4.5)
Dorsiflexion (R) (cm)	2.0	18.0	9.4 (2.5)
Dorsiflexion (L) (cm)	2.0	17.0	9.5 (2.6)
FPKA (°)*			
Drop Jump (R)	154.7	193.7	170.4 (6.6)
Drop Jump (L)	149.0	195.3	169.9 (7.4)
Single leg squat (R)	141.0	190.7	161.0 (9.0)
Single leg squat (L)	138.3	191.7	165.3 (8.3)

MC=movement competency; FPKA=frontal plane knee angle; L=left, R=right; *for FPKA 180°=neutral alignment, <180°=valgus alignment, >180°=varus alignment

in the C grade (mean difference [90% confidence limits] = 2.3 [1.3 to 3.4]; effect size moderate, $p=0.001$). There were no significant differences in total MC score between the A and B or B and C grades. Players from A grade teams also had greater jump height than C grade players (mean difference [90% confidence limits] = 3.5 [2.3 to 4.8] cm; effect size small; p value=0.001). Additionally A grade players recorded better power during the vertical jump than C grade players (mean difference [90% confidence limits] = 2.0 [0.5 to 3.5] W; effect size small; $p=0.03$).

One hundred and six players completed the knee injury questionnaire and 113 players completed the ankle injury questionnaire. Total knee injury score ranged from 0 to 74 and total ankle injury score ranged from 0 to 92. The prevalence of all knee problems was 31% and the prevalence of substantial knee problems was 10% (players reporting moderate or severe reductions in training volume/sport performance or complete inability to compete in sport). The prevalence of all ankle problems was 51% and the prevalence of substantial ankle problems was 24%. There were no significant differences in total MC score, jump performance or dorsiflexion range of motion between players with or without a history of knee or ankle problems (Table 2). Players with a history of ankle problems did have a significant difference in FPKA (more valgus position; effect size small; $p=0.02$) on the left side during the single leg squat than players with no history of ankle problems. There were no other significant differences

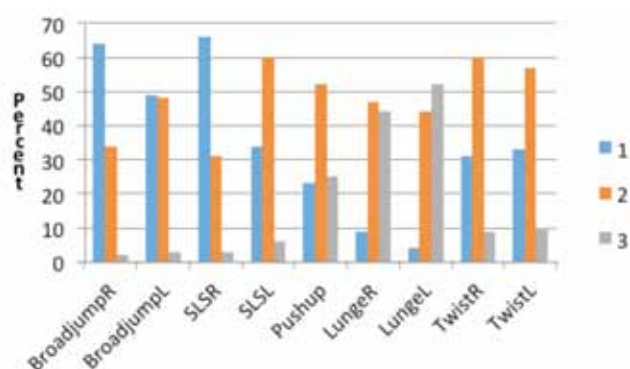


Figure 2: Movement competency ratings for four of the functional movement tasks. 1=poor, 2=moderate, 3=good, SLS=single leg squat, R=right, L=left.

competency in the BJ, SLS and Twist and only 40 to 50% were rated as having good movement competency in the lunge. Additionally only 14% of the players were rated as having good movement competency during the squat/vertical jump

Total MC score was better in the A grade players than those

in FPKA between players with or without a history of ankle or knee injury.

DISCUSSION

Movement quality and landing technique in netball are considered important in terms of performance and injury risk. There has been little investigation of this in youth netball previously. This study describes the movement quality (as assessed by a battery of simple tests), physical performance and prevalence of knee and ankle problems in

(21 out of 32) that could be considered to show at least moderate competency across all tests. Additionally this may be a conservative cut-off as based on a previous study of a healthy young population, using a movement competency rating with a maximum total score of 21, a proposed average score for movement competency has been reported as 16.²³ In percentage terms this represents a score on our scale of 24 out of 32. Approximately 80% of

tests.¹⁹ We did note during testing that many of the players were unfamiliar with the push up task. However the push up was not the worst scoring task and the other movements used to evaluate MC are likely common activities in netball warm-up drills and thus familiar to the players. We acknowledge that a limitation of these findings is that the validity of the rating criteria used in the movement competency screen has not been well established and in particular that there

Table 2: Difference in jump performance, movement competency and knee angle between players with and without a history of injury

	No History of Injury Mean (SD)	History of Injury Mean (SD)	Mean Difference (90% CL)	ES	P-value
Knee Injury	n=74	n=32			
Total MC Score	19.3 (3.4)	20.1 (3.1)	-0.7 (-1.9 to 0.5)	0.11	0.30
Jump Height (cm)	25.2 (3.6)	25.7 (3.0)	-0.5 (-1.6 to 0.7)	0.08	0.52
Max power (watts)	38.1 (4.3)	39.1 (4.5)	-1.0 (-2.6 to 0.6)	0.11	0.30
DF (L) (cm)	9.8 (2.6)	9.9 (2.5)	-0.1 (-1.0 to 0.7)	0.04	0.80
DF (R) (cm)	9.7 (2.7)	9.8 (2.2)	-0.1 (-0.9 to 0.80)	0.04	0.94
FPKA (L) Drop Jump	170.0 (7.7)	169 (6.5)	1.0 (-2.0 to 2.5)	0.07	0.51
FPKA (L) SL Squat	165.8 (7.2)	164.1 (9.9)	1.7 (-1.5 to 4.8)	0.10	0.38
FPKA (R) Drop Jump	170.3 (7.1)	170.0 (6.2)	0.3 (-2.1 to 2.6)	0.02	0.87
FPKA(R) SL Squat	159.5 (9.6)	161.8 (9.9)	2.3 (-5.9 to 1.5)	0.12	0.32
Ankle Injury	n=53	n=60			
Total MC Score	19.2 (3.4)	19.7 (3.4)	-0.5 (-1.6 to 0.6)	0.07	0.46
Jump Height (cm)	25.3 (3.4)	25.7 (3.3)	-0.3 (1.4 to 0.7)	0.04	0.58
Max power	38.2 (4.0)	39.0 (4.8)	-0.9 (-2.2 to 0.5)	0.10	0.30
DF (L) (cm)	9.7 (2.5)	9.5 (2.8)	0.2 (-0.6 to 1.0)	0.08	0.70
DF (R) (cm)	9.5 (2.6)	9.6 (2.7)	-0.1 (-0.9 to 0.7)	0.04	0.81
FPKA (L) Drop Jump	169.8 (7.6)	169.6 (7.6)	0.2 (-2.1 to 2.5)	0.03	0.88
FPKA (L) SL Squat	166.6 (7.9)	162.6 (8.3)	4.0 (1.2 to 6.8)	0.49	0.02*
FPKA (R) Drop Jump	170.5 (6.2)	170.0 (6.2)	0.5 (-1.7 to 2.7)	0.08	0.70
FPKA (R) SL Squat	160.2 (9.9)	160.1 (9.6)	0.1 (-3.2 to 3.5)	0.01	0.94

CL=confidence limits; MC=movement competency; DF=dorsiflexion; FPKA=frontal plane knee angle; ES=effect size; SL=single leg; L=left, R=right; *p<0.05

a group of secondary school netballers. Additionally it investigates differences between higher performing players and those with and without a recent history of knee or ankle injuries.

The distribution of total MC scores shows some players move well and others very poorly based on the tasks evaluated and the rating criteria used. If players were rated as moderately competent across all tests their total score would be 21. Over 50% of players tested failed to reach a total score

the players failed to reach this standard. We acknowledge that performance in a movement competency screen may indicate a lack of familiarity with a movement task rather than a lack of competency and this could influence the outcomes. Additionally a recent study investigating a similar group of secondary school netballers reported poor scores in the push up and single leg squat and suggested this may indicate the group are not physically strong enough to meet the benchmark criteria for these

is little quality evidence that it is related to actual movement during athletic performance. We do however believe that the criteria are based on patterns commonly identified by clinicians and trainers as being associated with poor movement. Many of the criteria are also similar to those used for rating similar functional tasks that have been linked to injury.²⁴⁻²⁶ Coach and player education around landing technique has been ongoing for a number of years in netball and a key message has been to land with knees over feet.²⁷ It was therefore disappointing to find more than 50% of players failing

to achieve this during a drop jump task. Players from the A grade did score better on the total MC score and did also produce greater jump height and power. While we are obviously not able to establish this as a causal relationship it may be a useful association to promote when looking to engage players and coaches in strategies to improve movement ability.

Seventy three percent of players failed to reach the suggested minimum range of ankle dorsiflexion. This may be in part

due to the high prevalence of ankle injuries in netball as previous ankle sprain has been linked to a reduction in dorsiflexion range of motion.²⁸ Importantly a lack of dorsiflexion has been associated with an increased risk of lower extremity injury²⁸ and is thus of concern in this group. The reduced dorsiflexion may increase frontal and transverse plane motion at the hip, knee or ankle during landing and/or alter lower extremity stiffness and these biomechanical changes may lead to increased injury risk. The average frontal plane knee angle in our study during the drop jump appears similar to that reported previously in young active females.²⁹ Herrington²⁹ studied a slightly older population of active females and suggested a normal range for this knee angle could be considered to be 167 to 173 degrees during the drop jump. Based on our results approximately 66% of players would fall within this range.

Based on our findings knee and ankle injuries continue to represent a substantial issue for secondary school netball players however there was little in our assessments of movement or performance that could differentiate players based on injury history. The only significant difference in movement ability between players with and without a history of ankle problems was for the FPKA on the left leg during the single leg squat. This is difficult to explain from a mechanistic perspective and may have been an aberrant finding. There were no other differences between MC total score, dorsiflexion range of motion, jump height/power or FPKAs between those with or without a history of ankle and knee problems. One limitation of this finding is obviously the recall bias of the injury questionnaire as we asked the players to recall the events of the previous 12 months. It may however also reflect the lack of association between the MC total scores and injury risk and/or that a key component of injury risk is exposure/load and we have not captured this in the current study. It does however highlight, as suggested in a recent systematic review,¹⁵ the need for further high quality studies to identify movement outcomes that can identify injury risk. Furthermore it may be that to identify injury risk, movement quality should only

be assessed based on specific tasks that replicated known injury mechanisms and the value of a general movement quality assessment like the MC score may be limited. In fact it has recently been proposed that movement rating may always lack sufficient sensitivity and specificity to be used as a valid screening tool.³⁰ That said, given the success of neuromuscular warm-ups in reducing injury risk, future studies should target retraining of movement faults associated with specific injuries and evaluate the effect on injury rates.

CONCLUSION

Movement competency score, landing technique and ankle range of motion are poor in a high proportion of secondary school netballers. Knee and ankle injuries are common in this group however none of these measures nor assessment of jump performance was able to differentiate players with or without a history of injury. Strategies to improve landing technique, ankle range of motion and movement quality should remain a focus in player and coach education.

Practical Implications

- Assessment of movement quality using the MC score is not useful in explaining a history of ankle or knee injury in youth netballers.
- Landing technique in youth netball players is poor and coach education should continue to focus on strategies to improve this.
- The association between higher playing level and better movement could be promoted to help engage coaches and players.
- Knee and ankle overuse problems continue to be a concern in youth netball.

ACKNOWLEDGEMENTS

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Utilising technology and muscle activation patterns for improving sprint cycling performance

HENDRIK J PIENAAR, WILLIAM O PAYNE, JALANA L KEITH

ABSTRACT

Aim

The purpose of this study was to analyse a standing 250 m track lap to investigate muscle activation patterns, muscle imbalances, muscle fatigue and to determine individual muscle involvement in applying force and power development.

Study Design

Prospective observational study.

Participants

Highly trained competitive sprint cyclists ($n = 12$, six male; six female) were recruited from Cycling Southland, New Zealand.

Methods

Anthropometric measurements of each cyclist were recorded. Participants completed six trials of an all-out 250m time trial, three trials in each of two different modes of riding. The first mode of riding was performed on a velodrome indoor 250 m wooden track. The second mode of riding was on a Velotron Pro cycle ergometer and was performed in a Human Performance Laboratory. Utilising synchronised video footage and wireless standardised surface electromyography (SEMG) protocols, eight muscles were analysed during all sprint performances.

Results

The main results of the study identified significant ($p < 0.05$) differences between the muscle activation patterns of the first and last 125 m of the sprint event. The differences in muscle activation patterns between the first and last 125 m could be indicative of peripheral fatigue, eliminating these differences could result in improving all out sprint performance on the track.^{2,21} Paired sample correlations helped the researchers to identify which muscles were unequally matched. The Velotron results showed an inverse relationship between power and time/speed. The greater the power development of the cyclist the faster the times were. Combining synchronised video footage with the muscle activation patterns of the individual muscle groups, the researchers were able to identify which muscles showed a decrease in muscle activation patterns over the duration of the sprint, along with the order in which the muscles were utilised. The researchers used group averages for the purpose of this study, however it should be noted that there were significant differences between individual test subjects, with different muscle group fatigue rates and imbalances. Although there were many common trends, one of the most important findings were that elite athletes should be assessed individually.

Conclusion

The findings of this research highlights the many benefits of the use of technology and muscle activation patterns to improve Sprint cycling performance. Although there were many common trends, it is recommended that elite athletes should be analysed individually.

Key Words: Muscle activation patterns, EMG, Sprint cycling, fatigue, video analysis

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INTRODUCTION

Track sprint cycling is one of the oldest cycling events dating back to 1893 at the World Championships in Chicago.²⁰ The New Zealand (NZ) men's track sprint team has come from its beginnings in 2009 to 5th in the world in 2010 and 2nd in 2013, losing the gold medal to Germany by 0.049 of a second.¹⁹ In 2014, the NZ men's track sprint team won the world championship by 0.236 sec against Germany.¹⁸ At the 2015 world championships the NZ men's team sprint had a dominant 0.18 second win (NZ 42.892 sec, France 43.072 sec) over the hosts France, but were relegated back to the silver medal for a technical infringement.¹² At the recent Rio Olympics 2016 the New

Zealand sprint team was pleased with a silver medal after a record ride, missing gold (to Great Britain) by an agonising 0.102 seconds.¹⁶ Considering the small winning margins involved in sprint cycling, elite cyclists are utilising the help of a range of sport and exercise professionals which may include; technical coaches, biomechanists, nutritionists, exercise physiologists, sport psychologists and strength and conditioning trainers.

The men's team sprint event is a battle against the clock by three riders over three laps (750 meters). The racing strategy involves two teams who line up on opposite sides of the track. The race starts when a mechanical starting gate releases the lead rider after a 60

second countdown, where the goal is that the team gets up to maximum speed as fast as possible. This first lap is called a standing lap as the number one rider starts from a mechanical starting gate. After the first lap the lead rider from each team pulls off, then the second rider leads the second lap and then pulls off to allow the third rider to finish the race. The clock is stopped once the final rider crosses the finish line.¹⁷ A track bike is optimised for racing at a velodrome or similar outdoor track. The major difference between road and track bikes are that track bikes have a fixed single gear and cannot freewheel or brake.²³ These bikes and equipment, are at the forefront of the latest technology and governed by strict rules and regulations,

Table 1. Mean (\pm SD) baseline characteristics of competitive spring cyclist participating in the study (n=12).

	Males (n = 6)	Females (n = 6)	Total (n = 12)
Age (yrs)	21 \pm 12	30 \pm 13	26 \pm 10
Body Mass (kg)	84.9 \pm 11.3	70.8 \pm 4.9	77.9 \pm 11.3
Height (cm)	180.8 \pm 7.7	168.6 \pm 6.9	174.6 \pm 9.4
Body fat (%)	8.8 \pm 1.8	19.5 \pm 4.5	14.2 \pm 6.7
Sum 8 SKF (mm)	74.3 \pm 21.4	121.5 \pm 46.3	99.9 \pm 42.4

ensuring both the safety of riders and the fairness of competition.²² Cyclists and their coaches will go to great lengths to optimise individual bike set-up's. Each rider is uniquely different in their anatomical make-up and will require different sized frames, gearing and crank lengths. These factors will again be influenced by each rider's own preferences, previous experiences, previous power development strategies and their level of training.^{24,13}

The pedal cycle may be viewed as a continuum of a closed circuit that involves push (quadriceps) and pull (hamstrings) components. In sprint track cycling it is important to balance this continuum, since unbalanced forces applied through the pedals will result in a bounding effect on the track. The unbalanced forces will lead to insufficient movement patterns that would waste much needed energy, which is required to optimise performance and prevent muscular fatigue. Being able to identify unbalanced muscle activity patterns during a sprint cycle race will allow the researchers to make recommendations that may improve sprint cycling performance. Black et al. mentions that the peripheral component of fatigue, as estimated non-invasively using SEMG, appears to be especially important during high-intensity exercise.² According to Twomey et al. "a decrease in the amplitude of the evoked response is used as a global measure of locomotor muscle fatigue and the technique is sensitive for detecting relatively small disturbances".²¹ Gandevia et al defines muscular fatigue as "an exercise induced decline in the ability of the muscle to exert maximal force".⁵ The possible causes for neuromuscular fatigue include; decreased cardiovascular capacity, decreased energy supply, lowered motivational levels, poor biochemical conditions and impaired muscle recruitment.^{2,10,21} Although there are many

elements involved in neuromuscular fatigue, limiting unbalanced muscle activity could bring elite sprint cyclists a bit closer to the very small winning margins in this very competitive sport.

The purpose of this study was to analyse a standing 250 m track lap to investigate muscle activation patterns, muscle imbalances, muscle fatigue and to determine individual muscle involvement in applying force and power development. It is hypothesised that the SEMG and the synchronised video footage will find imbalances in muscle activation along with technical inefficiencies, which will effect performance time and power during the standing 250 m lap.⁹

METHOD

Participants

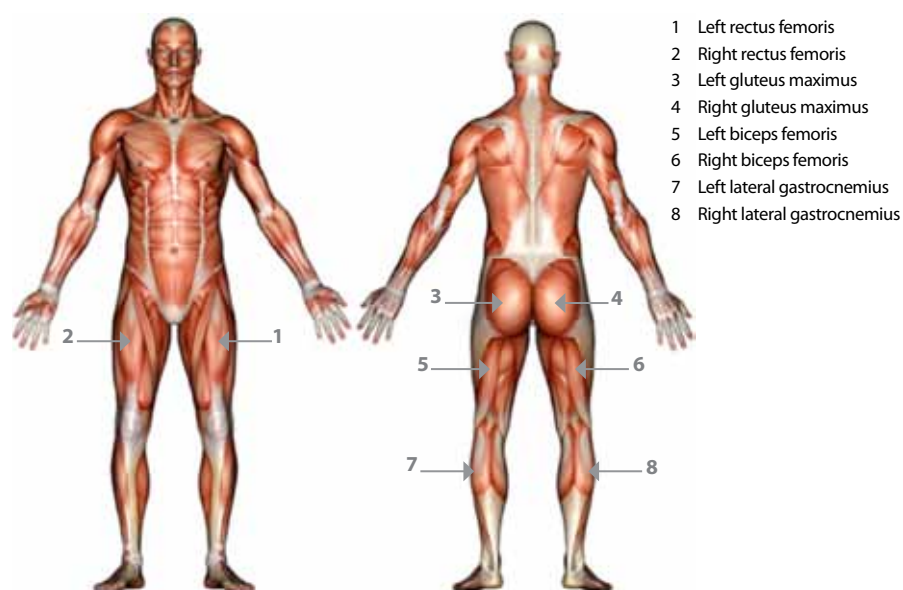
Highly trained competitive sprint cyclists (n = 12, six male; six female) were recruited from Cycling Southland. Participants were tested (July/August 2012) on the track at the SIT Velodrome in Invercargill and at the Human Performance Lab (HPL) at SIT.

To be eligible to participate, participants need to have represented at a national level and needed to be over the age of 18 years old. The baseline characteristics of the competitive sprint cyclists participating in the study are presented in Table 1. Written informed consent was obtained from each participant before the commencing of the study and all experimental risks were fully explained. Each participant was also required to fill out a health questionnaire form before testing. Ethical approval for the study was received from the SIT Human Research Ethics Committee.

Preliminary Measurements

Upon arrival, a Society for the Advancement of Kinanthropometry (ISAK) level one qualified research assistant measured skin fold thickness from eight sites (biceps, triceps, subscapular, supraspinale, iliac crest, abdominal, medial calf and thigh) to the nearest mm, according to ISAK protocols using calibrated Harpenden skinfold calipers.⁶ These measurements were used to calculate body fat percentage (Yuhasz, excluding biceps and iliac crest). Body mass was measured to the nearest 0.01 kg, using digital scales (BM-150; UWE Co Ltd, Taiwan).

After the body compositions was measured, Noraxon dual SEMG electrodes were connected to participants.¹¹ Using standardised SEMG protocols eight muscles were analysed.⁸ The selected muscles and electrode sites are shown in Figure 1 below.

