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David Pyne  David Pyne is a sports scientist in the Department of Physiology at the Australian Institute of Sport, Canberra, Australia. His primary interests are exercise and the immune system, environmental physiology, the applied physiology of swimming, and fitness and conditioning for team sports. He holds adjunct professor appointments at James Cook University, Cairns, Australia; the University of Canterbury; and Griffith University, Southport, Australia. He was Founding Editor of the International Journal of Sports Physiology and Performance from 2004-2009 and currently serves as an associate editor.

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Sandra Webb  Sandra Webb is a general practitioner and sports doctor based in Dunedin. She was team doctor for the Black Ferns from 2000-05, the 2002 Manchester Commonwealth Games and the Highlanders Super 15 rugby team from 2005 until 2011. A fellow of SNZM2 she also served as National Chairman from 2006-10. Her current interests include travel medicine and diving medicine.
Beyond the Rule Book

BRUCE HAMILTON

I recently stumbled across a copy of the June 23rd, 1969 issue of Sports Illustrated. Sports Illustrated (SI) is not usually considered an academic journal, although despite this, it is likely a truism that the annual swimsuit edition is carefully studied. First published (after a few failed attempts in the preceding years) in 1954, Sports Illustrated has become one of the world’s most recognisable and successful sporting magazines with a circulation of over 3 million. As an athlete, you know you have made it when you star on the cover of Sports Illustrated, in the company of Michael Jordan and the LA Lakers as the most regularly featured athletes. While these regularly featured athletes clearly suffered no ill effects of being on the cover of Sports Illustrated, not all athletes were so lucky, with many suffering from the so-called “Sports Illustrated cover jinx”. Likely (but possibly not) an urban myth, the cover jinx implies that subsequent to being featured on the cover of Sports Illustrated, athletes performances will be jinxed or suffer from bad luck. Indeed, as a case in point, two weeks before the particular issue that I discovered, defending US Open golf champion Lee Trevino was featured on the cover of SI and the build up to the 1969 US Open, only to miss the cut in the Championship. Proof indeed. An alternative explanation for the observations this myth is founded upon may be found in statistics, with athletes merely “regressing to the average”. Applying this explanation, after a series of outliers (exceptional performances, after which athletes are invariably featured on the SI cover), future performances will more likely reflect an individual athlete’s typical or average performance, thereby giving the appearance of being “jinxed”. Unusually for Sports Illustrated, the cover of the June 23, 1969 issue did not feature an athlete, but rather a strikingly colourful array of pills and potions, and was headlined “Drugs: A Threat to Sport” (Figure 1). Ironically, the back cover contained an attractive full page advertisement for “menthol fresh, filter cigarettes”, not so subtly implying that smoking that particular brand of death sticks is sexy, fresh and healthy. Notwithstanding what is now an obvious irony, the feature article inside highlighted doping issues that remain very relevant to 21st century sport.1 However, even in 1969, the threat of drugs to the integrity of sport was not a new issue, as the use of drugs in sport had been anxiously discussed for 40 years or more.2 For example, in 1928 the IAAF (then the “International Amateur Athletics Federation”) published one of the first (and perhaps the last where there was a unanimous agreement amongst all attendees) formal position statements on doping in sport, stating that “Doping is the use of any stimulant not normally employed to increase the power of action in athletic competition above the average”; and in 1965 a comprehensive “International Symposium on Doping in Sport” had taken place in Belgium.3 Of interest, but tangential to the principle purpose of this editorial (which I will get to eventually), the IAAF position in 1928 determined that identifying and penalising those found to be assisting athletes in doping, was as important as penalising the athletes themselves. Specifically, the IAAF identified that “Any person knowingly acting otherwise, or assisting shall be excluded from any place where these rules are in force”.4 This feature of anti-doping has been resurrected in the 2015 WADA Code (albeit in a slightly more expansive manner than the two paragraphs dedicated to anti-doping in 1928), an evolution of the anti-doping code with which all those working in sport should be familiar. Forty-six years after the publication of the June 23rd 1969 Sports Illustrated, it is unfortunate for us all that doping in sport has not moved from the “cover jinx”. No indeed. Rather than the SI cover of 1969 representing a series of outliers or rare events with a subsequent moderation in anti-doping behaviours, in 2015 it seems that just about every paper you open, every magazine you pick up and every TV channel flick you make, you will find a ‘doping’ or ‘anti-doping’ story breaking. The public shaming of Lance Armstrong seems a distant memory, replaced by the grandiosely titled “Sport’s Biggest Drug Scandal” referring to alleged doping infractions that occurred in the Australian Football League (I suspect that the title of this book from our Australian neighbours is a little misplaced given the history of doping around the world).5 Recently, further challenging questions have been asked of the great American athlete-turned-coach Alberto Salazar, regarding his performance enhancement techniques (for more details on this topic see editorial NZJS(5):7).6 In the immediate post-Armstrong cycling era, of 520 samples taken from cyclists during the 2014 Tour de France, 520 samples taken from cyclists during the 2014 Tour de France, the UCI formally announced that “there were no positive tests”. However, at the same time, an independent investigation commissioned by the UCI into drug use in elite cycling concluded that “doping is still taking place”, “a culture of doping in cycling continues to exist” and that “doctors play a key role in devising programmes that provide performance enhancement”.7 The World Anti-doping Agency (WADA) has (for the first time) published a summary of anti-doping rule violations (ADRVs), compiled from more than 200,000 athlete samples taken in 2013. From that immense sampling pool, 2540 athletes were initially reported as having adverse analytical findings, and 1687 (0.8%) were ultimately confirmed as ADRV’s (the difference between these two numbers results from athletes either being found to have valid TUE’s, categorised as “no case to answer”, being exonerated or represent case that are still pending).8 Perusal of the WADA website highlights that more than 350 international athletes are currently serving a suspension for drug related activities in track and field alone.9 New Zealand’s own anti-doping Tsar has suggested that in New Zealand, the anti-doping cause was “not helped by a culture of secrecy which is in some sports”.10 This brief rundown on recent anti-doping ‘highlights’, which merely scratches the surface of anti-doping incidents, makes for challenging reading for those involved, interested, or participating in all levels of sport. I admit to a morbid fascination with this topic and there is abundant verbiage out there to feed that fascination, but reading the available mainstream literature (and therefore by definition probably not having any idea of what is or was actually going on) surrounding both the “Salazar” and “Eisenbud’s sags” was at times a painful process. I was however, struck by an apparent similarity between underlying elements of the two sagas. Specifically, both episodes illustrate an apparent willingness from participants to apply the principle of “if it’s not explicitly against the rules, then its fine to do” along with actively seeking any ambiguity in the rules as a reasonable justification to “push the envelope”. It seems that in modern sport, an individual’s responsibility for sportman- (and woman-) ship has been relinquished, with the moral compass of modern sports being determined by a rule book, umpires or even lawyers, rather than internal sporting and moral principles.11 Brooding, ruminating or mulling over this is really beyond the scope of my medical skills, and I know that sport psychologists, sociologists, ethnics and others will likely be able to explain and rationalise this far more clearly than myself. However, when one considers the nature of elite sport in the modern world, it is clear that it faces challenges, and the abdication of moral responsibility is one of them. Traditionally, sport was considered a means to develop an individual’s character, resilience and health. However, participation in modern elite sport is now a career, whose fundamental modus operandi remains grounded in the amateur ethos of fair play and sportsmanship, but which exists within a larger entertainment industry whose fundamental principles are based not around fair play, but revenue generation. While it is obvious that the imperatives of elite sport (ie, success) and the amateur ethos (fair play, comradesry) are not always well aligned, participants in modern sport must remember that it is the historical features of sport, that provide it with much of its validity and integrity. Pragmatically, in this world of conflicting imperatives, it seems that it’s the willingness of athletes, coaches and support staff to abandon their individual responsibility for maintaining the integrity of their chosen sport, and rather to rely on others to determine and articulate the moral standards in the “rule-book”, that justifies their search for illegitimate means of success. That WADA address this issue in their rationale for inclusion of substances on the prohibited list is significant. By placing the “spirit of sport” on equal footing with “health” and “performance enhancement” when determining whether a substance or method should be on the prohibited list, WADA have recognised the importance of protecting the underlying ethics and ethics of sport. Indeed, while the vague nature of the description of the spirit of sport in the WADA Code frustrates some,12,13 I would contend that this is one of the most important and under-emphasised elements of the WADA Code. While elite sport is indeed entertainment for the masses, without an underlying and believable ethos of sportsmanship and fair play, the appeal of watching and engaging in elite sport (at least to me) is greatly reduced. Englishman John Mill (1806-1873) was considered one of the most influential political philosophers of the nineteenth century. Mill had strong views on individual liberties, believing that an individual ought to be free to do as he wishes - unless that individual harms others. No matter how you look at it, utilising performance enhancing drugs