**Figure 1.** Electrode Placement Positions

Adapted from "<http://www.shapesense.com/images/blank-muscle-anatomy.jpg>"

Electrode site preparation was done by shaving the skin (no hair), followed by a light abrasion with fine sandpaper and cleaned with a Medi-wipe (sterilised wipe). Dual surface electrodes were placed on the muscle belly of each muscle and the sensors were placed 20 mm away from the dual electrodes. The wireless sensors were placed towards the lateral side of the body, in order not to interfere with the biomechanics of cycling. Electrodes were attached to the participant's body with double sided tape and then secured with a single layer of strapping tape. The participants also wore compression clothing to hold the electrodes in place.

Experimental Protocol

The research required the participants to undertake six trials of an all-out 250m time trial, three trials in each of two different modes of riding. The first mode of riding was performed on a velodrome indoor 250 m wooden track. The purpose of the "on the track trials" were to investigate the muscle activity patterns during the standing lap. The second mode of riding was on a Velotron Pro cycle ergometer and was performed in a Human Performance Laboratory (HPL). The purpose of the Velotron trials was to measure the power output of the cyclists during the 250m time trial.

All testing for the first mode of riding was performed on the same day at the SIT Velodrome (250m wooden track) in Invercargill, New Zealand, with each participant racing with their own equipment and bike.

The second mode of riding was performed two weeks later on a Velotron Magtonic DX-047RU Pro ergometer bike and was performed at the SIT HPL. Two consecutive test days were required to collect all the relevant data.

Experimental Protocol on the Track

After the IMVC, each participant performed a 20 min self-selected sub maximal warm-up (on a wind trainer or on the track). Selection of all the cycling equipment, which included the fixed gearing ratios was pre-selected by each participant. Participants used their own race bikes, with their individual pre-determined bike set-up, they were informed that they were not allowed to change the equipment between trials.

The participants performed three 250 m

time trials on a velodrome indoor 250 m wooden track (SIT Velodrome) with 20 min of recovery time between trials. The active recovery protocol was dependent on each participants cooldown preferences, participants performed their active recovery on wind trainers or on a Monark cycle ergometer. The 250 m time trial test started from the starting gates after a 60 sec countdown. The starting gates were automatic hydraulic release starting gates. All participants performed a standing start. Once released the automated track timing system started. Additional timing lights were placed at the start/finish line and at the 125 m mark. Utilising the wireless MyoResearch XP allowed researchers to measure muscle activity patterns during performance.⁹

The participant's movement patterns were synchronised with the MyoResearch XP software with a video camera (JVC HD 100 fps). The camera was positioned outside the track. The camera was fixed on a tripod and zoomed in as much as possible, in order to produce a full view. The camera followed each participant for the whole duration of the lap.

Experimental Protocol on the Velotron Pro bike

After the IMVC each participant performed a 20 min warm up on a Monark cycle ergometer, with a self-selected workload.^{15,1}

After the warm up was conducted, the participants had time to setup the Velotron ergometer bike, with seat height and handle bar position to match their track bike set-ups. The setup was recorded for subsequent trials. Participants were allowed an extra two minutes

warm up to ensure the bike dynamics were correct, and to make sure the gear that they selected was similar to their track bike set-up. Calibration was done with the Accuwatt™ test (Velotron Coaching Software, Version 1.6.458, RacerMate Inc., Seattle, WA) before each trial. All testing was performed over two consecutive days in the HPL with similar temperatures and relative humidity.³

Due to the differences in the dynamics of the Velotron and the starting gates, participants could either select a standing or a sitting start (predominately, the standing start was used). The participants that preferred the seated start moved to a standing position shortly after the pedal cycle commenced. A five second countdown was given before the testing commenced. The test was a 250 m all out sprint using the participant's chosen gear. Participants were informed when they reached the 100 m and 200 m mark followed by a completion command. Muscular activity and power output was monitored throughout the entire duration of the test. The participant's movement patterns were synchronised with the MyoResearch XP software with a video camera (JVC HD 100 fps). The camera was fixed on a tripod and zoomed in enough to produce a full view.

Data Analysis

The EMG information for each of the 250 m

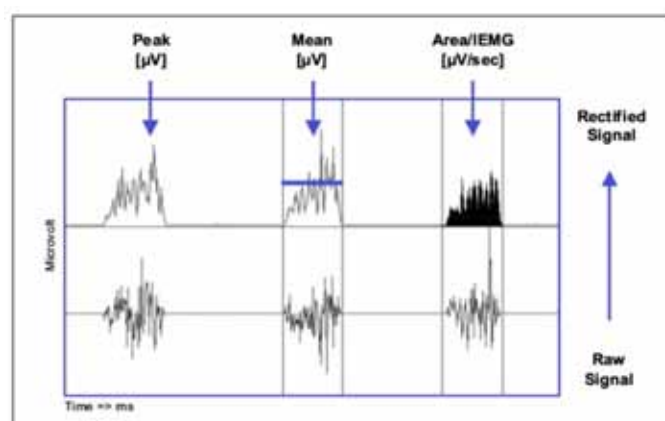


Figure 2. EMG standard amplitude parameters based on the rectified EMG curve.⁸

Table 2. Mean (\pm SD) times for 250 m standing start on competitive spring cyclist over all three trials (n=12).

	Males (n = 6)	Females (n = 6)	Total (n = 12)
125m (sec)	11.74 \pm 0.57 *	13.16 \pm 0.38	12.45 \pm 0.89
250m (sec)	19.43 \pm 1.00 *	21.83 \pm 0.82	20.64 \pm 1.54

* Significant difference between male and female values (p < 0.05)

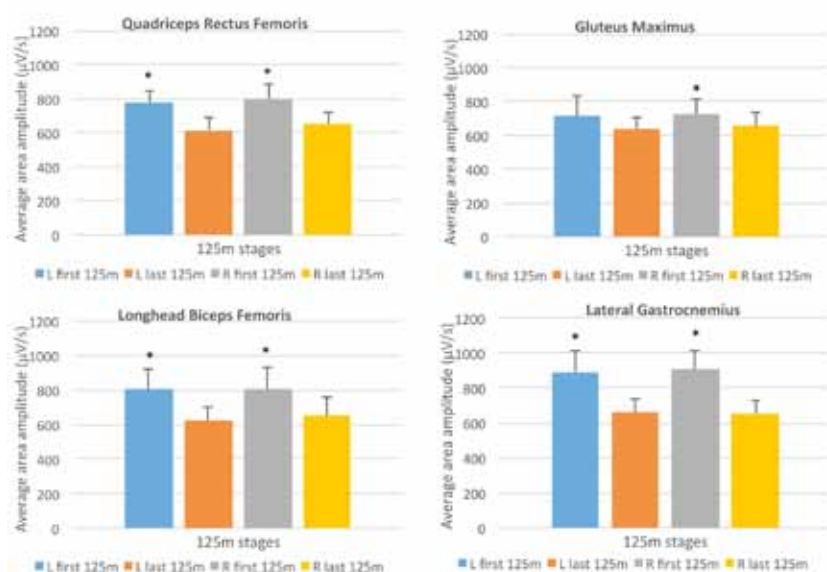


Figure 3: Average amplitude ($\mu\text{V/s}$) on four bilateral muscle sites on competitive sprint cyclists over 250m for all three trials on the Velodrome track ($n = 12$).

* Mean value of the first 125m were significantly different compared to the last 125m ($p < 0.05$)

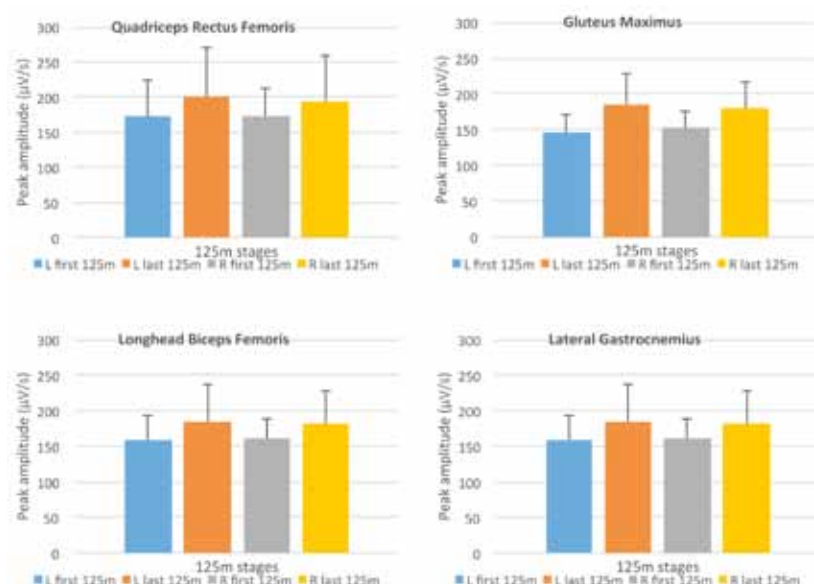


Figure 4: Peak amplitude ($\mu\text{V/s}$) on four bilateral muscle sites of competitive sprint cyclists over 250m for all three trials on the Velodrome track ($n = 12$).

Table 3. Mean (\pm SD) amplitude ($\mu\text{V/s}$) for all muscles on competitive sprint cyclists over all three trials on the track ($n = 12$).

	Mean (\pm SD) ($\mu\text{V/s}$)
Area amplitude	
First 125m	803.9 \pm 74.4 *
Last 125m	641.8 \pm 66.0
Peak amplitude	
First 125m	157.9 \pm 26.0 *
Last 125m	185.4 \pm 47.0
Mean amplitude	
First 125m	66.5 \pm 5.1 *
Last 125m	78.6 \pm 3.2

* Mean value of the first 125m were significantly different compared to the last 125m ($p < 0.05$)

selected muscle for a given task and is best suited for comparison analysis, where the Area is the true mathematical integral under the EMG amplitude for a selected analysis period.⁸ The Area measurement has the added benefit of being directly dependent on the time duration selected for the analysis, which was ideal for the comparisons made between muscle groups in this study.⁸

After completion of all the testing, the data was analysed. All test data were statistically tested using SPSS v.22 (ANOVA, correlations and t-tests were applied and the level of significance were set at $p < 0.05$).

RESULTS

Baseline Characteristics

Baseline characteristics were measured on 12 participants (six males and six females) on the day of testing. The age range of the group was between 19 to 49 years of age (mean \pm SD: 26 \pm 10 years of age). Mean (\pm SD) body weight for males was 84.9 \pm 11.3 kg and females was 70.8 \pm 4.9 kg. The mean (\pm SD) sum of the eight skinfolds were 74.3 \pm 21.4 mm for males and 121.5 \pm 46.3 mm (Table 1) for the female group.

Standing Lap on the Velodrome Results

Mean (\pm SD) standing lap times over the 250 m were 12.45 \pm 0.89 sec for the first half and 20.64 \pm 1.54 sec for the overall time. Males were significantly faster than the females over both the first 125 m (males 11.74 \pm 0.57 sec: females 13.16 \pm 0.38 sec) and the final 125 m (males 19.43 \pm 1.00 sec: females 21.83 \pm 0.82 sec) (Table 2) ($p < 0.05$).

The mean amplitude for area, peak and mean were all significantly greater in the first half of the standing lap for all muscle groups over all trials compared to the second half of the lap ($p < 0.05$) (Table 3). When comparing individual bilateral muscle groups for mean area amplitudes, there were a significantly greater amplitudes for the left and right side measurements during the first half of the standing lap compared to the second half measurements ($p < 0.05$) (Figure 3). There was no difference in the individual bilateral muscle groups for the mean peak amplitudes for the left and right side during both halves of the standing lap (Figure 4).

Standing Lap on the Velotron Cycle Ergometer Results

The mean (\pm SD) time for 250m cycle

ergometer was 18.50 ± 2.96 sec for all seven participants. Males had a significantly faster time of 16.43 ± 1.88 sec compared to the female time of 21.26 ± 0.97 sec ($p < 0.05$) (Table 4).

The average and peak power output means (\pm SD) was 892.1 ± 465.2 W and 1165.6 ± 671.9 W respectively. Male's average (males: 1182.3 ± 410.4 W, females: 505.3 ± 62.6 W) and peak (males: 1568.0 ± 671.9 W, females: 629.0 ± 60.7 W) power output means (\pm SD) were significantly higher compared to the female results ($p < 0.05$).

When converting average power into power to weight ratios (males: 13.0 ± 2.9 W/kg, females: 7.5 ± 0.8 W / kg) and power to BMI (males: 42.5 ± 11.3 W/kg, females: 20.6 ± 2.0 W/kg) males again had a significantly higher output ($p < 0.05$). Males also had a

help of the wireless MyoResearch XP EMG technology.⁹ By utilising the synchronised video feed and the muscle activity patterns of the individual muscle groups, the researchers were able to identify which muscles showed a decrease in muscle activation patterns, along with the order in which the muscles were utilised during the pedal cycle.¹⁴

Another interesting finding was that the paired sample correlation between the averaged Peak amplitudes across all muscle groups for all trials of the first and last 125 m of the sprint, showed a significant correlation ($r = 0.908$; $p = 0.000$) (Table 3). This would confirm that the cyclists were consistently working at 100 % of their ability. Making use of paired sample correlations would also help researchers to identify which muscles are unequally matched. With the focus on

ergometer showed an inverse relationship between power and time/speed (Table 4). The greater the power development of the cyclist the faster the times were. This would suggest that strength training techniques that develops power would be best suited for these athletes to optimise performance.²⁵

The highest muscle activation patterns, recorded during the 250 m sprint were the right rectus femoris, followed by the left rectus femoris and left biceps femoris (Figure 4). The gluteus maximus muscles had the lowest peak amplitudes (Figure 4). Correlations between time taken, power output and fatigue existed. Interestingly, the right gastrocnemius provided a higher amplitude than the right biceps femoris (within the first half of the sprint). However, in the second half of the sprint the biceps femoris had a higher amplitude, suggesting that the gastrocnemius might be a muscle group that will need to be focussed on when conditioning sprint cyclists. Consistent with previous findings, the fastest starters tend to be those cyclists who were able to co-ordinate the following three actions: pushing off the gate as it releases, drive the body forward, and initiate proper mechanics for the first pedal stroke.²⁶

Within this study there were several limitations. Firstly, there were variations in the abilities of the cyclists, ranging from international riders to provincial riders. Due to the unavailability of power meters on many of the track bikes, the Velotron trials were performed to determine the power output of the cyclists. These trials were performed two weeks later in an HPL and not all the cyclists were available for the Velotron trials. It was difficult to match the exact track starting sequence and bike set-up on the Velotron. Ideally, the researchers would have preferred to use SRM power meter technology to measure power output during the different stages of the sprint and then synchronise these measurements with the muscle activity patterns. Future research will focus on comparing on track muscle activation patterns in relation to SRM power measurements. This should show if true correlations between muscle activation / fatigue and cycling performance exists.

The researchers only used group averages for the purpose of this study, however it should be noted that there were significant differences between individual test subjects,

Table 4: Mean (\pm SD) for power output and ratios on competitive sprint cyclists over 250m on the Velotron cycle ergometer (n = 7).

	Males (n = 4)	Females (n = 3)	Total (n = 7)
Time (sec)	16.43 ± 1.88 *	21.26 ± 0.97	18.50 ± 2.96
Average power (W)	1182.3 ± 410.4 *	505.3 ± 62.6	892.1 ± 465.2
Peak power (W)	1568.0 ± 671.9 *	629.0 ± 60.7	1165.6 ± 671.9
Average Power to weight (W/kg)	13.0 ± 2.9 *	7.5 ± 0.8	10.6 ± 3.6
Peak Power to weight (W/kg)	13.8 ± 5.4 *	9.3 ± 0.8	13.8 ± 5.4
Average power to BMI (BMI/W)	42.5 ± 11.3 *	20.6 ± 2.0	33.1 ± 14.2
Peak power to BMI (BMI/W)	56.1 ± 18.1 *	25.6 ± 2.2	43.0 ± 20.7

* Significant difference between males and females ($p < 0.05$)

significantly higher peak power to weight ratio (males: 13.8 ± 5.4 BMI / W females: 9.3 ± 0.8 BMI / W) and peak power to BMI (males: 56.1 ± 18.1 BMI / W females: 25.6 ± 2.2 BMI / W) compared to the female group ($p < 0.05$) (Table 4).

DISCUSSION

The main results of the study identified significant ($p < 0.05$) differences between the muscle activation patterns of the first and last 125 m of the sprint event (Table 3). The differences in muscle activation patterns could be indicative of peripheral fatigue, eliminating these differences could result in improving all out sprint performance on the track.^{2,21} One of the unique differences of this study was that the researchers were able to monitor muscle activation patterns during the sprint performance on the track with the

individual muscle activation patterns, it was evident that some muscles (average Peak, Mean and Area / IEMG signals for the left and right biceps femoris and the left and right gluteus maximus during the first 125 m of the sprint performance) (Figure 3) did not show significant correlations, indicating that these muscle groups are unmatched, suggesting that the muscles with the weaker signal values (left biceps femoris & left gluteus maximus) are those that will require attention (Figure 4). The same trends were found with the Velotron trials. At first it was thought that the elevation angle of the Velodrome track could have caused the muscle differences, but due to similar findings with the Velotron trials this can be ruled out, although this could be due to the training effect of riding on the track over a long period of time.

The results from the Velotron cycling

with different muscle activity imbalances. Although there were many common trends, one of the most important findings were that elite athletes should be assessed individually.

CONCLUSION

From the discussion it is evident that there are many benefits for making use of technology and muscle activation patterns to improve sprint cycling performance and therefore the hypotheses will not be rejected. The use of individual muscle activation patterns, allowed the researchers to identify which muscle groups were unmatched and which muscles required conditioning. Some trends and patterns were identified amongst the research population. However, these correlations and findings are likely to differ according to the sport being analysed, and as such it is probably unsafe to generalise the findings from one sport to another or within the same sport genre or competition.⁴ It is recommended that an individualised approach be followed for analysing elite athletes.

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Preparing for an NZOC Health Team Role: What is involved?

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INTRODUCTION

2017 marks the start of a new Olympic cycle, with athletes and sporting organisations refocussing on what it will take to generate medal winning performances in Tokyo 2020. After a period of transition and reflecting the continuous nature of international competition, the New Zealand Olympic Committee (NZOC) has recently completed a recruitment drive for doctors, physiotherapists and massage therapists to participate in a range of international multisport events in 2017 and 2018 - including the Commonwealth and Winter Olympic Games. The NZOC received well over 100 high quality applications for these roles, making the selection process a challenging exercise in discrimination. Charged with determining the selections (BH/JS), the authors recognise both the privileged role we play in deciding who will attend these prestigious events, and the potential influence our decisions have on careers and life experiences. Unfortunately, there are only limited opportunities to represent NZ as part of the health team at these pinnacle events. This brief manuscript is written with the goal of supporting those who may harbour ambitions of working in the Olympic sports medicine environment.

BACKGROUND

In 2013 High Performance Sport NZ (HPSNZ) and the NZOC collaborated to appoint a joint Medical Lead (subsequently evolving into the HPSNZ Director of Performance Health and NZOC Medical Lead). A unique role among international sporting and Olympic organisations, the goal of this joint appointment was to

streamline the health management of the elite athlete, from the training ground to the international competition arena. Aligned with this appointment, since 2012 HPSNZ has provided sports medicine support to carded Olympic athletes through an increasingly centralised model. By far, the majority of funded athlete programmes are based around either the National Training Centre or Regional Performance centres, where athletes may train, recover and receive comprehensive multi-disciplinary support. Reflecting the centralised approach, the clinical needs of many elite athlete groups are increasingly being met by practitioners supported by HPSNZ to be immersed (albeit to varying degrees) within National Sporting Organisation (NSO) programmes. Working within the centralised HPSNZ structure provides a unique opportunity to practice in a truly multi-disciplinary manner, and to broaden skill sets beyond clinical work alone. However, concurrent with the increasingly centralised delivery model for sports medicine support, there has been a corresponding reduction in opportunities for practitioners around NZ to be routinely engaged with elite Olympic sport. Furthermore, since athletes competing in pinnacle events consistently report the value of having recognisable and trusted practitioners incorporated into the traveling team, international team support opportunities for practitioners not working within the centralised system have potentially declined. As a result, both HPSNZ and the NZOC have recognised that articulating a pathway for sports medicine providers into the arena of sports medicine care for elite athletes is essential to ensure the ongoing availability of high quality, experienced practitioners (Figure 1). Establishing a process that encourages and develops capable and enthusiastic practitioners to choose the care of elite athletes as their career (or as a component of their career) is a crucial element in sustaining the standards of care for elite athletes in NZ, and thereby optimally support athletes at pinnacle events such as the Olympic Games.