Figure 1: Front cover of Sports Illustrated Magazine, June 23 1969.
in modern sport is not a victimless crime. As practitioners working in all fields of Sports Medicine, it is vital that we consider both the ethics of our chosen profession and the values of sport when working with athletes and coaches. Rather than being part of the doping problem, we have a key role in the prevention of doping, working with athletes, coaches, medical practitioners and all the other specialty areas that make modern sport work, to ensure the ethics and values of sport are recognised and applied. While WADA and the sporting federations provide an anti-doping framework and a rulebook for sport, this does not deflect responsibility from the individual to take a strong ethical position, in order to protect the underlying ethos of sport. We all have a role in protecting sport from the perils of doping, for as Mill said: “The only thing necessary for the triumph of evil is that good men [sic] do nothing”. Let’s all do something about protecting sport from dopers.

References


Modern youth sport: Too much? Too serious? Too organised? Too many injuries!

CHRIS WHATMAN

When did kids sport get so serious? Most of the kids I’ve met recently are playing multiple sports, training most days of the week and playing the rest. The good old days of playing one sport in winter and one in summer seem long gone and it all seems so serious! Boys as young as eight and nine point out “rep” players in the opposition that need targeting – I didn’t even know they had reps at that age and I’m The coach!

Recently I read about the selection of an under 12 New Zealand baseball team, 30 odd kids selected to play in the World Series in America later this year. Call me old fashioned but an under 12 national side just seems strange and a world series for 12 year olds – really? A quick look around other sports suggests that baseball is not alone and it seems your representative career can start very early these days. I recall when interviewing Laura Langman she mentioned that as a kid there was no “under 8s” and netball didn’t really become serious for her until secondary school – sounds far more sensible to me. It seems sport has got so serious that even the lawyers are getting involved when parents think their children have been unfairly omitted from a team – seems like a slippery slope!

I have seen efforts by some sports to tone things down a bit – mostly trying to get parents to behave on the side line. Local clubs I visit have been displaying signs stating things like “This is not the world cup”, “These are only kids”, “the referees are volunteers” – good stuff in my view but maybe sports need to do more.

Why should this concern those in sports medicine? Fairly simple and certainly not news to anyone - too much early specialisation/exposure in sport has been linked to increased risk of overuse injury – repetitive load accumulates and can lead to tissue breakdown. This isn’t a new concept, Scott Dye proposed the envelope of function for the knee in 1996 (the range of loads that can be applied without causing structural failure) theorising that even small magnitude loads if repeated enough would eventually cause problems.” The envelope of function describes a range of loading that is compatible with tissue homeostasis. Recent evidence suggests the best youth volleyball players are at greater risk of injury simply because they are involved in the game more and thus experience greater frequency of loading. How many of our young athletes are pushing beyond the bounds of their envelope of function? Do we really have a good understanding of what that envelope looks like and the consequences of pushing it too far? Physiotherapy colleagues have recently expressed concerns regarding young clients presenting with multiple overuse injuries due to excessive exposure to sport. Coaches have stories of teams playing and training on all days of the week leading into a national secondary school tournament. Irrespective of the increased injury risk my coaching colleagues in academia point out there is evidence this early exposure/specialisation in many sports isn’t the best/only way to achieve sporting success!

Unsurprisingly there have been many reports over recent times pointing out that while sport has many benefits for youth the risk of injury is a significant concern. Some authors are suggesting that ankle and knee injuries in youth can be linked to increased risk of osteoarthritis in later life which is obviously associated with significant public and personal cost. Osteoarthritis is considered a major contributor to reduced activity in later life and the subsequent increased risk of associated diseases and reduced quality of life.

Adding to the serious nature of youth sport is the advent of 1st team rugby and netball televised live on Sky Sport – great for the overseas talent scouts but maybe not so good for the young talent? If a team mate messed up playing 1st XV for the mighty Wellington College back in the day it wasn’t on display to the nation – different story today: What impact does this have around decisions to play a player who may or may not be fully fit? Recent evidence from America suggests significant numbers of youth athletes play down injuries so they can play on and many coaches report having been pressurised to play injured players – sounds like youth sport getting too serious to me.

So what to do? Seems the sports themselves have a responsibility to set up structures that allow children to undertake sport in a way that optimises player development and minimises the risk of injury. Educating parents would obviously also have to sit alongside this. Why not get rid of representative teams until secondary school at the earliest and encourage kids to play a variety of sports to develop a full range of movement skills? I don’t know much about nutrition but my young boys tell me I should have lots of different colours on my plate to ensure a healthy diet! I’d suggest lots of “colours” in sports participation in youth could have the same merits and many would agree. Perhaps there also needs to be time/ opportunities for kids who want to play but don’t want to sign up to a structured competition? Maybe they just want a bit of fun in a “pick-up” game with their mates – no time for that in the serious training and playing schedule of many youngsters these days!

References

there were two issues of BJSim in March. The first of these contained a number of articles from Physios in Sport (UK), the body responsible for compiling the foot. There is another journal. It included a provocative editorial by Jeremy Lewis, a New Zealand physiotherapist who has risen up the academic ranks in the UK and is based at the University of Hertfordshire, just north of London. Entitled ‘Blood letting for pneumonia, prolonged bed rest for back pain, is subacromial decompression another clinical illusion’, Lewis comments that there has been a huge increase in the number of surgical repairs of the rotator cuff performed in 2006 compared with a decade earlier. In particular, there has been a six-fold increase in the number of repairs performed arthroscopically. He comments that many physiotherapists have embraced the subacromial impingement syndrome model, where a forward head posture is associated with an increase in the thoracic kyphosis and with an imbalance of the shoulder girdle muscles. There is secondary anterior tilt and downward rotation of the scapula which, in turn, provokes impingement and rotator cuff pathology. However, this dogma has recently been challenged and an alternative theory suggests that the symptoms result from intrinsic failure of the rotator cuff tendon. Whatever the genesis of the problem, surgical procedures do not seem to have a dramatically superior outcome to non-operative treatment for rotator cuff impingement. Clinicians therefore face the challenge of translating the available research into clinical practice, particularly when this research is often conducted in populations that are not representative of their own clinical practice. In essence, Lewis recommends an appropriately conducted exercise programme rather than resorting to surgical management, as often do we. Later in the same issue was an article by Irene Davis and colleagues from the Medical School, entitled ‘The foot core system: a new paradigm for understanding intrinsic foot muscle function’. The authors propose that a concept of core stability, already well delineated for the lumbar spine region, could equally well be applied to the arch of the foot. There are four anatomical stabilisers, the four layers of plantar intrinsic muscles, and the global movers, which are those muscles which originate in the lower leg then insert on the foot. Irene and her co-authors expanded further their meetings in San Diego earlier this year and it certainly has some merit. I am sure you will hear more about this as time goes by.