SPORTS MEDICINE FOR ELITE ATHLETES

There is often animated discussion as to whether providing sports medicine support for elite athletes poses unique challenges in comparison to caring for the “weekend warrior”. It is our contention that while there is significant clinical overlap, operational elements of the two scenarios are distinct and increasingly divergent. Specifically, community based sports medicine support (and in this discussion we will arbitrarily consider this as including physiotherapy and medicine) is typically reactive, time constrained and consultation room based. While inter- and cross- disciplinary referral is utilised, it is not necessarily the immediate default approach, and funding for services provided is based around either ACC, private health insurance or user pays. In this necessarily business model approach to sports medicine, data collection is often limited to professional and legal requirements, research is rare and the application of novel treatments have both commercial and clinical considerations. By comparison, the provision of centrally funded sports medicine care to elite athletes allows for ease of access and an expectation of inter-disciplinary care. Funding and support is not determined by external funding bodies, and as a result clinical options are determined by knowledge, acquired skills and resource availability. Incumbent in the latter approach is a complex accountability to multiple parties, including the coach, athlete (patient), National Sporting Organisation (NSO), discipline and HPSNZ. While there is significant overlap in required clinical skill sets, the two environments are structurally and organisationally distinct, and success in either environment is characterised by the ability of practitioners to continuously learn and adapt.

CARE OF THE OLYMPIC ATHLETE AT PINNACLE MULTI-SPORT EVENTS: CORE REQUIREMENTS

The clinical care of the elite athlete during international camps and competitions is a

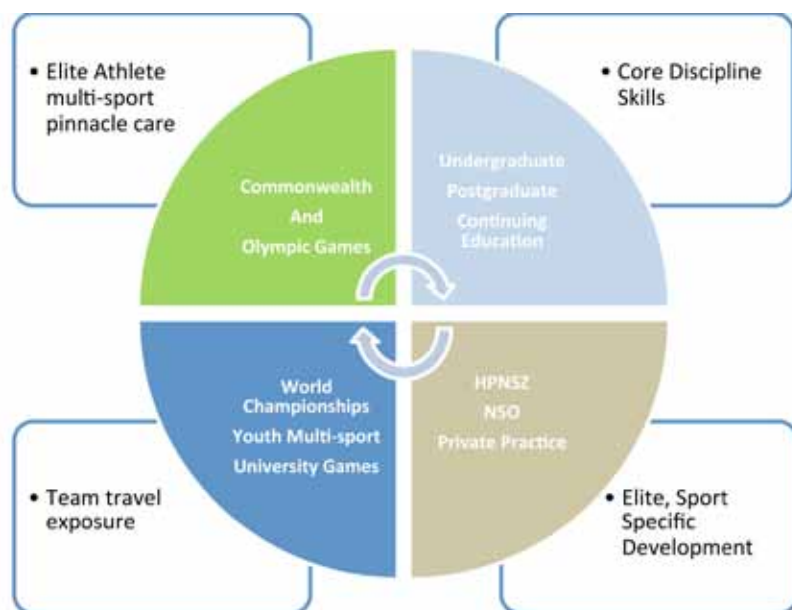


Figure 1. Schematic representation of evolution of individuals involved in Health Team representation at Olympic and Commonwealth Games

relatively unique feature of sports medicine support. The Olympic Games is considered the pinnacle of multi-sport events for athletes (notwithstanding the significance of individual sporting code world cups or world championships), and is often held in similar status by practitioners with respect to their individual career ambitions within sports medicine.

Paradoxically, while the Olympic Games is a highly charged and pressured environment, it may not have the challenges that are imposed by many smaller events, where a practitioner of any discipline may often be the sole health care provider and event medical support may be limited. Hence, traveling with elite athletes to all levels of events impose quite distinct demands on practitioners, with unfamiliar environments, conflicts of interest, scope of practice extensions, long working days and clinical isolation all creating challenges that must be adapted too in order to be successful. Like all clinical skills, team travel is a capability that must be learnt. The health team for a pinnacle multi-sport event such as the Commonwealth or Olympic Games is required to support athletes and support staff through a broad range of potential situations. Critical attributes of team members are found in table one.

PINNACLE EVENT: TEAM CAPABILITY AND FUNCTION

In addition to the individual capabilities described above, an individual's selection

and ultimate role within a multi-sport team is also determined by the overall capability of the health team. Thus, team considerations such as the specific skill set mix, sport specific experience, communication, leadership styles and gender mix, all play a role in the final health team formulation. Furthermore, ensuring an appropriately skilled future team, through careful planning for succession, is a critical function of any multi-sport health team, and this further complicates the team selection matrix (Figure 2).

Table 1. Attributes of individual health team members at a pinnacle multi-sport events

Clinical Reasoning for Health and Performance impact	Applied and detailed understanding of specific aspects of individual athlete management, including the impact of illness or injury upon wider performance variables. Established ability to collate multiple clinical and non-clinical factors in the formulation of a management strategy, in a time compressed environment and in the presence of potentially conflicting imperatives.
Event experience	Experience and proven capability at an international competition level, preferably multisport event. May be developed through individual sporting federation world championships, or junior events such as youth Olympic and Commonwealth Games.
Proven ability to work in a complex team environment	Established record of effective inter-disciplinary team involvement in the management of elite athletes
Advanced communication skills	Effective communication of timely, relevant and accurate information to inform multi-disciplinary decision making under pressure of time and conflicting imperatives.
Skills under pressure	The ability to remain positive and effective despite the challenging multi-sport environment. The ability to recognise individual limits, work within your scope of practice and respect colleagues.

As a result of the large number of individual and team factors implicated in selection, and the extremely limited number of positions available, securing a role at an Olympic or Commonwealth Games team for NZ is challenging (but not impossible).

PREPARING FOR SELECTION TO AN NZOC HEALTH TEAM

In 2017, over 120 applications were received for opportunities to be part of the health team for the World University Games, Youth Commonwealth and Olympic Games, Winter Olympics and Commonwealth Games. From this long list, 42 applicants were ultimately interviewed and 39 traveling and reserve positions were appointed. Thus, getting through the initial selection phase is critical, and the following observations are made to assist those wishing to enhance their chance of being involved in future NZOC health teams.

- If you are unsure whether to apply – apply. As illustrated above, multiple factors are involved in determining the ultimate team make-up, and you never know what factors may be in play at any given time.
- Be realistic in your assessment of your experience and capabilities.
- Be clear and honest on your career aspirations and your motivations.



Figure 2. Summary of factors involved in NZOC multi-sport health team selection

Remember, those selecting the team are interested in what you can do for the team, not just that you are really enthusiastic (which is universal)– it's about the team, not the individual.

- Be clear on what makes you special. What can you bring to the team, that differentiates you from other practitioners? While an important part of your application preparation, this should also be part of your career planning – if you want to work in this environment, what do you think is going to be needed, and how can you make yourself the best person for that role?
- Be able to illustrate where you have made a difference. Most practitioners are able to provide illustrations of where they have positively influenced an athlete's outcome – what have you done that has had a long term sustained effect on groups, sports, systems, beliefs and practices? Can you articulate clearly why would this be useful to the NZOC health team?
- Be prepared to provide illustrations of soft skills such as team work, collaboration, critical observation, problem solving, adaptability and conflict resolution.
- More (or less) experience is not necessarily better. What is the quality of what you have been doing and how does it differentiate you from others? For example, having attended 25 conferences may not reflect development or progression of “non-clinical” competencies as much as teaching or

lecturing on a few courses (or contributing to organisations such as SMNZ, or contributing clinical articles in local educational forums such as the SMNZ journal).

- Take opportunities to work with NSO's and HPSNZ. If you have a passion for a particular sport, look for opportunities to showcase and develop your expertise. HPSNZ is regularly advertising for practitioners to work in the centralised hubs, or travel with teams. In the last year, HPSNZ Performance Health Team has established a sports medicine fellowship for sports physician registrars, and is currently finalising a physiotherapy internship.
- Prepare your curriculum vitae. Ensure that it is up-to-date, does not include typographical errors and does not include multiple colours or fonts! The pieces of your CV that you consider important and relevant to your application should be highly visible on a quick perusal – that may be all the opportunity you get.
- Prepare for the interview carefully by researching and asking questions of those that may have experience – try to avoid the trap of making assumptions on what may or may not have occurred before. Be primed with examples for a range of potential scenarios that illustrate your strengths and weaknesses.

CONCLUSION

Being a member of the health team in an NZOC multi-sport pinnacle event is both challenging and highly rewarding. Quite appropriately given the nature of the event, membership of this team is highly sought after and given the size of the team, selection is highly competitive. Despite the increasingly centralised approach to the provision of health care to elite NZ athletes, both HPSNZ and the NZOC are committed to supporting the development of practitioners with the right skill set and desire to work

with elite athletes. As illustrated above, health team selection involves consideration of multiple factors and is increasingly challenging. Those charged with its selection take the responsibility seriously, recognising the significance of the appointments, and are committed to transparency of process and development of individuals in this inspirational area of work.

As with athlete selection, selection to an NZOC pinnacle multi-sport event health team requires years of commitment, sacrifice and hard work. It doesn't come easy for anyone. However, working at one of the great spectacles, alongside talented and committed colleagues and athletes, makes that hard work worthwhile.

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The travelling athlete

TONY PAGE

The key to a medically successful tour is preparation. Using the old adage: “if you fail to plan, then you plan to fail” is generally true.

It starts as soon as you know that you are going to be involved.

DESTINATION ISSUES

What is the general state of the healthcare system in the country that your team is travelling to? Is it poorly organised, low level? Is it highly privatised? Will the team have travel insurance? If they do not, then consider whether you should be involved.

Sometimes health insurance policies can specifically exclude medical care in certain countries eg, USA.

It is helpful to find a local medical practitioner in the destination country to chat to. They can be a source of very useful information. You will very likely need to ask them to write out a prescription for you and it is useful to request this in advance. Check out the NZ government travel advisories (<https://safetravel.govt.nz/>) and the CDC reports for the destination (<https://wwwnc.cdc.gov/travel>). Sometimes there are specific risks such as dengue fever, malaria or even cholera.

Once you have gathered this information then assess what resources you are likely to need. These include local medical contacts, medical evacuation and pre travel vaccination.

PERSONAL FACTORS

Now you find out who is likely to be in the team. Who are the non-travelling reserves as they also need to be included in case they are called up at the last moment? Your management team are likely to be the ones with risk of medical illness like cardiac or respiratory disease so include these high risk and often poorly conditioned individuals in your planning. Consider giving management a special pre tour reminder to visit their own GP and start a pre travel fitness programme!

Get the contact details, next of kin from your team manager and start doing the leg work. It is far easier if there is a preseason/ pre-tournament camp so that you can gather information. If you are likely to need to

update vaccinations, eg, hep A, influenza, typhoid then arrange access to a vaccination service during the camp. Where these vaccines cause side effects, it may be difficult to do them at the beginning of a camp where performance and training are critical.

Each player should be interviewed following the usual medical paradigm of history, examination and potential investigations. Particular emphasis should be placed on vaccination status. Medication use and allergic reactions should be enquired about. Make sure to top up player's personal medical supplies by writing a prescription, and keep some emergency supplies in your medical kit. Enquire about sleep habits and how the player finds air travel. Are they anxious? Do they get home sick? Should they take a familiar pillow? How will they contact family when away?

SUPPLIES

Make a list of what medical supplies you need considering the destination, the team and likely injuries and illnesses. Once you have your list then make sure that you add these items to your medical kit. Check the rules for transporting medical equipment and keep an up to date inventory of medication.

Have a pre travel meeting and talk to the team about your suggestions for combatting jet stress. This can include noise cancelling headphones/ear plugs, eye pads to block out light, when to sleep and when to stay awake and fluid and food advice.

Stress the risk of infection with crowded spaces and tiredness. Hand washing is essential and it is useful to provide each member of the travelling team with a small hand sanitizer in a clear plastic packet. Discuss team policy on eating out and buying “street food”. Give advice about looking after the spine by moving about the cabin, lumbar and neck support and calf stretching to prevent DVT.

DESTINATION

Upon arrival keep the players up until evening with team activities. A walk in the fresh air and sun is helpful on many levels. Decide whether you are going to use melatonin in

the evening for a few days. Get the players up and exposed to early morning sun. Schedule activities at low intensity for the first few days. Discuss this with the coaches offering specific guidelines, eg, day 1, 60% RPE, day 2 80% RPE, day 3, allow maximum efforts.

Normalise time zone adjustments and reassure all that it will resolve in a few days, particularly if time is spent outdoors and evening “blue light” screen time is minimised.

Illness is inevitable in a large travelling group. Make sure that you are decisive with significant illness and isolate the player early on until they are no longer infectious. Team first should be your dictum.

GETTING HOME SAFELY

Hopefully you have a successful tour on a number of levels. Now make sure you return safely. In the post tournament roller coaster of emotions make sure the team are safe, and try to get an immediate idea post event of any significant injuries. Arrange a post travel assessment and start writing handover communications on the way home. Consider calling medical staff on return to NZ and follow up any significant injuries to clearly state who is managing the treatment.

Lastly, just when you think it is over, you will probably have to write a tour report, so get going!

Tony Page

Sports Physician / All Black Team Doctor

KEYNOTE ADDRESS

REGULATION OF ACTIVITY DURING EXERCISE – MAINTAINING OVERALL CONTROL OF THE TWO HORSES CALLED REASON AND PASSION IS ALWAYS A CHALLENGING AND COMPLEX BUSINESS

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Background: Despite a large quantity of research in the field, the mechanisms of how exercise is regulated while it is ongoing are not well understood. Explanations and hypotheses are generally reductionistic, and look at one specific physiological system or body organ function as regulating exercise. For example, in the peripheral 'catastrophic' model of exercise regulation of physiological activity in either the muscles, lungs, or heart is suggested to be the predominant regulator of activity, and cessation of activity is related to either fuel substrates in one of these organs running out, or physiological system / biochemical pathway metabolites building up over time that overwhelm the specific system postulated to be the overall exercise controller. In the central model of the regulation of exercise, the brain is suggested to be the ultimate regulator of exercise, using homeostatic principles, and regulates activity in a pre-emptive manner to ensure absolute failure of any system never occurs, based on afferent inputs from the internal physiological milieu and external environment, and knowledge of the exercise task to be performed and prior experience of other similar events.

Aim: In this presentation we examine these concepts, and suggest that in contrast to the models described about, it is rather the competitive interaction between physiological and psychological requirements in the individual initiating the exercise bout (or between physical homeostasis and the desire to achieve success which could result from performing the exercise activity) that is the overall governor of exercise activity, and each person's final level of activity during the event they are competing in is a result of this 'competition' between the 'two horses' known since antiquity as reason and passion and the control of them – both the relative 'need' for either achievement benefits or the maintenance of homeostasis and an attenuation of physical risk. It is suggested that future work should examine regulation of activity from the basis of psychological versus physiological 'competition', rather than the previously described central versus peripheral mechanisms that have been described to such a degree in the literature in the last few decades.

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Keywords: Fatigue; Regulation of Activity; Homeostasis; Biological Drives; Exercise Regulation

INVITED ADDRESSES

COMBINED STRESSOR TRAINING AND CROSS TOLERANCE FOR HEALTH AND PERFORMANCE

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Humans adapt to chronic/repeated stress, such as exercise or warm environments, to become more tolerant of subsequent exposure. Certain types of cellular and systemic adaptations enhance one's tolerance when exposed to novel stressors, i.e., provide cross tolerance. The parameters of stress – e.g., form(s), magnitude and pattern of energy imposed – used in conditioning influence the nature and extent of adaptations, as do factors that govern individuals' sensitivity and capacity to adapt (e.g., sex, age, disease state, fitness). Exercise training/conditioning is a complex and inadequately-understood stressor that drives the immense array of adaptations that constitute fitness. Fitness therefore enhances cross

tolerance to some stressors (e.g., heat, cold, dehydration), but not others (e.g., orthostasis). Conditioning with isolated stressors is increasingly being examined with or without exercise training for its ergogenic or health-related potential; these typically being hypoxia, heat, ischaemia or restricted carbohydrate. Such stressors used in conjunction with or in place of exercise training are readily shown to be effective physiologically in untrained or moderately trained participants, but appear to show little transfer to highly endurance-trained participants or may not confer measurable ergogenic benefit. Research into combined-stressor conditioning is almost nonexistent despite clear physiological rationale and potential applications. Combined heat & hypoxia conditioning is appealing but also highlights problems of interference in adaptation. This presentation will provide an update on the immensely promising field of isolated and combined stressor conditioning. Potential applications are numerous and include performance, primary prevention, prehabilitation, rehabilitation and cross tolerance.

Keywords: Adaptation; Training; Stress Conditioning; Acclimation; Heat; Hypoxia; Exercise

EFFECT OF REPEATED SPRINT TRAINING UNDER HYPOXIA ON NORMOXIC REPEATED SPRINT PERFORMANCE

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Aim: This study aimed to investigate the effect of repetitive sprint training under hypoxia on subsequent normoxic repetitive sprint ability.

Methods: Well-trained male rugby players underwent 3 weeks of repetitive sprint training (six sessions of four sets of 5 x 5-s sprints with 25 s of active recovery) in either normobaric hypoxia (Hypoxic; n = 9; FIO₂ = 14.5%) or normobaric normoxia (Normoxic; n = 10; FIO₂ = 20.9%). Pre and post-training performance was evaluated with repetitive sprint (8 x 20 m timed to go every 20 s), and Yo-Yo Intermittent Recovery Level 1 (YYIR1) tests. After each training set, heart rate, oxygen saturation and rating of perceived exertion were recorded.

Results: Compared to baseline, both the hypoxic and normoxic groups improved fatigue over the 8 sprints one week after the intervention (Week 1, -1.8 ± 1.6%, -1.5 ± 1.4%, mean ± 90% CI in Hypoxic and Normoxic groups respectively). However, from Week 2 onwards, only the hypoxic group maintained the performance improvement compared to baseline (Week 2 -2.1 ± 1.8%, Week 3 -2.3 ± 1.7%, Week 4 -1.9 ± 1.8%, and Week 5 -1.2 ± 1.7%). YYIR1 performances improved throughout the recovery period in both groups with unclear differences found between groups. Relative to the normoxic group, the hypoxic group's SpO₂ was substantially lower, and heart rate substantially higher during training bouts.

Conclusions: Repeated sprint training in hypoxia for 6 sessions increases repeated-sprint ability but not YYIR1 performance in well-trained rugby players.

Keywords: Normobaric Hypoxia, Yo-Yo Intermittent Recovery Test, Team Sports, Repeated Sprint Ability, Intermittent Hypoxic Training.

CHASING THE 0.2: STRIVING FOR IMPACT IN HIGH PERFORMANCE SPORT

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A recent editorial by Buchheit 2016, titled "Chasing the 0.2", challenges today's modern applied sport scientist to ask research questions that make real impact in an elite performance setting. In reference to statistic's smallest important (standardized) effect, attainment of 0.2 by sport practitioners is not always easy. However, it is the modern day Sport Scientist's responsibility to strive for this goal, through their daily work with athletes and coaches. Using Buchheit's editorial as reference, this presentation will outline practical examples of attempts towards a 0.2 effect, with specific reference to my work with Rowing New Zealand and other professional sports.

Keywords: Athletic Performance; Effect Size; Elite Sport

SEX DIFFERENCES IN HYDRATION, THERMOREGULATION AND PERFORMANCE

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Sex differences exist from birth, yet are often under-reported in exercise and nutrition research. Often women are excluded or grouped with men, without menstrual cycle phase acknowledgement. The aim of this talk is to describe sex differences as they apply to performance parameters of thermoregulation, hydration/hyponatremia, and thirst. The perturbations of sex hormones across the menstrual cycle induce several metabolic, thermoregulatory, and neuroendocrine challenges, which may impact performance. Women, compared to men, have higher body surface area to body mass ratio, higher body fat mass, and higher density and number of sweat glands. Women also use a higher percentage of sweat glands while secreting less sweat. These facts may cause inherent differences in tolerance to heat between the sexes. Women are at greater risk for exercise-induced hyponatremia (low blood sodium concentration) and this risk has been attributed to their lower body weight and size, excess water ingestion, and estrogen-mediated inhibition of potassium transfer. Moreover, the greater levels of estradiol in plasma and tissue also play a role in increasing the risk of hyponatremia in women. The hormonal influences of sex hormones affect fluid dynamics by altering capillary permeability, vasomotor function, and the central set-point control of renal hormones and plasma osmolality. Elevations in plasma progesterone concentrations during the luteal phase inhibit aldosterone-dependent sodium reabsorption at the kidneys due to progesterone competing with aldosterone for the mineralocorticoid receptor. Moreover, progesterone is thermogenic, induce a core body temperature rise by 0.5°C; with concomitant resetting of cutaneous vasodilation and the osmotic set-point for thirst.