Our own Bruce Hamilton and colleagues from various institutions, including those in Qatar and Spain, collaborated on a narrative review on the classification and grading of muscle injuries.1 This is a good overview, but it should be noted that the full version is only available in the online edition of the journal. [Editors note: its also available from the editor on request]

Later in the same issue was an article assessing the diagnostic accuracy of clinical tests for injury of the shoulder.2 Written by a group of Australian authors from Sydney, it evaluated the various tests and found that the inability to perform a single leg hop had the highest sensitivity at 89%, whereas specificity was highest for pain out of proportion to the apparent injury at 79%. Of the clinical tests, the squeezer test had the highest specificity at 98%, and the dorsiflexion external rotation stress test plus synovitis ligament tenderness had the highest sensitivity values. In essence, a combination of the sensitive and specific signs seems to provide the best diagnostic information to the clinician. This is a finding that has cropped up in frequent review articles relating to other body sites as well.

Issue 6, also published in March, had a range of articles put together by the Swiss Sports Physiotherapists Preventive Association. There was a thought provoking editorial by Adam Meakin entitled ‘Soft tissue sore spots of an unknown origin’. Generally known as trigger points, they were first described by Travell and Simons as tender, painful areas found in myofascial tissue when palpated.3 This theory has had widespread acceptance despite limited evidence put up in support. Meakin proposes that when clinicians are palpating trigger points they are actually experiencing the phenomena of ‘pareidolia’. This is defined as a vague and obscure stimulus that is perceived as something clear and distinct. Meakin’s studies suggest that the symptoms result from eccentric strengthening from randomised control tests. These authors suggest that decreased compliance with the strengthening regime is a key reason for the inconclusive evidence.4 They recommend exercise implementation should be applicable to the entire team so as to get buy in.

There are many physical examination tests for hip dysfunction, and Michael Reiman and colleagues have evaluated each of these in an excellent review article accompanied by illustrations.5 Tests evaluated include Trendelenburg’s sign, the Thomas test, flexion and internal rotation test, as well as various tests for gluteal tendinopathy, femoral fracture and adductor related pain. The authors found the anterior adductor test, performed when the patient is supine with both legs extended, to be the most diagnostic of the tests for sports related chronic groin pain. This paper is well worth reading, particularly for those clinicians who see a lot of hip and groin injuries, and for those clinicians involved in any training and examinations at diploma or fellowship level. High risk stress fractures in the lower leg include those affecting the anterior tibia, cortical navicular and base of the 5th metatarsal.6 The injury is frequently recommended for these injuries, and from Amsterdam evaluated 18 studies including two for the anterior tibia, eight for the navicular and eight for the 5th metatarsal.7 They found the quality of the evidence to be low and subjected to a high risk of bias. However, surgery for a navicular fracture provided an early return to sport, and for the 5th metatarsal surgery provided the best results.

Issue 9 of JOC supported issue and included a survey of the sports injuries and illnesses in the Sochi 2014 Olympic Winter Games.8 Overall, 12% of the athletes suffered at least one injury during the Games and 8% an illness. These data are similar to previous Olympic Games. Within individual disciplines there was significant variation, and athletes competing in alpine skiing comprised 49% of the athletes injured in Sochi compared with only 19% in Vancouver four years earlier. The Relative Energy Deficiency in Sport document released in 2014 attracted widespread comment and some criticism.9 In 2015 the authors have made some additions to the consensus statement and these are outlined in a four page article plus an appendix.10 This is well worth reading for anybody who deals with athletes in sports where energy balance is disturbed. Rugby is our national sport (some would say our national religion) and, hence, many New Zealanders have a vested interest in injuries relating to the rugby scrum. Trewartha and colleagues conducted a literature review of the injury and biomechanical perspectives on the rugby scrum.11 They found that the incidence of acute injury associated with scrumming is moderate but the risk of a serious injury is high. They suggest that emerging acknowledgement of the potential for scrumming to lead to premature degenerative change in the cervical spine. Certainly, this is a frequent observation by clinicians such as myself who have spent several decades in the field. Rugby is frequently promoted these days for its health benefits. What is the evidence for different sport disciplines? Oja and colleagues, mainly from Finland, reviewed 69 eligible studies across 26 different sport disciplines.12 They found that there was strong evidence that both running and football improve aerobic fitness and cardiovascular function, and that football reduced adiposity. There was conditional evidence that running and football improved metabolic fitness, adiposity and postural balance, and that football improved metabolic fitness, muscular performance, postural balance and cardiac function. Evidence for health benefits from other sports disciplines was less conclusive, however I am sure that sports other than running and football can provide health benefits. Absence of evidence is not the same thing as evidence of absence of an effect, and non-academics should not be hoodwinked. We should remember Hills causality criteria,13 and if something is biologically plausible this makes it much more likely to be true, even if we are still awaiting the statistical evidence for it.

It could well be described as the concussion issue and contained many useful articles on that subject. Prominent among these was a systematic review of concussion in rugby league. The authors, mainly from Australia, found that in comparison to other collision sports, research evaluating concussion in rugby league is limited.14 However, we see ample evidence of it occurring any week we care to watch televised NRL games. The ball carrier has been found to be at greater risk for concussion injury than tacklers. Not surprisingly, foul play was responsible for a significant proportion of concussion injuries (29% of all injuries, compared with 9% of injuries sustained in legal play).15 Jonathan Patricios and Michael Makdissi, two of the leading thinkers in concussion, have written an excellent article entitled ‘50 Shades of Gray: concussion complexities and constructive conclusions’.16 They recognise the clinical complexity and variation of the condition, but it is important to get simple messages across to the public, that 0% recognition, remove and refer is chief among them. The long term risks of a concussion remain poorly understood and often speculative. This provides ample opportunity for scaremongers in the media to have a field day. We need to keep plugging away with the information we do have and explain that, like other injuries, there is a spectrum of pathology and therefore the advice will vary depending on the individual circumstances.

Dizziness is a frequent symptom after sports related concussion. Jennifer Reneker and Chad Cook, both from the US, provide useful guidance on possible treatment to hasten recovery from this symptom.17 They describe the usefulness of vestibular rehabilitation techniques for the treatment of central and peripheral causes of dizziness in non-concussed patients. They believe that there is a case for extending this treatment to concussed athletes with persistent symptoms of dizziness. All those years ago in my undergraduate teaching, I recall that the complex and dense interplay of the upper cervical segment is an anatomical phenomenon. The sensory processing required to hold head position and movement is not fully understood, and dysfunction of the cervical spine frequently accompanies head injury. Mismatches in sensory information from an injured cervical segment, motor response and control, and dizziness ensures. These authors make a good case for active treatment of this symptom early in the course of recovery, allied with ongoing research. They promote the concept of ‘cervicogenic dizziness’ and recognise that there is a need for this message to penetrate the medical school curriculum, as well as continuing medical education sessions. As always, further research is required until this data emerges, it is quite likely that the rest paradigm will retain its position as the fall-back treatment of choice. Issue 9 from May could be entitled the FIFA issue. It presents articles on football for health and describes 20 years of the FIFA Medical Assessment and Research Centre. Edited by Jiri Dvorak and Astrid Jung, it outlines the progress made by FIFA in promoting preventive strategies such as the FIFA 11 for Health, efforts made to improve cardiac screening, and reducing long term health issues such as cardiovascular disease. 18 Tony Edwards and Mark Fulcher have had significant roles in the best of british
regardless of whether they took the field or a football match, and up to one-third of all (NSAIDs) are widely used by athletes. An Non-steroidal anti-inflammatory drugs density. When these benefits are combined function. It also lowers total body fat, by 7-8mmHg and 5-7mmHg respectively, lower systolic and diastolic blood pressure that recreational football training can to treat the injured plantar fascia. This NSAIDs seem to result in serious outcomes football. Despite the many theoretical risks, and Bangsbo and colleagues explore the have been doing over the past 20 years. Therefore, I feel somewhat vindicated when the more important side of the thing is to bear in mind that each episode of republished research from the British issue could well be called the groin pain in this issue entitled ‘The right vertebral following prolonged endurance exercise: are we looking at the more important side of the heart?’ Adriano Elliott and Andre la Gerche performed an analysis of 14 studies with 329 participants. They found that prolonged exercise is associated with a measurable reduction in right vertebral function, whilst left vertebral function is relatively unaffected. They comment that the short term consequences of transient right vertebral dysfunction require assessment. Transient right vertebral dysfunction could impact on cardiac performance during repeated exercise bouts. The final issue I analysed for this journal issue could well be called the groin pain issue. It included a summary of the Deba Agreement Meeting on terminology and definitions on groin pain in athletes. This consensus statement brought together leading thinkers from around the world and a significant proportion of these people have spoken at our annual conference over recent years. They agreed on three major subheadings of groin pain in athletes: these include ‘muscle’, e.g. adductor related, iliopsoas related, inguinal related and pubic related, as opposed to ‘hip joint related’, the second subheading. Causes that do not fit into either of these two major categories were listed in a third category entitled ‘other’. The definitions and terminology are based on history and physical examination, making it simple and suitable for both clinical practice and research. The article provides an excellent table, with headings familiar to those who regularly consult Bruker and Khan’s textbook, ‘common ‘other musculoskeletal causes’ and ‘not to be missed causes’. In the same issue there was an article entitled ‘Minimal reporting standards for clinical research on groin pain in athletes’ and this is essential reading for any would-be researchers in the area.22 Later in the same issue there was an interesting article entitled ‘Femoroacetabular impingement surgery: are we moving too fast and too far beyond the evidence’? Michael Reiman and Kristian Thorborg argue that whilst there has been an exponential rise in surgery for FAI in the past 10 years, there has been no such exponential rise in the strength of evidence supporting such treatment. They contended that FAI morphology does not equal pathology and recommend greater scrutiny on reported outcomes for each method of treatment. As a non-surgeon who reads reports from this side and the other side of the Tasman, I tend to think that there are more than a few people on the western side of the ditch who are being managed by knee knives that may not be necessary its treatment. Only time will tell. This article wins my vote for the most influential article in the last few months as it challenges our traditional thinking, and this is an essential feature of prospective practice. I applaud clinicians that treat patients with hip pain should read it and draw their own conclusions. References