Keywords: Female Athletes, Sodium-Potassium Balance, Fluid Dynamics

ORAL PRESENTATIONS

ASSESSING THE POTENTIAL FOR CLINICAL EXERCISE PHYSIOLOGY IN THE WAIKATO REGION OF NEW ZEALAND: A PILOT STUDY

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Background: There is a clear link between physical inactivity rates and the prevalence of non-communicable diseases (NCDs) in the Waikato region of New Zealand, as well as globally. These rising numbers indicate that there is clearly a lack of facilities and practitioners with the appropriate skills and knowledge to cater for people in the moderate to high risk categories for NCD's in the Waikato.

Aim: To ascertain primary healthcare providers' current attitudes and practice towards counselling on physical activity (PA). This included determining what, if any, barriers exist in preventing them counsel patients on PA, and what level of qualifications for exercise professionals they deem essential to be confident in referring. To determine the current situation for people in the Waikato region of New Zealand with NCDs. How, if at all, are their needs being addressed. Is there a need for CEPs in the Waikato region of New Zealand?

Method: A survey was adapted from a previous survey developed by Exercise is Medicine®. Five medical centres in Hamilton and Te Awamutu, and nurses at a conference were asked to complete the survey. 61 hard copies were delivered with a total of 44 responses received. Analysis of the New Zealand Health Survey 2014/15 and the Green Prescription Patient Survey 2015 was conducted to determine the health status, and services currently provided for people with NCDs, in the Waikato region.

Results & Conclusions: Currently under analysis, due end of September 2016.

Keywords: Non-Communicable Diseases; Physical Activity; Primary Healthcare; Exercise is Medicine®.

STANDING WORKSTATIONS: EXPERIENCE, ACCEPTABILITY, AND EFFECTS ON OCCUPATIONAL SEDENTARY BEHAVIOUR AND METABOLIC HEALTH OF OFFICE WORKERS

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Background: Metabolic Syndrome (MetS) is a collection of clinical signs that represent unfavourable metabolic changes in the body, associated with increasing risk of cardiovascular disease (CVD), Type 2 diabetes mellitus, stroke, and all-cause mortality. In recent years, sedentary behaviour has been linked to markers of MetS, CVD and all-cause mortality. The negative effects of sedentary behaviour may be separate from the benefits of physical activity and steps should be taken to replace sedentary behaviour with regular light intensity physical activity.

Aims: To examine the physical effects and lived experience of six office workers following the introduction of sit-stand workstations.

Methods: In this single-case design study, the effects on physical activity and metabolic markers during baseline, 'phase-in' and intervention periods were measured. A concurrent qualitative study aimed to understand the experience of participants. Three semi-structured interviews were conducted and the data were analysed to generate themes and subthemes.

Results: Changes occurred for daily sitting and standing time for 5 participants. Standing time increased between 111 min/day and 341 min/day following the introduction of the standing workstation. Decreased daily sitting time ranged from 107 min/day to 311 min/day. Changes to daily sitting and standing times remained stable and the acceptability was mirrored in qualitative data. Participants reported physical changes, including improved tolerance to standing and a perception of improved posture, as well as emotional changes including increased productivity, cognitive function and tolerance to stress. Three participants showed decreases in waist circumference between 2.5 and 6.7 cm.

Conclusion: The use of sit-stand or standing workstations reduced daily occupational sitting and increased daily occupational standing in all participants where inclinometry data were available. Changes were stable across the entire intervention period suggesting high acceptability of the standing workstation. The failure to detect changes to metabolic markers may be suggestive of study limitations or the complexity of metabolic syndrome.

Keywords: Standing Desk; Occupational Health; Physical Inactivity

Funding Sources: Dan Archer was supported by a Todd Foundation Award for Excellence.

DOES OSTEOPATHIC MANUAL THERAPY WITH BREATHING RETRAINING ALTER EXERCISE ECONOMY, SYMPTOMS OF DYSFUNCTIONAL BREATHING, OR HEART-RATE VARIABILITY?

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Background: Dysfunctional breathing (DB) is an alteration in the normal patterns of breathing which can result in intermittent or chronic respiratory and non-respiratory symptoms. DB is often brought about by stress and anxiety, and may have other physiological effects, such as reduced exercise ability.

Aim: To determine whether osteopathic manual therapy with breathing retraining can improve exercise economy, breathing-related symptoms, cardiac autonomic markers or exercise economy.

Methods: Development of the osteopathic intervention entailed several iterations of trials and evaluation, and involved over a dozen experienced practitioners. Active participants (n=19), who perceived that breathing might be limiting their exercise performance were randomised to receive 4 – 6 weeks of intervention either immediately (n=10) or after a 4-week delay (n=9), and were assessed for changes in exercise economy, symptoms suggestive of dysfunctional breathing and heart rate variability.

Results: Improvements in heart-rate variability were noted in those who

received treatment compared to those yet to receive it: effect sizes (ES) were 0.7 – 1.2 and 0.39 – 0.40 respectively ($p < 0.05$). Changes in heart-rate variability from before to after treatment were also noted ($ES = 1.2 - 1.3$; $p = 0.001$). Pre- to post-intervention reductions in breathing symptom questionnaire scores and exercise economy were also noted, but differences were not statistically significant compared to control.

Conclusions: Whilst the mechanisms are unclear, osteopathic treatment with breathing retraining appears to have a beneficial effect on heart-rate variability. This may suggest that breathing exercises aimed at improving breathing habits can be useful for mitigating undesirable autonomic regulation such as stress responses.

Keywords: Abnormal Breathing; Breathing Pattern Disorders; Exercise Performance; Autonomic Response

SALIVARY HORMONES AND SPORT SCIENCE APPLICATIONS

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Background: As the primary anabolic hormone, testosterone has received a great deal of research attention, especially in regards to resistance training. While some recent studies have questioned the relevance of transient acute hormonal response following resistance exercise, the abundance of literature would suggest that testosterone plays a major role in muscle adaptation with evidence supporting this notion being described as “incontrovertible”. It should also be noted that testosterone plays a number of further roles including visuospatial ability, risk aversion, dominance, and attenuation of the integrated central stress responses.

Aim: To present the potential benefits of assessing and monitoring salivary testosterone in athletic populations.

Methods: A brief and targeted review of relevant literature.

Results: Data from a range of sources demonstrate an important role for endogenous testosterone in actualising functional gains in both male and female athletes. Prescription of specific exercise variables to elicit maximal acute hormonal elevations, at an individual level, is related to increased upper- and lower-body strength. Strength gains associated with blood flow restricted training were also associated with exercise-induced increases in testosterone. Psychological and behavioural aspects of testosterone have the potential to enhance training adaptation by complementing the known anabolic and permissive properties of testosterone. Previously unpublished data regarding a relationship between sport-specific skill tasks and testosterone, as well as data that suggests that caffeine responders display a distinctive hormonal profile, is presented.

Conclusion: Assessment of dynamic changes in salivary testosterone can assist in exercise prescription and assessing athlete status. Manipulation of endogenous hormones can have positive performance and training outcomes.

Keywords: Elite; Strength; Readiness; Over-Reaching; Motivation

BACK TO FUNDAMENTALS:

WHAT MOTOR SKILLS UNDERPIN PHYSICAL LITERACY?

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Background: A physically literate person can produce and transfer movement patterns to function effectively in different performance environments such as at school, in the workplace, competitive sport, etc. Physical literacy is a complex multi-faceted concept, including a motoric component composed of so-called fundamental movement skills (FMS). FMS are presumed to be the ‘building blocks’ for more sophisticated, context-specific motor skills. It has been suggested that if children do not acquire FMS within a critical developmental period then they will struggle to adapt and transfer these skills, and may consequently have limited opportunities for physical activity, later in life.

Johnson (1962) suggested that motor skills routinely practiced in sport and physical education classes were appropriate for the assessment of FMS (e.g., running, jumping, throwing, striking, kicking, etc.) While FMS assessment has evolved considerably since then, a ‘sport-centric’ focus has doggedly

persisted. Indeed, several of the motor skills tested by Johnson (1962) in his pioneering study remain in the dozen or so movement assessment batteries commonly employed today. Despite reported limitations in sensitivity, reliability and validity (Cools et al., 2009) many such movement assessment batteries are still being used to assess competency in the general population. Aim: Our general aim is to reconceive the concept of FMS informed by evidence from the motor control and learning literature to construct a more robust, general taxonomy of movement coordination. We are currently pilot testing in primary schools a new active video gaming platform to assess fundamental movement skills based on our taxonomy.

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Keywords: Movement Screening; Paediatrics; Skill Acquisition

THE ROLE OF AFFECTIVE RESPONSES TO EXERCISE IN MAKING AN AFFECTIVE FORECAST

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Background: The basic pleasant/unpleasant feelings and individual experiences during exercise are termed the affective response (Ekkekakis, 2003). Positive affective response has been shown to predict future exercise behaviour positively (Williams, 2008). This link could be explained by Decision Affect Theory (DAT; Mellars & McGraw, 2002), which proposes that the experienced affective responses and the affective memory of an event influence one's affective forecast for a future event. Specifically, they will base behavioural decisions for future event(s) around whether these affective forecasts are pleasant or unpleasant. But DAT has not been tested in the exercise context.

Aim: To explore the relation between affective responses experienced during exercise and the affective forecasts for future exercise.

Methods: Twenty inactive female participants (39 ± 11 y) completed three 30-min moderate-intensity exercise sessions one week apart. Before exercise, participants were asked to predict how they thought they would feel overall during exercise; from -10 (very unpleasant) to +10 (very pleasant). Affective responses were recorded using the Feeling Scale (Hardy & Rejeski, 1989), before, every 2 min during, and at 5, 10, and 15 min after exercise.

Results: Linear regression analysis showed that the mean affective response during exercise, positively and significantly predicted the affective forecast for the second ($b = .72$ $p = .002$) and third ($b = .63$ $p = .003$) exercise sessions. Conclusions: These relations show that how an inactive person feels during exercise predicts how they think they will feel the next time they exercise.

If, as DAT predicts, these experienced affective responses and affective forecasts will influence the decision to participate in future exercise, then it is important that individuals have a positive affective experience to their exercise sessions, at least initially.

Keywords: Physical Activity; Psychology; Predictions

FUNDAMENTAL MOVEMENT SKILLS OF CHILDREN WITH DOWN SYNDROME: THE ROLE OF BALANCE AND WORKING MEMORY

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Background and Aim: Fundamental movement skills (FMS) proficiency is important in children because it is associated with greater physical activity engagement. We previously showed that children with Down Syndrome (DS) have delayed FMS development, potentially as a consequence of balance deficits. This study, therefore, examined the relationship of FMS proficiency with balance ability. We also examined the relationship of FMS proficiency with working memory to support evidence-based intervention programming.

Methods: Participants included children with DS (n=21), and age-matched typically developing (TD) children (n=20). FMS subskills (locomotor, object control) were measured using the Test of Gross Motor Development-2. Balance ability (centre of pressure [COP] parameters) was measured using a force measurement plate. Short-term memory was measured using the forward digit recall test (verbal), and the forward Corsi block tapping test (visuospatial).

Results: COP parameters were associated with both locomotor and object control scores. Stepwise linear regression revealed that specific COP parameters explained the variance of object control to a greater extent than locomotor scores; more so amongst children with DS than TD children. Locomotor and object control scores were significantly associated with verbal and visuospatial short-term memory in children with DS; but only with visuospatial short-term memory in TD children.

Discussion: Children who displayed greater stance stability also had better FMS proficiency. Such an association was stronger in children with DS than in TD children. As FMS proficiency of children with DS appears to be related to balance ability, it is suggested that physical training of children with DS should consider incorporating balance components. Both verbal and visuospatial short-term memory influence FMS proficiency, implying that training programmes should be tailored to accommodate cognitive deficits. Further research is recommended to explore the findings in a training context.

Keywords: Down Syndrome; Children; Fundamental Movement Skills; Balance; Short-Term Memory

Funding Sources: The study was funded in part by the Health and Medical Research Fund of Hong Kong. The first author is funded by the University of Waikato Strategic Investment Funding for Home of Cycling Research Project.

ACCOUNTS FROM RIO: OPTIMISING PERFORMANCE SUPPORT IN A CHALLENGING ENVIRONMENT

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At the recent Olympic Games in Rio de Janeiro, High Performance Sport New Zealand operated a performance centre within the Olympic Village to aid the preparation and recovery of Kiwi athletes. The aim of the centre was to provide a performance edge by replicating services and spaces that the athletes access at training centres in New Zealand, thereby enabling them to continue with their normal training and competition routines amidst the high pressure Olympic environment. The centre included a preparation and recovery space, a resistance training area and a specialised kitchen for delivering sports nutrition in a safe and hygienic environment. This presentation will recount the details of what was delivered to the New Zealand athletes, the challenges that were faced and overcome, and practical recommendations moving forward for optimising performance support at pinnacle events.

Keywords: High Performance; Preparation; Recovery; Olympics

Funding Sources: High Performance Sport New Zealand and the New Zealand Olympic Committee.

DIABETES HACKING: A PROSPECTIVE STUDY OF DIABETES' PATIENTS' DIY TECHNOLOGY MODIFICATIONS AND INNOVATIONS

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Background: Although commercial diabetes technologies are studied in controlled trials, the hacking (i.e., modification and subsequent use) of these technologies has received little attention. Notably, diabetes hackers' developed an artificial pancreas many years prior to the release of an FDA-approved commercial equivalent.

Aim: To investigate the potential within the digital era for patients, in New Zealand and globally, to be active not only in managing their chronic illness, but in developing new treatments.

Methods: This study will use naturalistic methods to study the global diabetes hacking community, including examination of the hacking community's digital forums and interviews with key hackers. Hackers'

existing medical records will be requested in order to evaluate possible improved health outcomes from use of an artificial pancreas.

Results: Results are expected to highlight the role of digital media in the development of a hacking community, the decision-making processes through which hackers decided to make their hacks available for others to utilize and adapt, changes in perceived quality of life for diabetics and their families as a result of hacking, and, if possible, analysis of medical records to evaluate the success of artificial pancreas use improving health outcomes.

Conclusions: The implications of this global community's innovations will be linked to the New Zealand health context.

Keywords: Artificial Pancreas; Diabetes Online Community; Digital Health

THE DETERMINANTS OF FAST STRETCH-SHORTENING CYCLE FUNCTION DURING A DROP JUMP IN ELITE NZ TRACK AND FIELD ATHLETES

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Background: Fast stretch-shortening cycle (SSC) function is an important determinant of sprint and jump performance; understanding the relative importance of the constituent factors may have implications for the testing and training of athletes.

Aim: To investigate which performance and mechanical variables determined fast SSC function during drop jumps (DJs) from various heights in elite NZ track and field (T&F) athletes and recreationally active participants.

Methods: In a cross-sectional design, 12 elite NZ T&F athletes and 12 recreationally active participants completed one familiarization session and one testing session. Participants performed DJs from 0.25m, 0.50m and 0.75m onto a force plate. Contact time (CT), flight time (FT), reactive strength index (RSI; FT/CT) and leg stiffness were determined. Eccentric and concentric phase force, power and impulse were also assessed.

Results: Very large differences in RSI were found between elite T&F and recreationally active participants across all drop heights (3.02 vs 2.02 s.s-1; ES [±90% CL]: 2.02 ±0.56; p <0.01). This difference was accounted for primarily by briefer CTs (0.16 vs 0.22s; ES: -1.49 ±0.53; p <0.01) and leg stiffness (0.45 vs 0.28 kN.m.kg-1; ES: 1.67 ±0.62; p <0.01), with smaller differences observed for FT (0.50 vs 0.46 s; ES: 0.71 ±0.78; p >0.05). Eccentric, and concentric, force and power was higher in elite T&F athletes. However, the largest differences were observed in mean eccentric power (-85 vs -62 W.kg-1; ES: 1.83 ±0.56; p <0.01) which exhibited a very large correlation with CT (r ±90% CL: 0.89 ±0.11; p <0.01).

Conclusion: Elite T&F athletes exhibited superior fast SSC function compared with recreationally active participants. This was primarily due to the ability to strike the ground with a stiffer leg spring, an enhanced expression of eccentric power, and subsequently, a briefer ground contact time for a given flight time.

Keywords: Reactive Strength, Eccentric, Concentric, Leg Spring

PREDICTORS OF CARDIOVASCULAR HEALTH IMPROVEMENTS IN PATIENTS AT RISK OF CARDIOVASCULAR DISEASE: A CROSS-SECTIONAL ANALYSIS OF GREEN PRESCRIPTION

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Aim: To determine the factors predicting cardiovascular health improvements among patients reporting cardiovascular disease (CVD) risk.

Methods: The study was based on New Zealand's exercise prescription programme, Green Prescription (GRx). Using the 2016 GRx Patient Satisfaction Survey, cross sectional data were collected from patients who were referred to GRx in 2015 (n = 2843).

Results: Included in analysis were 71% of total respondents who reported one or more CVD risks, namely weight problems (n = 1463), high blood pressure/risk of stroke (n = 681), high cholesterol (n = 496), Type 2 diabetes (n = 463), pre-diabetes (n = 350), heart problems (n = 310) and/or smoker (n = 128). There were 50.5% reporting no CVD-related health improvements

and 49.5% reporting 1-5 improvements. A linear regression indicated 11 of 30 variables predicted cardiovascular health improvements (adj R² = .214, $p < .001$). Pearson's correlations indicated cardiovascular health improvements were positively related to reporting more CVD risk factors ($r = .28$), changing one's diet ($r = .25$), spending more time being active ($r = .19$), receiving a GRx extension in past year ($r = .17$), gardening ($r = .14$), cycling ($r = .13$), exercising with adult family members ($r = .12$), being male ($r = .12$), receiving one's first GRx over 6 months ago ($r = .11$), exercising in a sports club ($r = .10$) and exercising with friends ($r = .09$) (all $p < .001$).

Conclusions: Patients reporting more CVD risk factors showed the highest correlation with cardiovascular health improvements. Patients who changed their food and drink intake as a result of GRx revealed the second strongest correlation with cardiovascular health improvements. Other results suggest that lifestyle physical activity such as gardening and cycling combined with social components of exercising with family, friends and in a sports club are the most promising factors for improving the cardiovascular health of patients at risk of CVD.

Keywords: Exercise; Cardiometabolic Health; Clinical-Based Intervention; Disease Prevention; Physical Activity Counselling.

Funding Sources: Data provided by New Zealand Ministry of Health.

BEST STUDENT ORAL PRESENTATION – RUNNER UP FREQUENCY OF EXERCISE AND METABOLIC RESPONSES DURING SITTING, EXERCISE, AND POST-EXERCISE PERIODS

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Background: Breaking sedentary time imparts metabolic benefits in terms of postprandial glycaemia and insulinaemia, however, the effect of exercise frequency on metabolism during sitting, exercise and post-exercise periods has not been investigated.

Aim: To compare energy expenditure (EE) and substrate oxidation between different profiles of breaking up prolonged sitting.

Methods: Thirty-six (male=11) sedentary individuals, (age 26 ± 4 y, BMI 24.1 ± 4.6 , VO_{2max} 36 ± 8 mL.kg⁻¹.min⁻¹, mean \pm SD) performed four, two-day trials, in a randomised-controlled, crossover design: (1) prolonged sitting (SE), (2) sitting with regular activity breaks every 30 min for 2 min (RAB), (3) prolonged sitting with 30-min of continuous exercise at the end of day 1 (PA), (4) RAB and PA combined (RAB+PA). All treadmill exercise was undertaken at a speed/incline corresponding to 60% VO_{2max} . Participants consumed standardised meals during interventions and an ad libitum meal at the conclusion of day 2. Indirect calorimetry was used to estimate EE, carbohydrate, and fat oxidation during sitting, exercise, and post-exercise periods.

Results: Total EE on day one (7-h) in SE (2401 ± 92 kJ, mean \pm SE) was less than PA (3110 ± 92 kJ), RAB (3267 ± 92 kJ), and RAB+PA (4150 ± 92 kJ); all $p < 0.001$. There was no difference in total EE on day one between PA and RAB ($p = 0.516$). Post-exercise EE in PA (64 ± 4 kJ), on day one was less than RAB (697 ± 31 kJ) and RAB+PA (615 ± 26 kJ); both $p < 0.001$. Total carbohydrate oxidation on day one in RAB (90 ± 6 g) was less than PA (144 ± 6 g) and RAB + PA (129 ± 6 g); both $p < 0.001$. Total fat oxidation in SE (7.4 ± 1.2 g) on day one was less than RAB+PA (12.9 ± 1.5 g); $p = 0.027$.

Conclusions: Increasing not only duration but frequency of activity alters EE as a result of exercise. More frequent bouts, vs. one continuous bout, result in increased post-exercise EE. This elevation in EE punctuated throughout the day may be responsible for altered postprandial metabolic responses.