An Interview with Dr Lynne Coleman
Sports Doctor
Member of the New Zealand Order of Merit - 29 June 2015

INTRODUCTION
As part of the 2015 Queen’s Birthday Honours List, Dr Lynne Coleman was recently made a ‘Member of the New Zealand Order of Merit’ for her services as a Sports Doctor. This is an incredible achievement for Lynne, and is fantastic for a Sports Doctor in NZ to be acknowledged in this way. Lynne has made an immense contribution to Sports Medicine in NZ as was summarised as part of her Citation:

Dr Lynne Coleman is a sports doctor for high performance athletes in New Zealand. Dr Coleman gained her medical degree in 1984 and a Postgraduate Diploma in Sports Medicine (DipOM) in 2001 while working full-time as a General Practitioner. Since 2004 she has been involved in, and led the medical team for the New Zealand Olympic and Commonwealth Games teams. At the same time, she has also served as medical director for Swimming New Zealand, Athletics New Zealand and Basketball New Zealand and as team doctor for a number of our national men’s and women’s sports teams including New Zealand Rugby Union teams. She has been a Member of the Sports Tribunal of New Zealand since 2008, a body which considers anti-doping violations; was an elected member of the Wataimetata District Health Board from 2001 to 2010; and has volunteered her time to the regional sports Trust on the North Shore (Harbour Sport) since 2006. Dr Coleman is widely regarded and respected within the sector for her long-standing commitment to New Zealand high-performance sport through her work as a sports physician.

I have been lucky enough to have the opportunity to speak with Lynne about elements of her career in Sports Medicine.

When you were studying as an undergraduate, did you see yourself working in sports medicine?
Not as an undergraduate. Sports medicine was not a realistic option for me then, as at the time you needed to travel to the UK to get any type of qualification, and as I was newly married and ready to embark on starting a family this was not an option.

What inspired you to work in sports medicine?
I have always loved sport. I was brought up in a very sporting family, played tennis and netball at a reasonable level and continued to participate through medical school in teams until I was a Trainer Intern.

I decided to move into sports medicine after moving out of my obstetric career. I began working with my local rugby club and loved the work. I also helped with my children’s various sports teams and found myself assisting with injuries and advising parents and children alike. I decided I wanted to work in an area with relatively healthy people striving to live healthily and keen to test themselves in the sporting arena. I also fundamentally believe in the benefits of healthy eating and healthy living and the benefits of exercise participation for both physical health and mental wellbeing.

What are some of your highlights from working in sports medicine?
There are so many that come to mind really. I feel incredibly honoured to have led the NZ Health Team and worked with people such as Dave Carrie (CDOM) to build a sense of team around our elite athletes. It has been very inspiring. I have also enjoyed being part of World Championship winning campaigns with Women’s Rugby in 2016 and the U20 men’s team this year.

I took special enjoyment in Moss Burmester winning gold in Melbourne 2016 in 200 m butterfly – as I had worked with him for a long time and this was just reward to his endeavour. Watching Sarah Ulmer and her gold medal performance in Athens 2004 – another stand out performance by a very special athlete. I have been incredibly lucky to have witnessed some phenomenal sporting triumphs.

What have been your low lights of working in sports medicine?
Low lights... fortunately few and far between. I guess the disappointment in Mahe Drysdale in Beijing when he got sick and was not able to participate in his event to the best of his unaided ability. Whilst it was a low light, the very fact he did in fact compete at all was a credit to him and the multi-disciplinary support team around him. The only other aspect I would like to acknowledge is the time my family has had to have without me, and me them. I love being involved, but it does come with personal sacrifice and I could not have done it all without their loving support of me.

What do you see as your strengths working in sports medicine, and what are your areas of particular expertise/interest?
I believe my strengths draw from my generalist training and experience. The way I investigate and work through issues with my athletes, I try and take a truly holistic approach. I believe the years of experience in general practice grounds me with exposure to many different conditions and issues, and diagnostic ability is honed through these years – I bring all this to my sports medicine. I have a particular interest and strength in women’s and adolescent health, and am very interested in the psychological stressors within elite high performance sport. I believe my generalist background assists me in working in team with my other multi-disciplinary colleagues.

How do you see the relationship between and relative roles of sports physicians and sports doctors/general practitioners with an interest?
I believe they are complementary on many levels. True, there is overlap, but I believe the athletes all benefit by having both types of practitioner available to them. It is not unlike midwives and GP obstetricians, both are very capable but the two skills sets together cover so much more. I would be sorry to see the loss of generalist skills to the wider sports medicine community, so I hope my journey inspires new interest amongst my generalist colleagues.

What do you consider to be key areas in exercise and health that sports medicine practitioners should be influencing both with individual patients and in national/ regional policy?
Living an active lifestyle must be a national policy. We know the undoubted benefits of this and whilst we cannot all be elite athletes, we can be inspired to be healthy by these people and reap many of the physical and mental health benefits of exercise and healthy eating. This is another reason I would encourage young generalist doctors to perform postgraduate training in sports medicine. The fundamental principles taught in Sports Medicine add to your skill set in primary care setting, regardless of whether you work formally in a sport or with a team.

What would you like to see more of in undergraduate medical training?
Exposure to multidisciplinary teams and how the roles of nutrition, physical therapy, sports and exercise science and other paramedical disciplines can assist clinicians in our role of promoting health and wellness. I believe we have a responsibility to preventative medicine, as well has diagnosis and treatment. I believe we need to be emphasising wellness and maintenance of wellness, rather than being ’ambulances at the bottom of the cliff’ Taking this approach will be the main modifier of illness and disease in the future.

What advice would you give to an undergraduate or junior doctor with an interest in sports medicine?
I would encourage them to get as much exposure to a generalist sense as possible rather than focus into Sport Medicine at too early a stage. I would encourage them to get involved in their local sports clubs/teams as a junior doctor and to learn and understand the role of medicine in sport at the grassroots level. Being involved at all levels of sport makes you appreciate the ‘power and influence’ sport has in a Nation such as NZ. I have some concerns that there will not be enough full time roles for pure Sports Medicine doctors here in NZ, hence my comments around considering Sports Medicine as an adjunct to your medical career path.