Keywords: Sedentary; Metabolism; Excess Post-Exercise Oxygen Consumption (EPOC); Activity Break; Energy Expenditure

Funding Sources: University of Otago, National Heart Foundation

THE EFFECT OF MILK-PROTEIN SUPPLEMENTATION AND EXERCISE ON CHRONIC DISEASE REHABILITATION

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Milk-protein and amino acid supplementation has been shown to upregulate a variety of exercise-induced physiological adaptations in healthy and athletic populations. Some of these adaptations are clinically relevant to diseased populations if the pathology includes vascular irregularities, metabolic dysfunction, or muscle wasting. This presentation provides an overview of the growing body of literature describing this phenomenon and the preliminary findings of a whey-protein plus HIT training study that examined the effect of dual therapies on metabolic function in type-2 diabetics.

Keywords: Supplements; Dairy Products; Cardiovascular Disease; Diabetes Mellitus

IMPROVING JUMP AND REACH HEIGHT WITH OSTEOPATHIC MANUAL THERAPY TECHNIQUES IN ELITE MALE BASKETBALL PLAYERS

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Aim: To determine the acute effects of upper body manual therapy on vertical jump and reach performance in male basketball players, and to quantify the contribution of arm swing to ground reaction force during a counter-movement jump.

Methods: Thirteen semi-professional to professional basketball players received two 15-minute standardised osteopathic manual therapy protocols 1 week apart, one implemented to the upper extremities and thoracic spine and a control implemented to the lower extremities, in a balanced, randomized cross-over design. Vertical jump and reach height and peak ground reaction forces with and without arm swinging were measured before and immediately following both protocols.

Results: Vertical jump and reach height (mean \pm SD) was improved in the group receiving upper body manual therapy (59.3 ± 10.3 cm to 62.1 ± 9.8 cm) compared to the control group (59.3 ± 9.7 cm to 58.3 ± 9.7 cm; $p < 0.001$ for Time \times Protocol interaction). The between-protocol differences were retained when adjusting for changes in peak ground reaction forces. Arm swing increased peak ground reaction force from 2187 ± 357 N without arms to 2330 ± 337 N ($p = 0.005$ for effect of arm swing).

Conclusions: It appears that applying a brief upper body manual therapy treatment improved overhead jump and reach height in high level basketball players. The application of these osteopathic techniques could be beneficial for immediate in-game enhancements of vertical jump performance.

Keywords: Range of Motion, Articular; Musculoskeletal Manipulations; High Velocity Low Amplitude Thrust; Muscle Energy Technique; Shoulder; Athletic Performance

RAPID INTERVENTIONS REQUIRED! IMPLEMENTATION OF A USER- FRIENDLY INJURY SCREEN IN NATIONAL-LEVEL NETBALL PLAYERS

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Background: Sports injuries are a considerable public health concern, with a growing body of scientific literature focusing on screening for risk of injury. Although a priority in high-performance sports, limited resources are often ascribed to screening initiatives and effectiveness of practical interventions is vital, particularly in a team-sport setting.

Aim: To employ a rapid user-friendly injury screen in national-level netball players and provide rapid feedback to coaching and medical staff.

Methods: The anterior reach distance of the Y-Balance Test and the Landing Error Scoring System (LESS) score from 28-cm drop jumps were assessed to determine injury risk in 11 players from the National Netball Team of Malaysia. Players with anterior-reach distance differences > 4 cm and/or LESS scores ≥ 5 were categorized as being at 'high risk' of injury compared to their

'low risk' teammates. Medical reports were acquired for three months post-screening. Results: Of the eight high-risk players, five of them suffered a lower-extremity injury in the ensuing 3 months (63% positive predictive value). The three low-risk players all remained injury-free during the follow-up period. The screening battery took less than 5 minutes per player and feedback was provided to coaching and medical staff within 24 hours. All players who suffered an injury were correctly identified as being at high risk (100% sensitivity), with all players categorized at low risk staying injury-free (100% negative predictive value). Conclusions: The screening battery employed was quick, sensitive, and able to predict injury occurrence with relatively high accuracy. The early implementation of injury screening and prevention initiatives in netball players is advised given the current high injury rates associated with this sport and the ability to objectively quantify injury-risk factors. Keywords: Athlete Testing; Dynamic Balance; Female Athlete; Functional Movement.

A SELF-PACED VO_{2MAX} TEST: A REVIEW OF PUBLISHED AND UNPUBLISHED LITERATURE Patrick Lander

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The VO_{2max} test is arguably the most common measure used in exercise physiology.¹ However a ramp test which has no known endpoint and in which, once the participant has started, they have no ability to vary their performance, is unlike any other exercise environment we ask individuals to engage in. Numerous studies have addressed and re-addressed the concept of eliciting the highest possible VO_2 measurement from an individual whether that be labelled Max, Peak, Plateau, or Verified. In contrast, comparatively few studies have addressed the idea of a test to measure VO_2 which has synergies with sporting performance, and in which, athletes can vary their performance in accordance with transient perceptions of fatigue.²⁻⁴ This presentation will review the literature of other authors who have had varied success in gaining support for a reliable repeatable self-paced test which challenges the way in which we conduct one of the most common measures in exercise physiology. The presentation will conclude with findings from some of my own unpublished work on a self-paced perceptually regulated protocol to assess peak oxygen uptake.

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Keywords: Exercise Testing; Ratings of Perceived Exertion (RPE); Complex Metabolic Control

TIME LAG BETWEEN PERCEIVED DECREASED CONFIDENCE AND ACTUAL PHYSICAL FUNCTION FOLLOWING 16 WEEKS VIBRATION TRAINING IN FRAIL ELDERLY

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Background: Vibration exercise has shown to elicit gains in lower-limb strength in frail elderly, who cannot exercise conventionally. These gains can manifest as improved physical function, confidence and quality of life (QoL). However, it is unknown how long effects last after vibration exercise training ceases. Aim: Investigate the time line of detraining from whole body vibration (WBV) exercise in frail elderly. Methods: An RCT 16-week intervention with 1-year follow-up tracking the detraining profile. Rest-home residents (70+ years) were assigned to

a WBV-exercise group (WBV), a simulated-WBV-exercise group (SIM), or a control group (CON). WBV- and SIM-participants exercised thrice-weekly (20-min, 1:1 exercise:rest ratio), whilst CON-participants received only normal care. WBV-exercise started with 5 1-minute at 6 Hz/2mm amplitude, progressing to 10 1-minute when Hz/amplitude were increased ad libitum. Approximately 20° knee flexion was maintained during exercise for WBV (dampening effect) and SIM participants. Variables were measured at baseline, 8-weeks and 16-weeks of intervention, and 3-, 6- and 12-months post-intervention. Functionality and balance were assessed using the Timed Up-and-Go and Parallel Walk tests, complemented by the Barthel Index Questionnaire. Lower-limb strength was inferred using the 10-metre timed walk. The Activities-specific Balance Confidence scale measured falls-related confidence, and the EuroQol EQ-5D-3L health questionnaire assessed participant's QoL.

Results: Preliminary results reveal WBV increased physical function, lower-limb strength and balance during and at least 3-months post-intervention, while falls-related confidence and QoL increased during and at least 6-months post-intervention. The control group declined in all measures, as did the simulated-WBV group except for QoL, which may be indicative of the psychological impact of study participation.

Conclusions: Upon completing the 16-week training, all benefits were lost after 6 months. However, the psychological benefits of WBV exercise appeared to last longer than physical ones, leading to a mismatch between confidence and physical ability. This could potentially increase falls risk if not managed correctly.

Keywords: Frailty; Functional Tests; Sarcopenia

Funding Sources: NZ Accident Compensation Corporation (ACC)

BEST STUDENT ORAL PRESENTATION – RUNNER UP TIME-TRIAL PERFORMANCE IN DRY AND HUMID HEAT ENVIRONMENT: EFFECT OF MENSTRUAL PHASE AND CONTRACEPTIVE USE Tze-Huan Lei¹, James D Cotter², Stephen R Stannard¹, Zachary Schlader³, Blake Perry¹, Yu-Tzu Liu³, Toby Mundel¹

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Aim: This study determined women's endurance cycling performance within dry (DRY) versus humid (HUM) heat, in relation to menstrual phase and the eumenorrheic natural (EUM) versus the oral contraceptive pill (OCP) controlled menstrual cycle.

Methods: Environments were matched for WBGT (27 °C) and tested in crossover fashion and in both menstrual phases (n=16), whereas EUM (n=8) versus OCP (n=8) was tested between participants matched for VO_{2max} (59 ± 6 vs. 58 ± 8 mL·kg⁻¹·min⁻¹), peak aerobic power (267 ± 30 vs. 281 ± 26 W), body surface area (1.68 ± 0.06 vs. 1.75 ± 0.14 m²) and body fat (24 ± 5 vs. 24 ± 5%). DRY was 34 ± 0.3 °C and 42 ± 3% RH and HUM was 29 ± 0.5 °C, 82 ± 3% RH. The EUM tests were in early-follicular (EF) and mid-luteal (ML) phases, while OCP were time-matched.

Results: Mean power output during a pre-loaded, 30-min time-trial was not different across the menstrual cycle (p=0.8) or between groups (EUM: 147 ± 18 vs. 148 ± 21 W, OCP: 152 ± 22 vs. 151 ± 17 W, p=0.6), but was 5 ± 6% higher in DRY than HUM (p=0.01). The rectal temperature rise was not different between menstrual phases, environments or groups (EUM: 0.9 ± 0.2 °C, OCP: 0.8 ± 0.2 °C, all p>0.32).

Conclusions: We conclude that in females the type of heat exposure affects performance, but no effects of menstrual phase or control of the cycle were evident.

Keywords: Exercise Performance; Menstrual Cycle; Oral Contraceptive Pill; Dry and Humid Heat

EXAMINING EMBODIED COGNITION IN GOLF PUTTING Neha Malhotra¹, George Wardell², Rich Masters²

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Background: Embodiment theories propose that cognition is strongly related to our sensory and motor brain systems. In particular the facial feedback

hypothesis proposes that our facial expressions can affect our emotions and behaviour, challenging the traditional belief that our emotions bring about our expressions. A study by Strack et al. (1988) revealed that holding a pen between the teeth (triggering muscles used in smiling) led to higher funniness ratings of cartoons than holding a pen between the lips (smile muscle activity inhibited). The aim was to investigate whether the positive emotions brought about by holding a pen between the teeth would improve golf-putting performance by evoking a positive affective state.

Methods: Participants (n = 58) completed a putting task in which they were required to putt to a target. After a practice phase participants were asked to either hold a pen between the lips, teeth or behind the ear. Before each block participants put the pen in the assigned area and estimated the target size, completed a self-efficacy scale and rated 2 cartoons on their funniness. Size estimations of the target were collected to examine whether participants' positive affective state would influence their perception of target size. Participants then completed 5 golf putts each in 3 conditions. Distance from the target was the primary outcome measure.

Results: There were no significant differences in funniness ratings of cartoons and no significant differences in putting performance between the three pen conditions. The lack of significant findings could be attributed to a learning effect observed over the three learning blocks. In the pen in lips and pen behind ear condition higher self-efficacy scores were associated with better putting performance.

Conclusions: The findings of this study do not appear to support the facial feedback hypothesis. Further work can be carried out on experts using a more effective paradigm to evoke positive emotions.

Keywords: Embodied Cognition; Golf; Sport Performance; Facial Feedback Hypothesis

A COMPARISON OF UNIMODAL AND BIMODAL COUNTERMOVEMENT JUMP FORCE-TIME CURVES

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Background: The countermovement jump (CMJ) is one of the most utilised movements to assess and monitor ballistic performance in athletes. The majority of research has reported jump height, force or power as the primary outcome measure, often misinterpreting the athlete's ability to apply force to the ground during the various phases of the CMJ.

Aim: To determine if unimodal and bimodal CMJ force-time curves influence the primary outcome measures.

Methods: 21 professional rugby union players volunteered as participants for the study and performed 6 acyclic CMJ's standing on two dual-axis portable force plates sampled at a frequency of 200 Hz. The athletes were divided into the following three groups for statistical analysis: unimodal (n = 6), bimodal high-low peaks (n = 8) and bimodal similar peaks (n = 7). Mean percentage differences and effect sizes were calculated to determine the magnitude of difference between groups for a given dependent variable.

Results: The unimodal peak group produced moderately larger relative mean concentric force (ES = 1.14 and 1.08), slightly larger eccentric rate of force development (ES = 0.08 and 0.33) and much shorter contraction times (ES = 1.38 and 1.50) in comparison to both bimodal peak groups. Whereas, the bimodal peak groups produced moderately (ES = 1.05 and 1.15) larger net impulses and slightly larger jump heights (ES = 0.19 and 0.32) in comparison to the unimodal peak group.

Conclusions: Rugby athletes possessing unimodal force-time curves appear to develop greater eccentric rates of force, produce larger mean concentric forces and have shorter contraction times in comparison to their bimodal counterparts; in contrast, athletes with bimodal force-time curves produce greater net impulses and in turn jump higher than unimodal peak athletes.

Keywords: Impulse; Rate of Force Development; Jump Height, Contraction Duration, Rugby

A COMPARISON OF TWO NITRATE DOSING STRATEGIES ON HIGH INTENSITY CYCLING PERFORMANCE IN HIGHLY-TRAINED CYCLISTS

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Background (optional): In recent times dietary nitrate (NO₃⁻) supplementation has been championed as an ergogenic aid to reduce blood pressure, increase time to exhaustion, and enhance time-trial performance in moderate- to well-trained athletic populations. Initial reports suggested that athletes of moderate fitness levels improved time-trial performance in events of 6 to 30 mins by 1.3 to 2.8%. Subsequently, further research employing highly-trained populations over similar time-frames have shown more neutral outcomes.

Purpose: To compare the effects of two different dosing durations of dietary nitrate (NO₃⁻) supplementation on 1- and 4-km cycling time-trial cycling performance in highly-trained cyclists.

Methods: In a double-blind crossover-design, on a daily basis nine highly-trained cyclists ingested 140ml of NO₃⁻-rich beetroot juice containing ~8.0mmol [NO₃⁻], or placebo, for seven days. Participants completed a range of laboratory-based trials to quantify physiological and perceptual responses and cycling performance: time-trial on days 3 and 6 (4-km) and on days 4 and 7 (1-km) of the supplementation period.

Results: Relative to placebo, effects following 3- and 4-days of NO₃⁻ supplementation were unclear for 4-km (-0.8;95%CL, ±2.8%, P=0.64) and likely harmful for 1-km (-1.9;±2.6%CL, P=0.17) time-trial mean power. Effects following 6- and 7-days of NO₃⁻ supplementation resulted in unclear effects for 4- (0.1;±2.2%CL, P=0.93) and 1-km (-0.9;±2.6%CL, P=0.51) time-trial mean power. There were possibly beneficial enhancements in economy, relative to placebo, at 50 (0.14;±0.24%CL, P=0.42) and 60% (0.13;±0.29%CL, P=0.87) peak power output after 3-days NO₃⁻ supplementation. Effects were trivial or unclear for remaining measures.

Conclusions: Dietary NO₃⁻ supplementation appears to be detrimental to 1-km time-trial performance in highly-trained cyclists after 4-days. Whilst, extending NO₃⁻ dosing to ≥6-days reduced the magnitude of harm in both distances, overall performance in short duration cycling time-trials did not improve relative to placebo.

Keywords: Beetroot Juice; Time-Trial; Exercise Economy

GO FASTER STRIPES REALLY CAN MAKE YOU GO FASTER

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Background: High performance rowing is underpinned by the need to cyclically apply force according to perceptually specified temporal constraints. Of importance is the "catch" where performers must match boat motion with oar placement at the start of each stroke.

Aim: This study examined whether rowers could exploit contrasting textures between the water and striped markings on the top hull surface of the boat in order to improve performance.

Methods: A single-subject ABACA design was adopted involving a female sculler of national standard. Rower-boat velocity matching was examined via changes in speed and a coupling value based on boat speed and oar angle. Treatment effects were examined both visually and via effect size.

Results: Set against Cohen's (1992) criteria, sagittal lines had a large negative effect on speed (-1.2) and a trivial effect on coupling values. Transverse lines showed a large beneficial effect on speed (0.82) and mixed results for coupling.

Conclusions: Both treatments showed evidence of perturbed behaviour; but only transverse lines appeared to aid the perception of approach velocity, as supported by changes in boat speed and coupling values. Results tentatively support the use of contrast textures to enhance the perception for critical movement couplings.

Keywords: Rowing; Coupling; Contrast; Perception; Ecological Dynamics

CAN A PRE-PARTICIPATION TEST OF MOVEMENT QUALITY PREDICT INJURY IN SPORT AND EXERCISE? SYSTEMATIC REVIEWS OF RELIABILITY AND VALIDITY OF THE 'FUNCTIONAL MOVEMENT SCREEN'

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Background: Sport and exercise is critical for healthy communities, but participation is inevitably associated with exposure to risk of musculoskeletal injury. Loss of participation due to injury not only threatens the health benefit of physical activity, but also impedes competitive success. Injuries are also associated with substantial economic cost and personal suffering. Poor movement quality is a factor theorised to increase risk of injury. The 'Functional Movement Screen' (FMS) is widely used by applied practitioners as a pre-participation screening tool to identify poor movement quality. **Aim:** To critically appraise and synthesise studies investigating the reliability and predictive validity of the FMS.

Study Design: Two systematic literature reviews were undertaken, the first focused on rater reliability, and the second on validity of injury prediction.

Methods: Systematic literature search of bibliographic databases. Reliability studies were assessed for risk of bias using the QAREL appraisal tool, and validity studies assessed using the Q-Coh tool. Meta-analysis and a best evidence synthesis were undertaken.

Results: 12 reliability and 24 injury prediction studies were appraised.

Overall, there was 'moderate' evidence in favor of 'acceptable' inter- and intra-rater reliability. However, the strength of association between FMS composite scores and injury was not sufficient to support the use of FMS as an injury prediction tool in a wide range of sporting codes.

Conclusions: Although practitioners can achieve acceptable reliability, the validity of FMS as a tool for injury prediction is poor. We discuss the practical implications of these findings for practitioners and indicate directions for further applied research.

Keywords: Pre-Participation Examination; Sport; Injury Prevention

EXPLORING THE CHALLENGES OF OBTAINING OBJECTIVELY MEASURED PHYSICAL ACTIVITY DATA FROM PRE-MENOPAUSAL WOMEN

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Background: Physical activity-based health improvement initiatives required good quality, objectively measured physical activity data, however various challenges undermine the acquisition of such data.

Aim: To examine the efficacy and challenges of a standard hip-worn accelerometry protocol conducted in pre-menopausal New Zealand women. Specific objectives included determining rates of compliance, and understanding the barriers, burdens and acceptability associated with wearing accelerometers.

Methods: Healthy New Zealand women (n=406) of three ethnicities (Māori, Pacific, European) aged 16-45 y (30.9 ± 8.7 y) wore hip-mounted Actigraph wGT3X+ accelerometers for seven consecutive days, removing only during water activities. Post-hoc, a sub-sample (n=45; age: 29.4 ± 9.0 y) was interviewed to investigate the comfort/convenience and burdens of wearing accelerometers.

Results: Wear compliance (≥10 hr/day, ≥4 days) was 86%. European women returned more valid data (92.7%, p<0.04) than Pacific (73.0%) or Māori (82.1%) women. Data were completely missing for 22 participants (5.4%). Burden from accelerometer wear was greatest during sleeping (66.7%) due to discomfort. High burden in social settings (45.2%) resulted from visibility of accelerometers through clothing and restricted clothing choices.

Conclusions: Discomfort during sleeping, restricted clothing choices and embarrassment in social settings, and ethnicity are key factors affecting the

efficacy of collecting physical activity data from New Zealand women using hip-worn accelerometers. Refining accelerometer design to improve comfort and acceptability, and increasing participant engagement by ensuring appropriate understanding of study relevance should improve wear-compliance and data quality, and reduce attrition in hip-worn accelerometry protocols.

Keywords: Wear Time; Adherence; Activity Monitor; Movement Sensing Device
Funding Sources: Nutricia Research Foundation (number 2013-24).

SLEEP AND STRESS HORMONE RESPONSES IN TRAINING AND COMPETITION IN ELITE FEMALE ATHLETES

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Background: Stress hormone levels in a competition vs training setting are yet to be evaluated in elite female athletes. The effect that these levels of stress have on subsequent sleep quality and quantity is also yet to be investigated.

Aim: The aim of the current study was to evaluate different psychophysiological stress markers in competition and training environments and the subsequent effect on sleep indices in an elite female athlete population.