What do you see as critical elements of a success when working in sports medicine? Athletes validating the work you do with them. In the end it is always about them. If they appreciate your work, as well as the wider support team – coaching staff, performance staff – appreciate your timely intervention and thus hopefully the optimal return to play and availability of players for team selection – then we are definitely doing our job.

First and foremost ‘do not harm’ is really relevant too. Timely non-intervention is also a skill, and being able to step back from the emotional ‘heat’ of a situation and do the ‘right’ thing is critical. Often it is about the relationships you have with people and mutual respect for everyone’s position in any given situation, and ultimately everyone doing the very best you can in any given situation.

If you were not working as a doctor, what would you like to do?
Interesting question. I am quite a creative person, and I have often wondered if Architecture would have been good fit for me. That said, with my fascination for the human body and mind, in the end I do feel my career choice has been the right one for me.
INTRODUCTION

A s part of the 2015 Queen’s Birthday Honours List, HPSNZ Lead Performance Nutritionist Jeni Pearce was recently made a “Member of the New Zealand Order of Merit” for services to Sports Nutrition.

This is an incredible achievement for Jeni, and is great that her contribution to Sports Nutrition in NZ can be acknowledged in this way.

Jeni has made an immense contribution to Sports Nutrition in NZ, and around the world, as was summarised as part of her Citation:

Ms Jeni Pearce has contributed to sports nutrition for 30 years and is a recognised pioneer and world leader in the field.

Ms Pearce ran her own private clinics for more than 22 years, during which time she was the nutrition representative for the Sports Medicine New Zealand Conference Scientific Committee and other sports nutrition bodies. She has worked pro bono with high performance athletes and teams including for the Olympic and Commonwealth Games since 1985, and as a consultant for international events, teams and athletes and the New Zealand Defence Department. From 2010 to 2012 she was head of performance nutrition for the English Institute of Sport and British Olympic Medical Institute

Interview

Member of the New Zealand Order of Merit - 26 June 2015

BRUCE HAMILTON

Hearing alongside Jeni for many years, I have managed to coalesce her into this interview and talking about her career in sports nutrition.

How did you get into sports nutrition at a time that sports nutrition barely existed and what inspired you?

I was always keen on a range of sports at secondary school and made a number of local and regional teams for basketball and cricket as well as running. At the same time I was interested in food, nutrition and science, especially biology and chemistry. All I knew on entering Otago University was I wanted to work with food and people and did not wish to become a chef or laboratory scientist. At the end of my first year I asked to combine my ‘Home Science’ degree with the physical education programme and was told I would have to stay another 3 years depressingly, food was not a major part of my classes being the same. Playing sport in Dunedin at Otago University established a link for me between exercise and nutrition. My time as a clinical dietitian at Tauranga hospital forged the move to sports nutrition. At the time I was performing an enormous amount of training, typically running 5-8 km in the morning, swimming at lunch, gym workouts after work, while biking to and back to the hospital each day and doing long runs on the weekends around the beaches. I was also trying to experiment with weight lifting and body building. As a result, I was tired all the time but also realised that the hospital environment was not for me, as I felt the loss of patients terribly, especially the children. I worked with suffering from terminal diseases. This was when I applied to Iowa State University, on a scholarship with Otago University to study nutrition education/sports nutrition.

What was it like trying to get started in sports nutrition?

After completing my undergraduate degree at Otago, I was accepted into the Auckland secondary teaching programme and trained as a secondary teacher for chemistry, biology, physical education and home economics, which taught me about communication and knowledge sharing, but more importantly that working full time in educational institutions was not the ideal environment for me. Fortunately, I was then accepted into the dietetics programme at Christchurch hospital (an intensive one year internship and exams) at a time when having two career paths was uncommon and responded to the many challenges to graduated prior to starting work in a provincial hospital.

Jumping in feet first, after a quick look and scooping out obstacles, is part of my life philosophy – how bad can it be, and what’s the worst that would happen? And if it does work out what would the rewards look like?

Applying for the ISU scholarship in the USA was based along this line of thinking. At least they will know I am interested in further study at a time when diettitians with postgraduate degrees were uncommon. Living and studying in the USA gave me the confidence, courage and conviction to start private practice in NZ on my return, but it took three years for two nutrition concepts to come together: a self-sustaining business in private practice as a diettitian (where people would actually pay to come and seek my advice and support) and the specialist area of private practice (athletes, coaches and teams would seek out and pay for my advice). I was told on a number of occasions I would go broke in a week or a month. Fortunately, at the time some key members of SMNZ were incredibly supportive and invited me to join their organisation: Dr Noel Roydhouse, Dr Matt Marshall, Dr David Gerrard and Dr Chris Milne. These mentors continued to encourage and support my burgeoning career path, as well as to help athletes to seek support in sports nutrition.

Is it true that you have written recipe books?

I have written 12 books to date, of which the 7 books were practical and healthy with a focus on sport and making (the theory real) and including “The Active Kids Cookbook“. All have focused on the positive aspects of what can be done to change or improve nutritional intake for the active person. Ent to Compete, released in 1990, was the first and took 2 years to write!

I have also had recipes published in several other books (mostly for charity publications) and made contributions to sports nutrition textbooks in the area of Gut health and supplements. Due to my role at HPSNZ there is currently little time for book writing however there may be one last publication before I retire.

Editor Note: Jeni’s books have sold over 150,000 copies, with “Eat to Compete” having 7 reprints.

How has nutrition evolved over the last 20 years?

I have witnessed decades of trends and profound issues in sports nutrition science including:

• the move from sports drinks and CHO loading in the 1970-80’s
• high fibre eating and the low CHO high protein diets in the 1990’s (complete with the development of protein drinks such as Complan and Isostim)
• 21st century periodisation nutrition and critical review of CHO intake based on training and performance
• the use of creatine and supplementation (creatine, omega 3)
• the more recent evolution of whey protein and chocolate milk and a strong food focus and
• the influence of the microbiome (biota from gut faecal transplants) and the role and use of

Sports and performance nutrition will constantly be evolving as the depth and breadth of knowledge is increasing and developments in research fine tunes our knowledge.

You have led the way in trying to refine the title of nutritionists working with elite athletes to “Performance Nutrition” – why is that?

The term ‘sports nutrition’ has been used to cover a range of activities including the very general eating of health and activity practices right through to the elite athlete. There has been a concern that some nutrition messages that are designed for specific situations/ environments and sports have been translated directly into the gym or recreational areas, where they are not relevant or appropriate. The use and abuse of supplements (particularly whey protein and creatine) and sports foods like protein bars fit into this category. The term ‘Performance Nutrition’ has been used to more clearly define working at the elite end of sport. As such, at times the work is not necessarily about health and is very focused on performance outcome (weight making on sports such as light weight rowing, and other weight class sports are key examples where the athlete cannot compete unless they meet the weight criteria). A performance nutritionist has 6 key skill areas including:

1. strong knowledge of evidence based sports and exercise science
2. clinical nutrition skill set
3. catering expertise
4. in depth background in food science
5. high level communication and behavioural skills
6. an ability to be applied and practical

Do you see a conflict between health and elite performance, when it comes to nutrition advice?

Yes, but only for short or specific periods of time. For example, there is a real concern around energy availability, RED-S (Relative Energy Deficient in Sport) and performance. If athletes are required to alter body composition to extreme levels for performance this should be done for the shortest time possible and with careful follow up and multidisciplinary support. Athletes should then return to a more desirable body composition for health and training as soon as possible. At HPSNZ and with other most institute programmes we are privileged to work in teams. In Performance Nutrition we are privileged to work on an individual level with the coach, the athlete and the supporting sports science and medical teams. This is often not the case in many other environments outside of institutes and professional sport.

What are some of your highlights from working in Sports Nutrition?

Formula 1 motor racing (being an accredited pit crew member for a week), Americas Cup (watching the start of the race 800 m above the start line in a helicopter), travelling the world with the Whitedeer Sailing races and developing an international expertise in freeze dried food and packaging, working with young players and athletes and seeing their careers become dynamic and highly successful, seeing seasoned athletes reach their goals and winning Olympic Medals, the incredible coaches and thoughtful athletes over the years who have expanded my knowledge and application of the science, and those who continue to challenge and seek nutrition to benefit and impact performance.