Methods: The study involved 11 elite female netball athletes (mean ± SD; age = 23 ± 6 yrs) providing multiple salivary hormone measures and having their sleep monitored on two occasions; a match day, and a training day. The training and match were performed at the same time of day and were matched for intensity and duration. Saliva samples were collected immediately pre (5:00pm) and post session (7:15pm), and at 10:00pm and were analysed for cortisol concentrations. Sleep monitoring was performed using wrist actigraphy to assess total sleep time (TST), sleep efficiency (SE%) and sleep latency (SL).

Results: Cortisol levels were significantly higher (p<0.01) immediately post the match vs post training (mean ± SD; 0.925 ± 0.341 µg/dL and 0.239 ± 0.284 µg/dL, respectively) and at 10:00pm (0.143 ± 0.085 µg/dL and 0.072 ± 0.064 µg/dL, respectively, p<0.01). The difference between trials was associated with a very large effect (ES : 2.23) immediately post (7:15pm) and a large effect (ES : 1.02) at 10:00pm. There was a significant reduction in TST (mean ± SD; -117.9 ± 111.9 minutes, p<0.01, ES : -1.89) and SE% (-7.7 ± 8.5%, p<0.02, ES : -0.79) on the night following the netball match compared to the training session. Although not significant (p>0.05), there was an increase in SL following the netball match v the training session (67.0 ± 51.9 minutes and 38.5 ± 29.3 minutes, respectively), which was associated with a moderate effect (ES : 0.80).

Conclusions: The current study reports that cortisol levels are significantly higher and subsequent sleep quantity and quality is significantly reduced in elite female athletes following a match compared to a training session.

Keywords: Netball; Cortisol; Recovery

DEVELOPMENT OF AN AUTOMATED ATHLETE TRACKING SYSTEM FOR SNOWBOARD SLOPESTYLE ATHLETES

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Aim: As wearable sensor technology advances, comprehensive on-snow monitoring of snowboard slopestyle athletes can be developed [1, 2].

Objective data could be used to track training loads, monitor fatigue and potentially reduce risk of injury. This presentation reports on the progress of a research programme working to develop an athlete tracking system suitable for use by snowboard athletes.

Methods: The programme is comprised of four stages: 1) establish the accuracy and reliability of suitable inertial measuring units (IMU); 2) investigate relationship between body mounted accelerometers and landing impacts; 3) identify aerial manoeuvres using body mounted IMUs; 4) implementation and validation of an on-snow tracking system.

Results and Discussion: In the first stages, three candidate IMUs containing

an accelerometer, gyroscope and magnetometer sensors were identified and found to be accurate and valid for measuring acceleration, angular velocity and angular displacement. The OptimEye (Catapult, Australia) and iMeasureU (iMeasure U, New Zealand) were chosen for further research characterising landing impacts and identifying aerial manoeuvres. In the second stage, IMU measurements from drop landings were compared to force plate measurements. Both IMUs showed similar correspondence with the gold standard and were both selected for the next stage of the programme. Preliminary findings from the third stage suggest both IMUs will be able to identify aerial manoeuvres by calculating angular displacement around each axis to give a total rotational amount.

Conclusion: Findings from these studies will be used to refine data collection and processing techniques for stage four of the programme; implementation and validation of an on-snow athlete tracking system.

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Keywords: Sensors; Athlete Monitoring; Snowboard Slopestyle; Inertial Measuring Unit (IMU); Training Load

A BASELINE PROFILE OF BRAIN HEALTH IN A SEMI-PROFESSIONAL RUGBY UNION TEAM

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Background: Concussions in collision based sports are a major medical concern. There is emerging evidence regarding increased rates of depression, mild cognitive impairments and deficits in neurocognitive function in individuals with a concussion history. Concussive and sub-concussive impacts are deemed to have a cumulative effect that has been shown to induce neurocognitive changes. Adolescent rugby participation has been shown to have deleterious effects on neurocognitive and scholastic function compared to non-contact sports.

Aim: To observe brain health at pre-season in a semi-professional rugby team.

Methods: 55 semi-professional players provided data during a pre-season screen using the following measures: Pittsburgh Sleep Quality Index (PSQI), Rivermead Post Concussion Symptom Questionnaire (Rpq-3 and Rpq-13) Beck Depression Inventory (BDI-II) and Beck Anxiety Inventory (BAI) and the University of Pennsylvania Smell Identification Test.

Results: A disturbed sleep pattern and sense of smell were noted in 41.8% and 55.8% of players. BDI-II indicated that 72.7% were minimally and 5.5% were mildly depressed. The BAI revealed that 50.9% had minimal, 18.2% mild and 1.8% moderate levels of anxiety. The mean±SD for Rpq-3 and Rpq-13 were 1±1 and 3.4±4. Significant correlations were observed between PSQI and RPQ-13, RPQ-3, BDI-II and BAI ($r=-.31$ -.62, $p<0.01$). Age was found to negatively correlate with Rpq-13 ($p<0.01$), indicating players with higher post-concussion scores, were younger, more likely to be depressed, anxious and sleep poorly. Additional negative correlations were observed for years of club rugby experience, Rpq-13 ($r=-.41$, $p<0.01$) and BAI ($r=-.35$, $p=0.03$). Years of semi-professional rugby experience was negatively correlated to Rpq-13 ($r=-.33$, $p=0.01$) and BDI-II ($r=-.32$, $p=0.04$). Meaning older players with more experience were more likely to have lower post-concussion, anxiety and depression scores.

Conclusions: These findings provide a snapshot of pre-season brain health in semi-professional players. This forms the basis for further investigations and understanding the effect that concussive and sub-concussive impacts have on the brain.

Keywords: Brain; Concussion; Depression; Anxiety; Sleep

Funding Sources: Authors would like to acknowledge the Department of Medicine's Dean's Bequest Fund for financial support for the project.

DEFINING THE ROLE OF THE ANAEROBIC SPEED RESERVE IN MIDDLE DISTANCE RUNNING

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International standards and depth in middle distance (MD) running are becoming increasingly competitive. For example, new world records (mm:ss.ms) in the women's 1500m (3:50.07) and men's 800m (1:40.91) have been set in the last 5 years. How are competing nations from around the world developing speed over these distances? While the answer to that question is likely unattainable, there is nevertheless a need to consider new areas of opportunity for developing speed in these events in order to compete for medals on the international stage. The degree to which the anaerobic speed reserve (ASR) is required, or needed within and between MD events is yet to be investigated in the literature.

Data from 13 World Championship and Olympic Games (Sydney 2000 – Rio 2016) reveal the 'last lap kick' as a key performance determinant in 1500m running. Further, the increasing 'long sprint' nature of the Men's 800m event (2011-2016) suggests anaerobic qualities may be important determinants of medal winning outcomes in MD running (Billat et al., 2009; Mytton et al., 2015). 'Gun to tape' or 'sit and kick' pacing strategies dictate energetic distribution within a race, and are underpinned, amongst other determinants, by an interplay between aerobic and anaerobic energy systems. Therefore, the aim of this presentation is to offer current opinion on the rationale for MD programmes to develop ASR as well as offer perspectives on the physiological and mechanical qualities that underpin ASR with reference to the last lap kick in 1500m and the 'long sprint' 800m event groups.

Keywords: Pacing; Elite Performance; 800m; 1500m

DOES SELF-REGULATED COMBINED HIGH-INTENSITY AND SPRINT INTERVAL TRAINING CONFER VASCULOPROTECTION?

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Background: Controlled laboratory-based studies have demonstrated that aerobic, high-intensity and sprint interval training (HIT and SIT respectively) independently confer vasculoprotection, thereby reducing cardiovascular risk. However, no study has quantified effect magnitudes when exercise is self-regulated.

Aim: To determine the effects of community-based, self-regulated combined HIT and SIT on arterial health, specifically, tissue biomarkers associated with arteriosclerosis as well as arterial structural and remodelling indices.

Design and Methods: A repeated-measures between-subjects design was adopted during which fifteen healthy, sedentary adult males were randomly assigned to experimental (EXP) and control (CON) groups. The CON group maintained their routine lifestyles for eight weeks. The EXP group attended 45 min self-paced group cycling sessions involving HIT and SIT thrice weekly for eight weeks at a local gym. Assessments carried out at baseline (PRE), after four weeks (MID), and post-intervention (POST) included cardio-respiratory fitness (peak oxygen uptake, VO_{2peak}), resting carotid-femoral pulse wave velocity (cfPWV), augmentation index (AIx@75), central pulse pressure (cPP), wall thickness (common carotid and femoral intima-media thickness, cIMT and fIMT respectively), and arterial geometry (common carotid end-diastolic diameter, cEDD, and wall:lumen ratio, cWLR).

Results: The average heart rate during self-regulated sessions was 81±7%HR_{peak}. Improvements in VO_{2peak} and arterial health measures from PRE to POST were observed in EXP only ($p<0.05$). At POST, there were significant between-group differences in VO_{2peak}, cfPWV, cPP, fIMT, cEDD, and cWLR ($p<0.05$).

Conclusions: In healthy, sedentary adults, self-paced HIT and SIT cycling improves VO_{2peak} , reduces arteriosclerotic indices and systemic wall thickness, and increases carotid diameter. In consonance with evidence from laboratory studies, the present results demonstrate the effectiveness of a 'real-world' community-based exercise approach to enhance arterial health and potentially reduce cardiovascular risk.

Keywords: Vascular; Ageing; Atherosclerosis; Arterial; Health; Exercise; Training

Funding Sources: This research was supported in part by Les Mills International Limited, who provided the exercise classes and contributed towards project consumable costs.

PATTERN RECOGNITION IN RUGBY UNION

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Background: The ability to recognise patterns of play has been identified as a fundamental discriminator of performance in team sports (Smeeton et al., 2004) and specifically rugby union (Hendricks, 2012).

Aim: To investigate the effect of skill level and level of structure on recall of rugby union patterns.

Method: The current study used Chase and Simon's (1973) classic 5-second recall task to examine differences in memory for patterns of structured and unstructured game-play in rugby union. Experts (N = 48; age = 17.3 ± 0.7) and novices (N = 41; age 18.4 ± 3.2) viewed still images of structured (N=10) and unstructured (N=10) rugby patterns for 5 seconds before they were occluded. They were then instructed to recall player positions by marking them on a blank template. The average distances from the correct location of the players were analysed using a one-way ANOVA.

Results: Experts displayed significantly higher accuracy scores than novices for structured images ($p=0.001$); however, there were no differences when recalling unstructured images ($p>0.05$). Bivariate correlation analysis revealed a significant positive correlation between the number of sports played by rugby union novices and their accuracy scores on the unstructured images ($r=0.366$, $p=0.019$).

Conclusions: The experts' superior performance on the structured images is thought to be due to 'chunking' rather than superior memory. Large amounts of information are encoded and retrieved as a single entity or chunk, avoiding the restrictions of short-term memory. The association between number of sports played and accuracy scores supports Abernethy's (2005) claim that pattern recognition skills can transfer between sports.

Keywords: Chunking; Expert-Novice; Structured; Unstructured

A CRITICAL EXPLORATION OF THE ROLE OF THE LIFTERS AND JUMPERS IN THE RUGBY UNION LINEOUT

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Background: In a typical rugby union lineout, the attacking jumper is lifted upwards by two teammates in an attempt to catch the ball above the opposition jumper who is also competing for the ball. A common strategy promoted in New Zealand rugby is for the two lifters to squeeze the jumper up after the jumper reaches an approximate jump height of 20-30 cm. Despite the lineout being an important facet of play, little has been published on the relative importance of the various factors required to optimise the time taken for the jumper to reach their peak catch height. **Aims:** 1) explore the effectiveness of various jump-and-lift strategies used in Super Rugby; and 2) examine the effects of the jumper's body mass and attempted jump height, and the lifters' magnitude and point of force application on the time to reach peak catch height during the squeeze technique, specifically.

Methods: A measurement system was constructed that enabled real-time measurement of catch height and time to reach catch height during lineouts, which was then employed during a lineout training session to explore the effectiveness of various lift-and-jump strategies. From the pilot data, a biomechanical model was developed to explore the impact of change in various factors on time to peak catch height during the squeeze technique. **Results:** The squeeze technique produced the worst results (i.e., slowest time to peak height) during the training session. The model predicted that the magnitude of the lift force influenced time to reach peak height the most, with the other factors examined having a similar effect. **Conclusions:** Employing the squeeze technique increased the time to peak catch height by ~20-30% compared to an optimal jump-and-lift technique. These findings have practical applications that can impact the Rugby Union lineout strategies on game day.

Keywords: Coaching; Performance Enhancement; Technique Analysis

NO CLEAR BENEFIT OF MUSCLE HEATING ON HYPERTROPHY AND STRENGTH GAINS WITH RESISTANCE TRAINING

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Background: Heat is a major form of stress caused by exercise, though its value in driving adaptation is not well understood.

Aim: Through a contralateral-limb control study we examined whether supplemental heating of active muscle during resistance training differentially affected physical and functional adaptations compared to those from traditional training without muscle heating.

Methods: Ten healthy young adult volunteers (5 females) completed 12-wk progressive resistance training of the knee extensors, comprising 30 sessions of 32 repetitions (4 sets of 8) of unilateral knee extensions at 70% of leg-specific 1-RM. One randomly allocated thigh was heated during and for 20 min after each training session, using a customised heat pad eliciting muscle temperatures of 38–39.5 °C. Thigh lean mass was measured at baseline and 12 weeks, and concentric knee extensor maximal isokinetic (90°.s⁻¹) torque was measured at baseline and each 4 wk.

Results: Quadriceps' lean mass increased across 12-wk training, by $15 \pm 7\%$ (761 ± 280 g; $p=0.00$) and $15 \pm 6\%$ (752 ± 304 g; $p=0.00$) in the heated and control limbs, respectively; the difference being trivial ($0 \pm 3\%$; $p=0.94$). Peak torque increased ($p=0.02$) to more extent, by $33 \pm 38\%$ and $35 \pm 37\%$, respectively; with an unclear difference of $2 \pm 17\%$ between limbs ($p=0.82$). Rate of torque development increased by $47 \pm 44\%$ in the heated limb ($p=0.01$) and $45 \pm 39\%$ ($p=0.08$) in the control limb (difference: $2 \pm 18\%$; $p=0.90$). No sex differences were evident for mass or strength changes. **Conclusions:** Heating of the active muscle mass during and after resistance training shows no clear positive (or negative) effect on training-induced hypertrophy or the improvements in concentric isokinetic strength and rate of torque development, compared to those from resistance training without heat.

Keywords: Force; Torque; Females; Isokinetic; Quadriceps

EFFECT OF TRAINING LOAD ON ACUTE FATIGUE AND WELLNESS DURING AN IN-SEASON NON-COMPETITIVE WEEK IN ELITE RUGBY ATHLETES

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Background: Training adaptations will occur from the balance between training load and recovery. Therefore, it is critical to understand the effects of training load on the levels of fatigue and readiness of athletes.

Aim: The aim of this study was to understand the effect of training load on acute fatigue and wellness during an in-season non-competitive week in elite rugby athletes.

Methods: The training load, perceptual and neuromuscular fatigue of sixteen elite rugby athletes was monitored every morning during a non-competitive week within the in-season period of the Super Rugby competition. Training load was obtained from GPS during the field sessions, and from individual RPE for the extra conditioning and gym sessions. Perceptual fatigue was obtained every morning from a 5-item questionnaire (WQ) and

a questionnaire on the muscle soreness (SQ) at 9 different muscle sites. Neuromuscular fatigue was measured using a countermovement jump. Results: Although training day 3 had a significantly ($p < 0.05$) greater load in comparison to training days 1 and 2, there was a greater effect of training load on muscle soreness and neuromuscular performance when two training days were performed consecutively. Moreover, the effect of training load on muscle soreness was only evident in lower body muscles. Data from the present study also suggest that two days off training are adequate for complete recovery from a high-load training week in rugby athletes. Conclusion: There was a clear effect of training load on fatigue, with greater fatigue occurring when training took place on two consecutive days. Monitoring soreness from different lower body muscle sites was demonstrated to add important information for practitioners. Keywords: Training Load; Monitoring; Wellness; Elite; Rugby

BEST STUDENT ORAL PRESENTATION THE ROLE OF CONSCIOUSNESS IN BALANCE PERFORMANCE

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Background: Traditional centre of pressure (COP) measures do not account for the complex dynamics of postural control. Researchers have suggested that complexity-based COP measures not only describe the dynamic characteristics of sway but also inform about conscious control in balance. However, limited evidence is available for this claim.

Aim: To examine the relationship between traditional and complexity-based COP measures and the propensity for conscious control of movements.

Methods: Three groups, consisting of 53 young adults, 39 older adults with a history of falling, and 39 older adults without a history of falling, were asked to perform single- and dual-task quiet standing balance tasks. Four traditional COP measures were recorded: ellipsoidal area (85.35%), average velocity, standard deviation of medial-lateral and anterior-posterior axis.

Additionally, four complexity-based measures were recorded: sample entropy and detrended fluctuation analysis for medial-lateral and anterior-posterior axis. Propensity for conscious control of movements was measured using the Movement Specific Reinvestment Scale.

Results: The results showed that a higher propensity for conscious control of movements was associated with a more constrained (less complex) mode of balancing and more variable sway in the medial-lateral direction in young adults. The association was not apparent under dual-task conditions during which participants' attention was diverted away from the balancing task.

Furthermore, no relationship was apparent between postural control and propensity for conscious control of movements in older adult fallers or non-fallers.

Conclusions: It is of clinical importance to understand how consciousness affects postural control. Our findings show that complexity-based COP measures are indicative of conscious involvement in postural control in young adults. The absence of such relationships in the older adults raises questions about the underlying conscious and unconscious mechanisms of balance in older adults.

Keywords: Postural Stability; Reinvestment; Quiet Standing; Older Adults

EEG COHERENCE AND CONSCIOUS MOTOR PROCESSING IN GOLF PUTTING BEGINNERS

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Background: EEG coherence (a measure of cortico-cortical communication) between the motor planning and verbal processing regions in the brain has been proposed as a measure of conscious motor processing (Zhu et al, 2011). We used the Conscious Motor Processing (CMP) factor of the Movement Specific Reinvestment Scale (Masters et al, 2005) as a state measure to

examine differences in coherence as novices practiced golf putting in different learning conditions.

Methods: Novices ($n=13$) performed golf putts in three consecutive conditions. In a baseline condition, exploratory learning was induced by providing an insufficient movement instruction. In an implicit condition, a validated golf putting analogy was provided, and in an explicit condition, 6 putting instructions were provided. EEG (at locations Fz, Pz, T3, and T4) was recorded continuously during each condition. Participants completed a state measure of conscious motor processing (CMP) after each condition.

Results: No effects were evident in the baseline condition, but a significant positive correlation was visible between CMP state score and T3-Fz coherence in both the analogy condition ($r = .702$, $p = .007$) and the explicit condition ($r = 0.637$, $p = .019$).

Conclusions: Increased conscious motor processing was expected in the explicit condition but not the analogy condition. Masters and Liao (2003) argued that analogies reduce the cognitive effort required to learn a new movement, so we expected less conscious motor processing to be reflected by lower coherence. It is possible that initially processing analogy instructions is cognitively demanding, as suggested by Lam, Maxwell, and Masters (2009). Regardless, the associations between coherence and CMP scores underline that coherence may be a valid neurophysiological indicator of conscious motor processing.

Keywords: Implicit Motor Learning; Reinvestment; EEG Coherence; Golf Putting; Novice Golfers

PHYSICAL ACTIVITY NEEDS OF PROSTATE CANCER SURVIVORS COMPARED TO AGE-MATCHED NON-CANCER CONTROLS

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Background: In New Zealand, prostate cancer (PCa) is the most commonly diagnosed cancer in men. While better detection, diagnosis, and treatment have led to improved survival rates, many men do not survive well. Physical activity is often used as adjuvant treatment to improve a cancer survivor's quality of life, ameliorate treatment side effects, and/or prevent cancer recurrence. Targeted physical activity in the PCa population may improve health outcomes in this sector of the population.

Aim: To determine body composition, strength and physical activity levels in men with PCa compared with non-cancer age-matched controls.

Methods: Participants recruited for this case-control, cross-sectional study were PCa survivors who had completed treatment (other than hormonal therapy) or were on active surveillance compared with age-matched non-cancer controls. During a single one-hour appointment, body composition and handgrip strength were assessed and physical activity levels obtained by questionnaire.

Results: Ninety-eight men were recruited, 51 PCa survivors and 47 controls. There was no between group difference for body mass index, body fat percentage, or physical activity levels ($p > 0.05$). Skeletal muscle mass, fat free mass, skeletal muscle index and handgrip strength were lower ($p < 0.05$) in the PCa group.

Conclusion: Reductions in handgrip strength and lean tissue mass in PCa survivors compared to age-matched non-cancer controls indicate that resistance training should be a key component of a comprehensive survivorship programme to maintain independence.

Keywords: Exercise Prescription; Survivorship; Physical Function

POSTER PRESENTATIONS

HIGHER CEREBRAL BLOOD FLOW RESPONSES TO SWIMMING THAN TO LAND-BASED ARM OR LEG EXERCISE

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Background: Effective regulation of cerebral blood flow (CBF) is important momentarily and across life. Regulation of CBF involves several local and

systemic factors, all of which are altered during exercise. CBF thus depends on exercise intensity and mode. Mild, upright exercise in water increases CBF (velocity) by more than exercise on land. Swimming may provide a uniquely high CBF profile due to demand factors (widespread neuronal activation) and multiple supply factors (e.g., posture and compression), but has not been examined.

Aim: To profile CBF during swimming, and compare against arm and leg exercise on land.

Method: Eight trained adults (Mean \pm SD: age 29 \pm 14 y; $\text{VO}_{2\text{max}}$ 46 \pm 8 mL/min/kg; 5 females) completed swimming (overarm or breaststroke in flume), cycling and arm-cranking on different days (randomised order). Exercise comprised five incremental, 3-min stepped intensities based on perceived exertion, from "fairly light" to "extremely hard". CBF was indexed continuously from middle cerebral artery velocity (MCAv; transcranial Doppler).

Results: MCAvmean, pooled across intensities, was 9% (\pm 4; $P=0.0002$) and 14% (\pm 2; $P<0.0001$) higher in swimming than cycling and arm-cranking (89 \pm 14, 81 \pm 17, 77 \pm 13 cm.s $^{-1}$; $P=0.029$ and 0.026). MCAvmean peaked (102 \pm 15 cm.s $^{-1}$) at 60 \pm 25% HR reserve (HRR@peak) during swimming, 69 \pm 24% during cycling (87 \pm 12 cm.s $^{-1}$; $P=0.0675$) and 47 \pm 21% during arm-cranking (82 \pm 15 cm.s $^{-1}$; $P=0.0137$ vs. swimming, $P=0.682$ vs. cycling); differences in HRR@peak were not evident for swimming versus land-based modalities ($P>0.175$), but HRR@peak was higher in cycling than arm-cranking ($P=0.014$). PETCO $_2$, the major factor governing MCAvmean, was higher in cycling (37 \pm 3 mm Hg) than swimming (35 \pm 4; $P=0.072$) and arm-cranking (33 \pm 2; $P=0.004$), and in swimming than arm-cranking ($P=0.042$).

Conclusions: Swimming elicits higher MCAvmean (\sim CBF) than does cycling or arm-cranking across a range of intensities, despite higher PETCO $_2$ during cycling. MCAvmean peaked at typical training intensities, but our findings indicate that flow-mediated cerebrovascular adaptation may be greater with swimming than cycling or arm cranking.

Keywords: Brain Blood Flow; Hypercapnia; Front Crawl; Immersion

THE EFFECTS OF YOGA AS AN ADJUNCT TO HOME-BASED EXERCISES ON CHRONIC NON-SPECIFIC NECK PAIN AND DISABILITY

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Aim: To determine the degree to which yoga classes are efficacious for treating chronic non-specific neck pain (CNSNP) as an addition to prescribed home-based exercises, and the role of psychosocial factors in recovery.

Methods: The yoga+exercises group ($n=13$) attended twice-weekly, 60-minute yoga classes and completed home-based neck and shoulder exercises for 10 minutes daily for 8 weeks, whilst the exercises-only (control) group ($n=11$) completed home-based exercises only. Outcomes, measured at baseline and weeks 4, 9, and 12, included neck pain intensity via Visual Analogue Scale (VAS); disability via Northwick Park Neck Pain Questionnaire (NPNPQ); and quality of life (QoL) scores via The Medical Outcomes Study Short Form 36 item (SF36) questionnaire. Credibility and Expectancy Questionnaire (CEQ), and Yellow Flag questionnaire scores were analysed as correlates of change in outcomes.

Results: Pain intensity and disability decreased in both the yoga+exercises (baseline VAS: 5.4 \pm 1.4 (mean \pm SD), week 9: 3.6 \pm 1.2; baseline NPNPQ: 36.1 \pm 9.4, week 9: 17.7 \pm 8.8), and exercises-only (baseline VAS: 5.1 \pm 1.9, week 9: 3.1 \pm 2.0; baseline NPNPQ: 32.3 \pm 12.9, week 9: 18.5 \pm 9.7) groups. No additional change in pain intensity or disability was found in the yoga+exercises group compared to the exercises-only group. After 9 weeks, the yoga group demonstrated a more positive improvement in the SF36 physical functioning health dimension (median 25 points) compared to the exercises only group (median 10-point; $P=0.04$). A significant correlation between baseline CEQ credibility and 9-week change in SF36 general health dimension was demonstrated in both groups combined ($\rho=0.72$; $P=0.001$), and in the yoga group alone ($\rho=0.82$; $P=0.007$).

Conclusion: This RCT shows that yoga plus home-based exercises, and home-based exercises only, over an 8-week time period, are both appropriate interventions to decrease pain and disability caused by CNSNP. Yoga plus home-based exercises may improve physical functioning QoL outcomes

more than home-based exercises alone.

Keywords: Physical Rehabilitation; Exercise Therapy; Chronic Pain

REAL WORLD EFFECTS OF NON-IMAGE FORMING LIGHT

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Background: We have all seen futuristic shows where miraculous devices are used to heal injuries and illnesses; but, that is just science fiction, right?

Yes, and no. The knowledge that light can impact human physiology should not come as a surprise. Sun exposure is an obvious example of the ability of invisible light wavelengths (UVB rays) to penetrate the human body and cause direct DNA damage and inflammation (sunburn), initiate a prophylactic protective response in the form of an increase in melanin (suntan), and regulate positive endocrine effects (vitamin D production). The usage of appropriate light wavelengths and dosages for health and performance benefit, however, is still relatively under-utilised.

Aim: To present the potential human health and performance benefits of both short (450-495 nm) and long (620-904 nm) wavelength light.

Methods: A brief and targeted review of relevant literature.

Results: Benefits include: enhanced weight management, combating the negative effects of micro-gravity on bone and muscle, improved agility, pain relief, greater muscle recovery, elevated testosterone, heightened reaction times, improved cognitive function post traumatic brain injury, improved muscle endurance, higher IQ, and superior strength gains.

Light application can also manipulate circadian rhythms for athletic performance and off-set the negative impact of cross-time zone travel.

Correcting circadian disruptions may also have significant implications for global human health as the International Agency for Research on Cancer has recently stated that circadian disruption is "probably carcinogenic to humans".

Conclusion: Appropriate light application has the potential to impact a range of physiological functions with the capacity to enhance human performance, health, and well-being.

Keywords: Photobiomodulation; Light Therapy; Blue Light; Infra-Red

MENTAL REHEARSAL IMPACTS HORMONES AND SUBSEQUENT SPORT-SPECIFIC PERFORMANCE

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Background: Mental rehearsal is method used to deal with stressful situations, with positive visualization proposed to enhance complex skill performance. The use of a video stimulus has been associated with enhanced kinesthetic sensations and rapid hormone fluctuations that may contribute to enhancing the conscious and unconscious emotional state for skill execution.

Aim: Assess the presentation of negative and positive video on skill execution and hormones.

Methods: 10 professional athletes volunteered for a randomized cross-over study whereby they completed three preparatory phases (either positive or negative video guided mental rehearsal, or self-directed mental rehearsal alone) prior to an exercise stressor and sport-specific motor skill task. Salivary testosterone and cortisol were monitored to assess stress responses.

Results: The presentation of positive video imagery prior to an exercise stressor elicited a positive hormonal outcome and was associated with a significantly enhanced physiological stress resilience ($r=0.39$). Performance during a sport-specific task was also improved following the positive video condition compared to the negative video and self-directed mental rehearsal, with a significant correlation observed between performance and salivary testosterone ($r=0.47$).

Conclusion: Mental rehearsal is enhanced by appropriate, context-specific video presentation and propose that the interaction between sex steroids, the adrenal axis, and subsequent conscious and unconscious behaviors may be relevant to competitive sporting environs. Specifically, we suggest that relatively elevated free testosterone imparts a degree of stress resilience

and improves self-efficacy, which may lead to enhanced expression of competitive behaviors and provide a more optimal emotional state for skill execution.

Keywords: Visualisation; Motivation; Mental Toughness

THE DIRECT IMMUNOASSAY OF BLOOD-FREE TESTOSTERONE: IS IT VALID IN SPORT?

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Introduction: In sport, the direct immunoassay of blood-free testosterone (FT) is increasing in popularity, as it circumvents more costly, difficult and time-consuming methods. However, some technical considerations (e.g. sensitivity, specificity) can influence the accuracy and precision of this method, but not yet evaluated within a sporting context. Therefore, this study assessed the validity of direct FT measures, referenced against total testosterone (TT), during athletic competition.

Methods: Capillary blood samples from 49 male and 28 female athletes (age 16-20 years) were taken before and after a simulated Olympic weightlifting competition. The blood concentrations of TT and FT were measured using a solid-phase enzyme-linked immunoassay (DRG, Germany). The hormonal changes and predictive associations were examined using non-parametric statistics.

Results: The male and female athletes both experienced a significant rise in TT ($9 \pm 19\%$, $11 \pm 20\%$) and FT concentrations ($15 \pm 22\%$, $52 \pm 64\%$), respectively. The individual variances in TT and FT were strongly related in males ($r^2 = 0.911$) and females ($r^2 = 0.757$), with the FT values representing 0.2-0.3% of blood TT.

Discussion & Conclusions: The athletic competition promoted a corresponding rise in the blood TT and FT concentrations of young athletes. The TT and FT measures were also strongly related in both sexes; however, the actual FT values were well below expected percentages (i.e. 1-3% of TT). This bias limits the use of direct immunoassays when comparing study or laboratory results, as well as establishing accurate reference ranges for similar-aged populations.

Keywords: Hormones; Stress; Androgen; Assay Specification

THE METHOD OF DEHYDRATION IS RELEVANT WHEN CONSIDERING THE EFFECTS OF DEHYDRATION

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Background: Passive dehydration has a relatively high reliance on sourcing extracellular fluid, whereas exercise-induced dehydration releases and also produces endogenous water from glycogen stores. Thus physiological and behavioural effects are likely to differ between exercise- vs heat- or fluid-restriction-induced dehydration.

Aim: To investigate physiological and behaviour-mediating effects of heat versus exercise-induced dehydration.

Design: Controlled-trial, fully repeated measures design; laboratory setting. Methods: Twelve participants completed four trials; they dehydrated to mild extent (3% Δ BM) or rehydrated to prevent Δ BM under passive heat stress ($\sim 40^\circ\text{C}$, 60% RH) or exercise heat stress (cycling intervals at $\sim 90\%$ $\dot{V}\text{O}_{2\text{max}}$ in 29°C , 50% RH). Plasma osmolality (Posm), change in plasma volume (Δ PV), and thirst were measured at baseline and 3% gross Δ BM. Respired gas was also measured at 3% gross Δ BM.

Results: PV decreased 2.3% more per % Δ BM in passive than exercising dehydration, and was 7.7% lower at 3% Δ BM (13.2 vs 4.4% ; $p=0.003$). But, after subtracting Δ PV across the corresponding rehydration trials, PV reductions were not clearly different between passive and exercise dehydration (1.2 vs 0.4% per % Δ BM; $p=0.550$). Posm rose by 6 ± 5 vs 3 ± 7 mOsmol/L during passive vs exercise dehydration ($p=0.087$). Again,

subtracting the corresponding value in the rehydration trial produced unclear differences (4 vs 5 mOsmol/L per % Δ BM; $p=0.880$). However, 'full rehydration' decreased Posm to 8 ± 5 and 11 ± 5 mOsmol/L below baseline in passive and active trials, respectively (main effect: $p<0.001$). Thirst averaged an unclear 1.1 ($/9$) points higher in active than passive dehydration at 3% Δ BM ($p=0.084$).

Conclusions: PV and perhaps Posm are impacted more by mild (3%) body mass deficit incurred by heat than by exercise. But, such effects may be due primarily to the stressors per se (heat or exercise) than to the mass deficit. Full replacement causes substantial hypotonicity, and thus seems inappropriate.

Keywords: Hypohydration; Heat Stress; Thirst; Plasma Volume; Exercise

IMPROVING JUMP AND REACH HEIGHT WITH OSTEOPATHIC MANUAL THERAPY TECHNIQUES IN FEMALE RECREATIONAL OVERHEAD ATHLETES

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Background: Lower body training to improve jump height for sport performance has been extensively researched. However, no research has investigated improving shoulder range of motion through osteopathic techniques in order to achieve optimal overhead jump reach.

Aim: To investigate the effects of an osteopathic intervention for shoulder and thoracic range of motion in female athletes on overhead reach during vertical jumping.

Methods: Participants were 17 healthy, active women (aged 18-37) who were involved in basketball ($n = 9$), netball ($n = 7$) or volleyball ($n = 1$). In a crossover design, they received an upper and lower body osteopathic intervention, in randomised order, 1 week apart. Jump reach and maximum ground reaction force with and without arm swings were recorded prior to and immediately following each intervention using a Swift YardstickTM Vertical Jump Tester and ground reaction force plate.

Results: There was no meaningful difference between interventions in the change in jump height following each intervention ($P = 0.96$). However, there was a significant change in standing reach height following the upper body intervention ($P=0.04$), from 211 ± 6.53 cm to 214 ± 6.4 cm (mean \pm SD). An arm swing increased ground reaction force during jumping from 1473 N [95% confidence interval 1328 to 1619 N] to 1660 N [1466 to 1854 N].

Conclusion: Overhead jump reach did not improve with osteopathic techniques for shoulder mobility in young, active women. Despite this, a significant increase in standing reach height was observed, suggesting that osteopathic techniques may be beneficial when used to improve joint ROM.

Keywords: Shoulder; Range of Motion; Jumping; Athletic Performance; Osteopathy; Muscle Energy Technique; Soft Tissue Massage; High Velocity Low Amplitude Thrust

THE ACUTE RESPONSE AND RECOVERY TIME-COURSE OF AUTONOMIC AND PERFORMANCE PARAMETERS FOLLOWING VARIOUS TRAINING INTENSITIES IN HIGHLY-TRAINED ROWERS

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Aim: To determine the acute effects of different interval training (IT) sessions on the post-exercise recovery response and time-course.

Methods: Thirteen highly trained rowers ($n = 10$, $n = 3$; $\dot{V}\text{O}_{2\text{peak}}$ 4.9 ± 0.7 L \cdot min⁻¹) completed three IT sessions on the rowing ergometer, separated by seven days. The sessions consisted of; 5×3.5 min, 4 min rest periods ($\dot{V}\text{O}_2$); 10×30 s, 5 min rest periods (Glycolytic); and 5×10 min, 4 min rest periods (Threshold). Participants were instructed to perform intervals at the highest maintainable pace. Blood lactate and salivary cortisol were measured pre

and post-exercise. Resting heart rate (HR) variability (HRV), post-submaximal exercise HRV (HRVex), submaximal exercise HR (HReX), HR recovery (HRR), and modified Wingate peak and mean power were measured pre and 1, 10, 24, 34, 48, 58, and 72 h post-exercise. Participants resumed training throughout the 72 h measurement period.

Results: Differences in acute responses (1 h post-IT) across IT sessions were either trivial or unclear for all recovery variables. HRVex demonstrated the longest time-course to return to baseline (HRVex time (h) to return baseline (mean \pm CL); Threshold = 37.8 ± 14.2 , Glycolytic = 20.2 ± 11.0 , and $VO_2 = 20.6 \pm 15.2$). Very large ($r = 0.80 \pm 0.09$; mean \pm SD) relationships existed between all acute response and recovery time-course data for HRV, HReX, HRR, peak and mean power following Threshold and Glycolytic IT.

Conclusions: Acute responses were similar following Threshold, Glycolytic, and VO_2 IT in highly-trained male and female rowers. However, the recovery time-course was greatest following Threshold compared to Glycolytic and VO_2 focused training. This suggests a durational influence on recovery time-course exists at HR intensities above the second ventilatory threshold ($\geq 80\%$ HRmax), which should be considered in the programming of high-intensity interval training.

Keywords: Non-Passive Recovery; Programming; Heart Rate Variability; High-Intensity Exercise

NOVICE RATERS DEMONSTRATE ACCEPTABLE INTER-RATER AND INTRA-RATER RELIABILITY OF THE TRIPLE JOINT FLEXION TEST ('TJFT') SCORES IN ADOLESCENT FIELD AND COURT ATHLETES

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Background: The Triple Joint Flexion Test (TJFT) is a new movement screening test battery derived from work in youth athlete development. The TJFT is intended for use in evaluating movement competencies involving the ankle, knee, hip, and lumbar spine in athletes. To date, there has been no previous investigation of rater reliability for the TJFT.

Aim: Investigate inter- and intra-rater reliability of TJFT scores in screening adolescent male court and field athletes by novice raters.

Methods: Using a repeated measures design, 7 trained novice raters rated TJFT sub-tests on two occasions using real time video. The TJFT was performed by 17 adolescent court and field athletes and separate 182 ratings were made on each occasion. Estimates of reliability were calculated using Gwet's AC1 and AC2 statistics.

Results: Inter-rater weighted agreement of the six TJFT sub tests by 7 raters on Day 1 and 6 raters on Day 2 demonstrated 'moderate' ($AC_2 > 0.41$) to 'substantial' inter-rater agreement ($AC_2 > 0.61$). Intra-rater weighted agreement of the six TJFT sub-tests by 6 raters was mostly 'moderate' ($AC_2 > 0.41$) and ranged from 'fair' ($AC_2 > 0.21$) to 'near perfect' ($AC_2 > 0.81$).

Conclusion: Inter- and intra-rater reliability was sufficiently reliable for clinical use. Further investigation of other TJFT measurement properties including exploration of factor structure, internal consistency, longitudinal validity, and responsiveness should be undertaken in a wide range of sporting codes. The relationship between TJFT findings and subsequent prescription of therapeutic exercise needs explication.

Keywords: Movement Screening; Reliability; Injury, Lower Extremity; Triple Joint Flexion Test

THE EFFECTIVENESS OF WATER IMMERSION TECHNIQUES POST-EXERCISE ON RECOVERY FROM EXERCISE INDUCED FATIGUE: A META-ANALYSIS.

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Aim: This meta-analysis investigated the effectiveness of various water immersion techniques post-exercise on the recovery process and provide a "gold standard" protocol for water immersion as a tool for stimulating accelerated recovery processes.

Methods: The search process was performed on the EBSCO Host Database on the UCOL intranet using keywords within the title, keywords & abstract.

All articles found during search were analyzed through a coding process before being included in the meta-analysis. Statistical analysis consisted of calculating estimated effect sizes (ES) using Cohen's "d". ES of 0.2-0.5, 0.5-0.8 & >0.8 were considered significantly small, moderate and large, respectively.

Results: We analyzed 14 studies for a total of 14 ES. The mean ES for all 14 articles was 0.51, demonstrating a moderately significant effect of water immersion techniques on the recovery process post-exercise

Conclusion: The evidence reviewed in this meta-analysis confirms the existence of a positive and moderate effect of water immersion techniques on the recovery process. CWI demonstrated the most significant effect on post-exercise recovery specifically in reducing the subjective perception of DOMS. Therefore, the use of water immersion techniques, specifically CWI, as a post-exercise intervention to stimulate accelerated recovery may be beneficial to coaches & athletes in aiding enhancements in sporting performance capabilities.

Keywords: Water Immersion; Cold-Water Immersion; Recovery; Fatigue; Contrast-Water Therapy; Muscle Damage

RELATIONSHIP BETWEEN BALLISTIC AND ISOMETRIC FORCE PRODUCTION IN ELITE RUGBY PLAYERS

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Background: The squat jump (SJ) and isometric midhigh pull (IMTP) are often implemented to assess an athlete's ability to produce maximum ballistic and isometric force, respectively. More recently, practitioners have calculated a dynamic strength index (DSI) in an attempt to better inform and individualise strength and ballistic training.

Aim: To determine the relationship between SJ performance and maximum IMTP force production; as well as evaluate the usefulness of the DSI to guide strength and ballistic training.

Methods: Twenty professional rugby union players volunteered as participants for the study and performed 3 acyclic static SJ's and three 5 sec maximum IMTPs using two portable dual-axis force plates sampled at a frequency of 200 Hz. Pearson product moment correlations (r) were used to determine the relationship between SJ and IMTP absolute (N) and relative (N/kg) peak force. The DSI (PFSJ/PFIMTP) was also calculated to better categorise individual ballistic and isometric force qualities.