Each sport has its own unique highlights and it’s also the experts you work along the way (boat builders, sail makers, researchers, food scientist) with whom you get to expand your knowledge and appreciation of the privileged environment we work in. In being involved in developing and growing the discipline of Performance Nutrition both locally and internationally and having Sports Nutrition acknowledged as a sustainable career path, has been a real highlight.

If you were not working as a Performance Nutritionist, what would you like to do?

Be a food and travel critic and reporter travelling the world with a Christmas shop on the side.

Thanks!
Self-reported sun protection strategies among Australian surfers: Are they heeding the message?

RUDI A MEIR, SHI ZOUH, MARGARET I ROLFE, WENDY L GILLEARD, ROSANNE A COUTTS

ABSTRACT

Aim
To establish the current sun protection strategies of Australian surfers and the incidence of medically diagnosed skin cancer in the 12 month period preceding data collection.

Study Design
Diagnosed skin cancer and skin lesions were recorded via online questionnaire. Participants: 685 self-selected surfers (mean 31.7 ± 12.9 y) participated in this research.

Methods
This research involved a retrospective survey of self-selected surfers completing an online survey that had specific questions related to sun protection strategies while surfing and whether respondents had been treated by a medical practitioner for a skin cancer or lesion and the site on the body where this was located.

Results
19.1% of respondents reported ‘never’ using suncreen/zinc on any sun exposed areas of the skin during the summer months with this figure rising to 46.8% in the winter months. Less than 4% reported wearing a surf cap in summer or winter. A total of 224 separate skin cancers/lesions were reported. 50% of all reported skin cancers/lesions were identified on the upper body with the face being the most common location overall (21.9%). This equates to a mean rate of occurrence of 9.1 skin cancers/lesions per 1000 hours surfed.

Conclusion
In spite of the significant investment and effort devoted to promoting appropriate forms of skin protection, survey responses indicate that surfers do not appear to be embracing the public health strategies related to sun protection.

Keywords
Ultraviolet radiation, skin cancer, surfing.

Introduction
Surfing is a sport enjoyed by millions of participants around the world with countries such as Australia and New Zealand having surf organisations as surf meccas. As an activity surfers challenge the body in a number of ways that place demands on a participants’ balance, coordination, cardiovascular fitness, muscular endurance, strength and power.1,2 Recent unpublished research has reported that surfers can typically spend between 1.2-5 hours in the water on each occasion they surf, with sessions lasting longer than 3 hours not unusual.3 Surf participation can result in a wide range of injuries caused by the equipment used (eg, being struck by a surfboard), striking the sea floor (eg, reefs, rocks, sand), impacting with the water (eg, wiping out and landing awkwardly) or resulting from the physical movements involved while riding a wave (eg, placing the knee under excessive valgus medial stress when landing).3 In addition to injuries associated directly from participation in surfing there is also the constant presence of potential marine based hazards (eg, being stung and bitten) and possible death from drowning or shark attack. While there has been published research on the types of injuries sustained during surfing7,8,9 and associated injury rates10,11,12 little attention has been focused on the possible consequences of the long hours of sun exposure while participating in this activity. Excessive sun exposure is considered a major factor that relates to skin cancer rates.8 The Australian Cancer Council estimates that annually approximately 1 million Australians are diagnosed with non-melanoma skin cancers with over 434,000 of these treated for one or more non-melanoma skin cancers with 95-99% of these caused by sun exposure. Risk factors associated with skin cancer include genetics and immunity but the most important risk factor, for both non-melanoma and melanoma skin cancer, is UV radiation (UVR).5,7 Melanoma is the third most common cancer in Australia with mortality rates increasing with proximity to the equator.5 The World Health Organisation estimates that each year more than 2 million skin cancers are diagnosed and while there are numerous types of skin cancer the three most common forms are basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and melanoma.20

According to Morthie27 outdoor athletes exposed to UVR are probably at higher risk of skin cancer with repeated UV exposure1-3. A exposure leading to photodamage which potentiates the effects of UVR on skin cancer formation. Research by Rosso et al.14 has suggested SCC risk is significantly associated with sun exposure during outdoor work, with BCC more likely linked with recreational sun exposure. Outdoor work exposes the individual to a more constant type of sun exposure throughout the year, with varying levels of solar irradiation, while recreational exposure is more intermittent. The former allows for some natural skin protection to develop through tanning and thickening of the external skin layers while the latter does not provide the opportunity for this same degree of natural skin protection to build up.15

Research14-19 has concluded that relatively low levels of sun exposure are enough to develop BCC whereas SCC is more likely to develop in those exposed to higher doses of solar irradiation over an extended period of time, ie, chronic UV exposure. Further, exposure to UV radiation at a young age plays a role in the development of both BCC and melanoma later in life, with the risk increasing if there has been a history of one or more sunburns in childhood or adolescence.18 Skin colour and ethnicity is also a significant factor with those of light colour being 80 times more likely to develop BCC and SCC, and 20 times more likely to develop melanoma than those of African American decent.19 Since 1980 Australians have been exposed to a range of public health campaigns designed to encourage behaviour change, increase awareness of skin cancer prevention and associated strategies. These strategies have included the use of mass media communications and intervention/education campaigns targeting schools, the workplace and community and leisure centres.20 These campaigns initially revolved around the slogan ‘Slop’/‘Slap’/‘Slap’ and while state based were soon to evolve into a national campaign under the SunSmart branding of Cancer Council Australia (www.sunsmart.com.au). While there is evidence that Australians across all age groups are using sunscreens as a sun protection strategy it is not forming part of a multi-faceted protection strategy (ie, seeking shade, avoiding the sun, particularly in the hotter times of the day, wearing protective clothing and eyewear, and using sunscreen for exposed areas of the skin) as recommended by health authorities.15 There is evidence that mortality from melanoma has stabilised in recent years in Australia, despite a rise in detection rates, and this might be attributed to a combination of early detection and treatment.21 Further, the SunSmart programme and its associated strategies appear to have improved sun protection behaviours and reduced sunburn up until the late 1990s. However, these improvements experienced a lapse from the late 1990s up to 2003-2004 but have now returned to more favourable peak levels reported in 1994-1995.22

Given the above, information on the current sun protection practices of Australian surfers and their self-reported rates of skin cancer may help to shed light on the current skin protection strategies being adopted by this at risk group. To this end this study investigated the current sun protection practices of surfers and their self-reported rates of skin cancer and treatment by a medical practitioner in the twelve months immediately preceding this study.

Methods
Study Design and Participants
This research used a retrospective, self-reporting web-based (online) questionnaire administered to a self-selected sample of surfers residing in Australia. The questions relating to sun protection strategies and reported skin cancer formed part of a larger survey instrument that was used to assess the prevalence and types of injuries sustained by surfers, the results of which have been reported separately. Potential respondents to this survey were advised of its availability via a range of online surf industry sources. However, the principal source of these was the project’s industry partner, Surfing Australia, who, in addition to distributing notification directly to its membership by email, also provided a “news” story and link on the homepage of its corporate web site. Additional media releases were distributed to general electronic and print media outlets and surf specific publications promoting this research and inviting interested surfers to consider participating.