Results: Mean group peak force outputs of 4034 ± 345 N (38.5 ± 4.1 N/kg) and 2635 ± 285 N (25.1 ± 2.5 N/kg) were produced during the IMTP and SJ, respectively. A DSI of 0.65 ± 0.06 U was also calculated as the ratio between SJ and IMTP peak force. Large correlations were observed between SJ and IMTP absolute ($r = 0.57$) and relative ($r = 0.64$) peak force, respectively.

Conclusions: The findings suggest that peak force production of elite rugby union players during ballistic and maximum isometric strength tasks are largely related. The DSI results also indicate that rugby union players produce much larger peak forces during the IMTP in comparison to the SJ; possibly suggesting a need to focus on improving ballistic force qualities in these athletes.

Keywords: Squat Jump; Isometric Midhigh Pull; Dynamic Strength Index; Rugby

PILATES EXERCISE IMPROVES CHRONIC LOW BACK PAIN AND PATIENT-SPECIFIC DISABILITY

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Background: Chronic low back pain (LBP) accounts for a substantial proportion of healthcare expenditure for back pain. Although Pilates exercise has been reported to improve pain, flexibility, proprioception, and perceptions of health in people with chronic LBP, there have been few studies investigating Pilates delivered in small group classes utilising both equipment-based and mat-based exercises.

Aim: To evaluate changes in pain, and functional disability in adults with chronic LBP following a 6-week Pilates intervention including both mat and

equipment based exercise.

Methods: A repeated measures pre-test – post-test single group design was undertaken. The intervention was scheduled so that each participant attended one mat class and one reformer class each week, for 6 weeks. Outcome measures (low back and leg pain intensity, Troublesomeness, Patient Specific Functional Scale, Oswestry Disability Index) were repeated at baseline and one week following conclusion of the intervention. **Results:** Data from 47 participants (n=31 females, n=16 males), between 25 – 65 years of age (mean age 41.3 years) were analysed. Participants attended a total of 12 sessions over a 6-week period. Post-intervention there was a significantly lower level of functional disability as measured using Patient Specific Functional Scale (mean difference = 2.81, $p \leq 0.001$, $d = 0.81$), and Oswestry Disability Index (mean difference = 5.58, $p \leq 0.001$, $d = 0.53$); and a decrease in average pain intensity ($z = 3.85$; $p \leq 0.001$; $d = 0.55$). Improvements in LBP Troublesomeness were also observed (mean difference = 0.96; 95% CI: 0.64 to 1.23, $p \leq 0.001$).

Conclusions: These findings suggest that Pilates is an effective treatment for improving functional disability and decreasing pain and Troublesomeness in adults with chronic non-specific LBP.

Keywords: Lumbar Spine; Lumbosacral Region; Chronic Pain; Movement Control Exercise Techniques; Exercise Rehabilitation; Functional Tests; Exercise Therapy

THE VALIDITY AND RELIABILITY OF THE GYMAWARE LINEAR POSITION TRANSDUCER FOR MEASURING COUNTER-MOVEMENT JUMP PERFORMANCE IN ELITE FEMALE ATHLETES

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Background: Lower-body neuromuscular power is commonly measured and monitored through various vertical jump assessments, which have previously been validated and studied for their reliability in male participants.

Aim: The purpose of the current study was to assess the validity of the Gymaware linear position transducer (LPT) device to measure jump height when compared to the 'gold standard' force plate (FP) in female athletes. A secondary aim of the study was to determine the test-retest reliability of the LPT in elite female athletes when tested three separate times over a one-week period.

Methods: The study involved a total of 38 female participants. Twenty-seven (age = 19.4 ± 2.2 yrs; body mass = 67.7 ± 10.2 kg) recreational athletes performed 3 counter-movement jumps on the FP, with the LPT attached to the athlete via a waist belt to compare jump height measurements simultaneously, to evaluate the validity of the LPT. To assess test-retest reliability of the counter-movement jump with the LPT, 11 elite netball athletes (age = 23 ± 6 yrs; body mass = 79.8 ± 8.9 kg) completed 3 counter-movement jumps on 3 separate days, separated by 48 hours.

Results: Pearson correlation coefficients between the FP and LPT for jump height was $r = 0.90$. The mean difference between the FP and LPT for jump height was 7.8 ± 2 cm. The test-retest reliability of the jumps measured by the LPT resulted in an intra-class correlation coefficient of 0.70 for jump height, 0.90 for peak velocity and 0.91 for mean velocity. The coefficient of variation for jump height, peak velocity and mean velocity were 6.2%, 4.7% and 6.7%, respectively.

Conclusions: The results from the current study would suggest that the Gymaware LPT device is a valid and reliable tool for measuring neuromuscular power in elite female athletes, as identified through high ICC's and low CV's for jump height, peak and mean velocity.

Keywords: Neuromuscular Performance; Technology

PREDICTING CLINICAL OUTCOME FOLLOWING PILATES EXERCISE REHABILITATION IN PEOPLE WITH CHRONIC LOW BACK PAIN

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Background: Identifying characteristics of patients with low back pain (LBP) who respond best to exercise therapy may allow their management to be better tailored according to subgroup classification.

Aim: To determine predictors of change in disability in people with chronic LBP following a Pilates-based exercise program.

Study Design/Setting: Community-based single cohort, before-after trial.

Methods: Healthy adults (n = 55) with non-specific chronic LBP completed a graded 6-week programme involving two 1-hour Pilates sessions per week (1 mat and 1 equipment-based) led in small groups by a trained Pilates instructor. Predictors of change in disability, as measured by the Patient-Specific Functional Scale, were identified through regression analysis and used to develop a clinical prediction rule.

Results: Clinically important improvement in disability was predicted by four variables that explained 48% of the variance in outcome ($P < 0.001$): gradual rather than sudden onset of LBP, patient-specific functional score < 3.7 points, absence of aberrant motions on forward bending, and body mass index > 24.5 kg/m². Failure to show clinically meaningful improvement was predicted by three variables that explained 40% of the variance in outcome ($P < 0.001$): sudden onset of LBP, patient-specific functional score ≥ 3.7 , and difference between left and right active straight leg raise $> 7^\circ$.

Conclusions: A combination of five, easily measured variables were able to predict disability outcome following a graded program of movement control exercises in people with chronic LBP.

Keywords: Activities of Daily Living; Functional Tests; Chronic Pain; Lumbosacral Region; Lumbar Spine; Movement Control Exercise Techniques; Exercise Therapy; Clinical Prediction Rule

BEST POSTER PRESENTATION

DESCRIPTIVE ANALYSIS OF LINEAR AND ANGULAR ACCELERATION FORCES EXPERIENCED AT THE HEAD DURING A SIMULATED FRONT-ON RUGBY UNION TACKLE

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Background: A concussion is a complex pathophysiological process affecting the brain as a result of a biomechanical force. In rugby, the tackle accounts for 50% of all concussions, which highlights the importance of understanding head impact kinematics during these events.

Aim: To explore the linear and angular head acceleration profile of forwards and backs during a simulated front-on rugby tackle.

Trial Design/Setting: Laboratory based descriptive study

Methods: Forty-one club level rugby players performed ten tackles each, five with the preferred and five with the non-preferred shoulder, in a randomized order. Participants performed a front-on tackle of a 50kg boxing bag traveling at a resultant linear velocity of 4.2m/s. Formalized instructions were provided to standardize the procedure and technique. During each tackle a CSx Head Positioning Unit was worn on the mastoid process behind the ear. The sensor recorded linear (g) and angular head acceleration (rad/s²) at 3200 and 4000Hz respectively, over an 18.75ms period for all impacts exceeding a 10g threshold.

Results: Of the tackles performed 370 exceeded the 10g threshold and were included in the analysis. Peak linear and rotational acceleration values of 88 ± 51 g and 2403 ± 604 rad/s² were observed for the backs. For the forwards peak linear values of 91 ± 48 g and rotational acceleration of 2560 ± 530 rad/s² were documented. The reliability of the head acceleration produced during the tackles were poor for both linear (ICC=0.21) and rotational (ICC=0.22) acceleration. No meaningful correlations ($p \geq 0.05$) were observed between the anthropometric variables, concussion history or the acceleration forces recorded at the head.

Conclusion: In the current study the peak linear acceleration experienced at the head was 88g, which is somewhat higher than what has been reported in tackle simulations in American football. Further investigation into head acceleration during game play is needed and in particular during the tackle situation.

Keywords: Concussion; Injury Prevention; Biomechanics

Funding Sources: CSx systems Ltd. for providing the Head Positioning Unit.

POOR CORRELATION BETWEEN THREE POPULAR FUNCTIONAL MOVEMENT TESTS IN PROFESSIONAL RUGBY PLAYERS INDICATES EACH TEST ADDRESSES A DIFFERENT ASPECT OF MOVEMENT QUALITY

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Background: Poor 'movement quality' is one of many modifiable intrinsic risk factors for overuse injury. Several different tests of movement quality have been described and are popular in pre-participation screening in professional rugby and other team sports.

Aims: 1) To report descriptive data for a sample of professional rugby union players performing the Functional Movement Screen (FMS), Y-Balance Test (YBT) and Landing Error Scoring System (LESS). 2) To investigate concurrent validity represented by the correlation between scores derived from the FMS, YBT and LESS. 3) To investigate differences between scores derived from the FMS, YBT and LESS in forwards versus backs.

Methods: Twenty-four professional rugby union players (13 forwards, 11 backs) underwent a battery of active movement tests (FMS, YBT, LESS) during pre-season screening prior to the competitive season. Composite FMS, composite normalised YBT, and LESS scores were generated using the standardised test scoring protocols and scoring criteria.

Results: The mean±SD composite FMS score for all players was 13.2±2.5, out of 21. Nine out of 13 forwards, and 10 of the 11 backs demonstrated a left-right difference (magnitude of difference ≥1 out of 3) in at least one FMS subtests. Composite mean reach distance on YBT was 95.5±9.4% of leg length (n=21). Overall, the mean number of landing errors on the LESS was 5.8±3.4. Loose forwards demonstrated the lowest (4.7±1.5) and locks the highest (7.3±4.0) number of landing errors. Pearson's correlation between the LESS and composite FMS ($r = -0.007$) and composite YBT ($r = -0.036$) were 'trivial'. The correlation between YBT and FMS scores was 'minor' ($r=0.274$). There were no significant differences between forwards and backs on any of the movement tests.

Conclusions: Each test may be addressing a different aspect of movement quality. We recommend that movement quality is evaluated using a range of movement screening tests.

Keywords: Pre-Participation Screening; Rugby Union; Injury Prevention

EVALUATION OF THE CYCLUS ERGOMETER AND THE STAGES POWER METER AGAINST THE SRM CRANKSET FOR MEASUREMENT OF POWER OUTPUT IN CYCLING

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Aim: The purpose of the present study was to evaluate two commercially available power meters: the Cyclus ergometer (CYC) and the Stages power meter (STA) in comparison to a highly-validated power meter (SRM).

Methods: Ten trained cyclists (mean ± SD; age 24 ± 8 y, body mass 69.7 ± 7.3 kg) performed an incremental exercise test to exhaustion (GXT), two 10-second sprints and a 1-min all-out performance test on a bicycle attached to a Cyclus (CYC) cycle ergometer. The bicycle was also fitted with the SRM cranks and the STA power meter. Power output (W) for the CYC and STA for each test was compared to the SRM to determine the validity of the devices. Results: The coefficient of variation (CV) for the STA vs SRM during the GXT was 2.4 ± 1.1% (±90% CL) and 2.3 ± 0.9% for the CYC vs SRM. For the 1-min all-out performance test, the STA vs SRM had a CV of 3.4 ± 1.6% and 3.0% ± 1.6% for CYC vs SRM. Comparison between power meters during the 10-second sprint test showed a CV of 18.2 ± 1.6% for STA vs SRM and 13.7 ± 1.6% for CYC vs SRM. Conclusions: In summary, both the CYC and STA are practical, easy to use devices and exhibit an acceptable level of agreement during low (< ~500W),

but not high (> ~650W) power outputs.

Keywords: Cycling; Performance; Monitoring; Mobile Power Meter

BEST POSTER PRESENTATION – RUNNER-UP IMPROVEMENT IN ACTIVE WEIGHT-BEARING DORSIFLEXION AND ACHILLES TENDON EXCURSION FOLLOWING SOFT-TISSUE PERCUSSION: A CASE SERIES

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Background: Restriction of lower limb dorsiflexion has been associated with adverse musculoskeletal outcomes. Impairment to soft tissue sliding of the tendo-Achilles region is one possible cause of decreased dorsiflexion.

Anecdotally, a novel percussive soft tissue technique has been used to increase tissue sliding and improve dorsiflexion range.

Aim: To explore the effects of a percussive soft tissue technique applied to the tendo-Achilles region of healthy participants with reduced dorsiflexion.

Methods: A percussive soft tissue technique was administered once on Day 1 and once on Day 4. Pre-post comparisons of active weight-bearing dorsiflexion (ADF) and Achilles tendon (AT) excursion were made before and after treatment on Days 1, 4 and 8 using high-resolution, B-mode, real-time ultrasound imaging. Findings were interpreted compared to minimal detectable change established from pilot work as 1.76° for ADF, and 0.64 mm for AT excursion.

Results: Six healthy participants (M = 3, F = 3, mean ± SD age: 27.2 ± 6.3 years, height: 1.75 ± 1.1 m, median body weight: 75 [range 62 to 98] kg) with reduced ADF participated in the study. All participants improved ADF, with mean change of 6.15° (d=0.81) on Day 1, 3.10° (d=0.37) on Day 4, and overall change (pre-intervention Day 1 to follow up Day 8) was 11.29° (d=1.49). Between pre-intervention Day 1 and follow-up Day 8, 3 participants increased AT excursion, 2 participants decreased AT excursion, and change was unclear (<MDC) for 1 participant.

Conclusions: In this case series, all participants improved ADF following the soft-tissue technique, though improvement in AT was inconsistent. These findings provide evidence to support further research with more power to investigate the influence of the percussive soft tissue technique on AT excursion and ADF.

Keywords: Sliding Surfaces; Manual Therapy; Tendo-Achilles, Ankle Range

THE USAGE AND PERCEIVED EFFECTIVENESS OF DIFFERENT RECOVERY MODALITIES IN AMATEUR AND ELITE RUGBY ATHLETES Francisco Tavares^{1,2}, Phil Healey², Tiaki Brett Smith^{1,2}, Matthew Driller^{1,2}

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Background: The use of recovery modalities to help enhance recovery is popular among athletes. However, little is known about the usage of various recovery modalities and the perception of their benefit amongst different levels of athletes.

Aim: The aim of this study was to compare the usage and perceived effectiveness of different recovery modalities in amateur and elite rugby athletes.

Methods: Fifty-eight amateur (n=26) and elite (n=32) rugby union athletes completed a questionnaire designed to determine the usage and the perceived effectiveness of 15 different recovery modalities. A 5-point Likert scale was used to examine the perceived importance of recovery for performance, the effectiveness of each recovery modality, the number of different recovery modalities used and the number of times each recovery modality was performed per week.

Results: No significant differences were found between groups (elite: 5.0 ± 0.2; amateur: 4.9 ± 0.3) for the perceived importance of recovery to enhance performance (p>0.05). When comparing the effectiveness of each recovery modality, the elite group perceived active recovery, massage, pool recovery, additional sleep and stretching to be significantly more effective in comparison to the amateur group. There was a significant difference (p<0.05) in the number of different recovery modalities (elite: 7.8 ± 1.3; amateur: 3.0 ±

1.8), and also in the total number of times a recovery modality was used per week (elite: 24.3 ± 5.4 ; amateur: 5.9 ± 4.3).

Conclusion: Although no differences were found for the perceived importance of recovery, elite rugby athletes used significantly more recovery modalities and performed these modalities more often when compared to the amateur group. This is likely to be related to both the limited access to recovery modalities and the lower perceived effectiveness of numerous recovery modalities by amateur athletes.

Keywords: Recovery; Perceived Effectiveness; Elite; Amateur; Rugby

DIFFERENCES IN STRENGTH, POWER AND SPEED BETWEEN AGE GROUPS IN ELITE SOCCER ATHLETES

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Background: Recently, it has been observed a high inflow of athletes with young age in professional football teams. However, it is unknown if athletes of different age groups differ in the strength, power and speed skills.

Aim: This study compared the strength, power and speed skills levels in soccer athletes of different age groups from an elite soccer club.

Methods: 69 elite soccer athletes from three age-groups [above 19 (senior, $n=19$), under 19 yrs (U-19, $n=24$) and under 17 yrs (U-17, $n=26$)] were tested during the pre-season. The knee extensors peak torque was assessed during an isokinetic ($60^\circ/s$) concentric knee extension test. The jump height was determined in three jump tests: counter-movement jump (CMJ), squat jump (SJ) and the 40cm box drop jump (DJ). Sprint times were obtained at 5m, 15m and 20m.

Results: A greater peak torque was observed in senior (mean, 246.7 Nm) compared to U-17 (214.6 Nm) athletes. A greater jump height was seen in senior (CMJ=44.0cm, SJ=43.3cm, DJ=43.6 cm) in comparison to U-19 (CMJ=37.6cm, SJ=36.1cm, DJ=36.7cm) and U-17 (CMJ = 36.6 cm, SJ=36.1cm, DJ=36.3cm). Sprint times in all distances were also lower in the senior athletes (5m=0.892s, 15m=2.203s, 20m=2.783s) compared to U-19 (5m=0.927s, 15= 2.267s, 20m=2.873s) and U-17 (5m=0.952s, 15m= 2.291s, 20m=2. 2.897s). No differences were found between the U-17 and U-19 groups for any variable.

Conclusion: The present results indicate that soccer athletes under 19yrs do not have the same strength, power and speed skills as professional athletes. Therefore, strength and condition interventions should be specifically designed in young athletes in order to ensure the same physical capacity when ingress in professional football.

Keywords: Elite Soccer; Strength; Power; Age-groups

DURATION OF CONCURRENT MUSCULAR STRENGTH AND ENDURANCE TRAINING IN SOCCER PLAYERS AND EFFECT ON PERFORMANCE: A REVIEW

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Introduction: The physical demands of soccer competition require players to have high levels of aerobic endurance and muscular strength. Therefore, concurrent training of both muscular strength and aerobic endurance is often used in soccer. Concurrent training, however, has been proposed to cause an interference effect between aerobic training and resistance training.

Aim: The aim of this study was to review recent research on concurrent training practices in soccer, with a particular focus on the duration of the training program.

Methods: Database SportDiscus was searched for journal articles published within the last 15 years with "concurrent training", and "soccer" or "football" as the search terms. The search yielded 380 articles, which were subsequently reviewed. Inclusion criteria for the review included programs of greater than 5 weeks duration, participants over 16 years of age and comparison of different training methods.

Results: Six articles addressed all of the selection criteria and were included

in this review. Performance measures included the Yo-Yo intermittent recovery test level 1 (YYIRT 1), maximal aerobic speed (MAS), 30m-sprint and one-repetition maximum squat (1RM). All six studies showed improvements in performance irrespective of the concurrent training protocol used.

Furthermore, concurrent protocols demonstrated greater improvements than soccer only programs. Study duration varied between 6 to 16 weeks. Greater performance improvements were associated with longer training programs (> 8weeks), compared with shorter duration programs.

Discussion: This review showed that concurrent training results in improved strength, aerobic performance and sprint performance in soccer players. It was also shown that when using concurrent training it is important to use programs lasting longer than eight weeks in duration in order to maximise performance gains. Future research should investigate the different training modalities used in concurrent training and the duration of the overall concurrent training program in soccer.

Keywords: Resistance Training; Aerobic Training; Periodization

EXERCISE PRESCRIPTION CAN BE MORE SUCCESSFUL WITH AN ADJUNCT MODALITY: HOLOGRAPHIC KINETICS

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Background: How exercise prescription could be more successful for mental health, especially in suicide prevention.

Waikato health reports of an increase in suicides, especially among young Maori residents. (Taupo Hospital, 29 August 2016). In private practice in Taupo and Turangi I met many young female adults having to cope with angry behaviour of their partners. The combination of holographic kinetics and exercise prescription demonstrated positive results in behaviours. Holographic Kinetics (founded by Steve Richards, Australian aboriginal descendent) deals with the aftereffects of the stolen generation and other interferences. A pilot study to ascertain the consistent positive effect of this combination of modalities could bring peace and harmony to the future generations.

Aim: "To investigate the effect of exercise prescription in combination with holographic kinetics upon behaviour alteration".

Methods: pre – and post intervention: interview, questionnaire re behaviour, anger level and management, depression, cortisol levels. Intervention: exercise prescription, holographic kinetics, behavioural changes.

Results: to be recorded in the future.

Conclusions: The right approach leads to happier families and safety for all.

Keywords: Suicide Prevention; Domestic Violence Reduction; Exercise Prescription; Holographic Kinetics; Lifestyle Alteration; Happy Families