The survey used a combination of “yes/no”, checklist and simple open response questions. The first 4 pages presented information related to the rationale for the research, ethics approval (institutional ethics approval number ECN-09-140) and consent, and tips on how to complete and submit the survey. The remaining 10 pages of the survey contained a number of categories of questions but the ones directly related to this current analysis were related to:

i Average time spent in the water when surfing – categories were broken down to identify time of year, ie, winter or summer

ii The sun protection strategies used by respondents when surfing – these were use of sunscreen/zinc, wearing a rash vest (or wetsuit) or surf cap

iii The sun protection strategies used when outdoors but not surfing, and their daily occupation/activity - these were wearing a singlet or shirt/shirt, wearing a wide brimmed hat, seeking shade, wearing sunglasses, whether they were predominantly indoors or outdoors

iv Whether respondents have been treated by a medical practitioner in the past 12 months for a skin cancer or lesion and the site on the body where this was located

A descriptive analysis was employed to summarise and present the results of each question utilising SPSS (IBM SPSS Statistics, ver. 18.0). Categorical data was summarised with numbers and percentages, and continuous data with means, medians and standard deviations. Where appropriate chi-squared was utilised to test association and student t-tests were used to examine bivariate relationships of categorical and continuous variables respectively, particularly in examining gender differences. Logistic regression was used to examine the relationship of having skin cancers (Yes/No) with surf craft type before and after adjusting for age and years surfed. An alpha level of p ≤ 0.05 (95% test of significance) was used for all statistical comparisons. All data were
RESULTS
A total of 772 participants responded in the survey. However, some respondents did not complete all questions. For a total of 87 participants, the amount of missing data was significant and therefore not included. On this basis descriptive analyses were based on 685 respondents who completed the survey fully. Table 1 provides a summary of respondents by age category and gender. The overall mean (±SD) age of respondents was 31.7 ± 12.9 (range = 12-87) years, with a median of 30 years. The age of the male and female participants were very similar, with a mean age 31.9 ± 12.9 and 29.7 ± 12.2 years respectively. The majority of respondents (71.3%) typically described themselves as “recreational surfers”. Unsurprisingly, the majority (71.3%) lived along the eastern seaboard of Australia with the remainder being “indoors”, “outdoors” or a combination in other states and territories.

The average number of hours per week surfed by respondents in summer was 10.9 ± 8.50 and in winter was 8.3 ± 6.98. Respondents indicated that they typically surfed for between 1 to 2.5 hours on each occasion. However, a number of respondents (19.6%) indicated that they typically surfed for longer than this with sessions lasting a minimum of 2.5 hours. Respondents were asked about their occupation and how they would describe their work environment (e.g. indoors or outdoors). A total of 617 surfers responded to this question with 277 (44.9%), 72 (11.7%) and 268 (43.4%) indicating that they would generally describe their occupation/daily activity as being one that involved them being “indoors”, “outdoors” or a combination of both respectively.

Table 2 details the types of sun protection strategies being employed in the warmer (October to March) and cooler months (April to September) by respondents when surfing. From these results we can see that 64% (n = 395 of 617) of respondents “always” or “most of the time” applied sunscreen/sun protective clothing to all exposed areas of skin when surfing in the warmer months with 19.1% (n = 118 of 617) reporting that they used no sunscreen at all in the warmer months. Similarly, the use of strategies such as the wearing of rash vests (short or long sleeved) and surf caps was less popular among respondents in the warmer months. The rates of sunscreen/zinc use on the nose, face and neck, and for all exposed areas of the skin in the cooler months was approximately half of that reported in the warmer months.

When not surfing but outdoors working or for some other form of recreational/relaxation activity during the daytime, the most popular forms of sun protection reported by respondents were wearing a shirt (“most of the time” or “always” = 481 of 617, 77.9%) and/or sunglasses (“most of the time” or “always” = 455 of 617, 73.7%).

The option of wearing a wide brimmed hat was the least popular, with 77.5% (n = 678 of 617) of respondents indicating that they either “never” or only “sometimes” used this strategy.

A total of 90 respondents (14.6%) of the 617 answering this question reported that they had been treated by a medical practitioner for a skin cancer or lesion in the 12 months immediately prior to completing the survey. Of these, 3 respondents were diagnosed with melanoma and 6 as having a BCC. A total of 224 separate skin cancers/lesions were reported, indicating that some respondents had more than one for the period. Table 3 provides a summary of these by age and frequency. The most common site category was the upper body (from below the neck to above hips) with 50% (n = 112) of all reported skin cancers/lesions. However, the most common location for skin cancers/lesions was the face with 21.9% (n = 49 of 224 report skin cancers/lesions) of all reported skin cancers/lesions (see Table 4). This equates to a mean rate of occurrence across all respondents answering “yes” to this question of 9.1 (median = 4.8) skin cancers/lesions per 1000 hours surfed in the 12 month reporting period. Statistically (p < 0.05) chi-squared analysis established that there were no differences between the reported frequency of skin cancers between males and females (p = 0.87). Similarly, t-test established that there were no differences between males and females with respect to the hours spent surfing per week (warmer months p = 0.17; cooler months p = 0.97). However, when all respondents were combined, chi-squared analysis established that there was a significant effect of age (p < 0.01), with a higher rate of skin cancer reported within the identified age categories with advancing years (i.e. 12-19 yrs = 3.3%; 20-29 yrs = 4.8%; 30-39 yrs = 12.4%; 40-49 yrs = 29.8%; and 50 yrs and over = 39.2%).

There was a significant association (Chi-square test) between total years surfed and higher rates of reported skin cancer (p < 0.01) among respondents who had been surfing for more than 4 years (10-20 years = 10.1%, 21-30 years = 9.9% and ≥ 30 years = 36%) compared with those who did not report a skin cancer and on average had less total years surfing (mean = 6.5 yrs, ±1.3 comparison). Chi-square test of association indicated that type of craft surfed (p < 0.05) was also associated to a higher percentage rate of reported skin cancers. In the 12 month period immediately prior to the survey, Bodyboard riders reported the lowest incidence of skin cancer (8.3%), followed by short board riders (12.6%), with Malibu riders reporting the highest rates (28.0%) of skin cancer. However, this was mitigated when adjusted for the number of years surfed (using logistic regression) indicating no difference in type of craft.

DISCUSSION
The sun protection strategies and self-reported rates of reported skin cancer leading to medical intervention among Australian surfers have not been previously documented. In this study a total of 90 (14.7%; n = 617) respondents had been treated by their doctor for a skin cancer or lesion in the 12 months immediately preceding participation in the survey; this equated to approximately 1 in 7 surfers being diagnosed in the 12 month reporting period. The face was the most common (21.9%; n = 49) location for these skin cancers/lesions. Age was a significant contributor to the reported rates of skin cancer, indicating the link between total exposure and the likelihood of sun cancer developing that requires treatment with advancing years.13,18 This is also supported by evidence that the total years surfed leads to higher rates of reported skin cancer. Previous research19 involving Australian cricketers has suggested that as cricketers age they are more likely to have had a skin cancer. However, as with the current study involving surfers, it is not clear whether...
they were a shirt to protect themselves from the sun and almost 75% indicated that they wore sunglasses ‘most of the time’ or ‘always’. One possible strategy to increase the use of sun protection strategies among high-risk populations (i.e. those experiencing increased UV exposure) among surfers, could be more targeted education campaigns. Further, primary care providers should consider screening patients that are known to surf (or participate in outdoor vocational and recreational activities) when they attend clinics for other unrelated medical reasons.

This study has several limitations that should be acknowledged and considered when interpreting the results. Not everyone has access to the Internet and it may also be that those who respond via this medium may or may not differ from those who did not have access to the survey via the Internet. In addition, as with all retrospective research involving the self-reporting of information, the authors were relying on the honesty and ability of respondents to recall their information accurately in the preceding 12 month period. It also assumed that all respondents had the requisite literacy skills to understand and comprehend what was being asked in the survey.

CONCLUSION
Surfing is a popular sport in both Australia and New Zealand. By its very nature the sport has numerous inherent dangers associated with participation. Not least of these, this study demonstrates, is that surfers are at an increased risk of skin cancer. This is not unexpected given the nature of the sport and its environment. Further, this study indicates that using a fragmented approach to sun protection while surfing is likely to see this population continue to be at risk of sun damage, resulting in an increasing incidence of skin cancer with age and years surfed. Medical practitioners can play an important education and prevention role by screening those patients that are known to surf and/or participate in outdoor vocational and recreational activities. In addition, a more targeted approach (e.g. through specific public health and media campaigns) to education and increasing awareness may also help to improve the adherence to a multi-faceted protection strategy that better protects participants of this sport from the harmful effects of the sun.

What this study adds:
• Australian surfers spend approximately 11 hours per week surfing in summer with the time spent in the water per surfer of ages typically ranging from 1-2.5 hours. However, during the warmer months of the year only 74% of surfers appear to be applying sunscreen or zinc to their face and neck, with 54% applying sunscreen to all exposed areas of skin and just 7.3% wearing a surf cap to protect the head, nose and ears. These percentages drop significantly in the cooler months.

• In a single 12 month period almost 15% of surfers reported being treated for skin cancer/lesion by a medical practitioner, these included melanoma and basal cell carcinoma. Some surfers will have more than one skin cancer/lesion identified in this period. This equates to a mean rate of occurrence of 9.1 skin cancer/lesions per 10 000 hours surfed.

• The three most common sites for skin cancer/lesion are the face, hand and forearm.

ACKNOWLEDGEMENT
The authors wish to acknowledge the financial assistance of the New South Wales Sporting Injuries Committee who provided funding for this project through the New South Wales Sporting Injuries Insurance Scheme. Industry partner, Surfing Australia, actively supported this project by promoting participation to its members and assisting with the distribution of the online survey via its corporate web site.

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original research

the self-reported rates of skin cancer are higher than that reported within the general population. The use of sun protection strategies in the summer months varied among respondents. A significant number of surfers (19.1%) indicated that they did not use sunscreen at all on any day or during the warmer months, with this number increasing (46.8%) in the cooler months. The majority of respondents to the survey lived in New South Wales (53.9%), where the average annual ambient temperature for the period 2000-2008 was 24.9°C (ABS, 2010). Further, the average annual UV rating ranges from 6-7 (UV rating of High) for the region south of Sydney and north to Coffs Harbour, to 8-11 (UV rating of Very High) for Coffs Harbour to the Sunshine Coast in South East Queensland respectively (BOM, 2013). As a result, the lack of sun protection while surfing is a significant issue for surfers. The Bureau of Meteorology (BOM) and Cancer Council Australia advise that a UV rating of 3 or above should prompt surfers to seek shade. These are:

- Australian surfers spend approximately 11 hours per week surfing in summer with the time spent in the water per surfer of ages typically ranging from 1-2.5 hours. However, during the warmer months of the year only 74% of surfers appear to be applying sunscreen or zinc to their face and neck, with 54% applying sunscreen to all exposed areas of skin and just 7.3% wearing a surf cap to protect the head, nose and ears. These percentages drop significantly in the cooler months.

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REFERENCES
23. Taylor DM, Bennett D, Carter M, Garewial D.
The effectiveness of preventative neuromuscular training on anterior cruciate ligament injury rates in female athletes: A systematic review

OLIVIA SIMPSON, DUNCAN REID, RICHARD ELLIS, STEVE WHITE

ABSTRACT

Aim
To evaluate the evidence of the effectiveness of controlled trials of neuromuscular (NM) training interventions aimed at preventing anterior cruciate ligament (ACL) injuries on the number of ACL injuries sustained by female athletes.

Data Sources
PubMed, CINAHL, MEDLINE, EBSCO and cross-referencing (Dates searched: 1995 to Dec 1 2014)

Study Selection
Studies were included if they were: 1) prospective controlled trials; 2) a neuromuscular training intervention was conducted; 3) female athletes were participants; and 4) the number of ACL injuries were recorded. Thirteen relevant studies were identified.

Data Extraction
Extracted data included: 1) study design; 2) participant sport and competition level; 3) participant age; 4) profession of person(s) who implemented the intervention; 5) nature of intervention; 6) timing of intervention; 7) intervention frequency; 8) duration of intervention sessions; 9) intervention compliance; 10) dropout rates; 11) number of ACL injuries incurred; 12) ACL injury mechanism (contact or non-contact); 13) incidence of ACL injury per 100 sporting hours

Data Synthesis
The mean modified Downs and Black score of all reviewed studies was 18.5/28 (range 13 to 26). The mean modified Downs and Black score for studies that employed a NM warm-up intervention was 21.4/28. Quality Index score calculation showed that four studies had strong methodological quality, eight had moderate methodological quality; and one had limited methodological quality. Across all studies, control group athletes sustained 170 ACL injuries, as compared to 83 ACL injuries sustained by intervention group athletes. For control group athletes, mean injury incidence was 0.15 (range 0.03 to 0.24) ACL injuries and 0.11 (range 0.03 to 0.23) non-contact ACL injuries per 1000 sporting hours. For intervention group athletes, mean incidence injury was 0.08 (range 0.00 to 0.19) ACL injuries and 0.04 (range 0.00 to 0.09) non-contact ACL injuries per 1000 sporting hours. Overall, female control group athletes were more likely to sustain an ACL injury and much more likely to sustain a non-contact ACL injury.

Conclusions
Studies varied widely by sport intervention-type, participant characteristics and study design characteristics. Studies that employed an NM warm-up were of higher methodological quality and were relatively more effective than other types of interventions. Due to lack of heterogeneity of studies, more research is required. Overall, there is a moderate level of evidence for the efficacy of neuromuscular interventions in preventing ACL injuries in female athletes.

review

leading to reconstruction was netball (364), with the second highest amount occurring in soccer (82) (Mr B Tietjens, personal communication with ACC, 17 November 2014). These figures also showed that the number of ACL ruptures for New Zealand female netball players increased every year over five years, with 34% more ACL reconstructions performed on female netball players in 2012/13 as compared to 2008/09 (Mr B Tietjens, personal communication with ACC, 17 November 2014). ACL injuries in female New Zealand netball players are certainly a costly and growing problem.

Several prospective studies have employed a variety of training interventions with female athletes in an attempt to decrease ACL injury rates. 18-30 These studies employed what is commonly described in the literature as 'preventative neuromuscular training', which included one or more elements of movement competency training, strength training, plyometrics, stretching, balance and proprioceptive training. 19-20 Some studies employed a stand-alone intervention, such as 'Soederman et al in which intervention athletes used balance boards for 15-10 minutes at each training session. 18,29,31,32 Other studies employed what this review will refer to as a 'neuromuscular warm-up' (NM warm-up). In these studies the traditional sport warm-up before training sessions and games was replaced by a 15 to 25 minute session that included a combination of cardiovascular exercise, strength training, balance, and plyometric components, with exercises progressed throughout the season. 20,21,29,31

The objective of this research was to perform a systematic critical review of prospective controlled trials that have investigated the effect of neuromuscular training interventions on the number of ACL injuries sustained by female athletes. The primary purpose was to evaluate the quality of the evidence and then to draw conclusions, based on the strength of the evidence, as to the effectiveness of such programmes. A secondary purpose was to evaluate the evidence for the efficacy of NM warm-up interventions as compared to other types of interventions.

METHODS

Literature Search
This review was conducted following the PRISMA Statement guidelines. 24 A literature search was conducted in December 2014. Databases searched included PubMed, CINAHL, EBSCO health databases, and MEDLINE. Dates searched were from 1995 to 1 December 2014. Search terms included "anterior cruciate ligament", ACL, female, women, "women's", neuromuscular, intervention, program*, prospective, RCT, and "control" trial*. See Table 1 for literature search strings. The language was limited to English. Studies were identified by one researcher (OS). The following inclusion criteria were applied: (1) participants were female athletes only; or if participants included both females and males, the data for females was analysed separately; (2) prospective controlled trial study design was employed; (3) a neuromuscular training intervention with the aim of preventing ACL injuries was undertaken; and (4) number of ACL injuries as confirmed by magnetic resonance imaging (MRI) or visualisation during surgery was reported. Abstracts and unpublished data were excluded. No authors were contacted for additional information. See Figure 1 for search strategy:

<table>
<thead>
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The review calculated that 10 years after ACL injury, the prevalence of developing knee osteoarthritis was as high as 13% for isolated ACL injury and 48% for combined ACL and meniscal and/or medial collateral ligament (MCL) injuries. 6 In New Zealand, from 2000 to 2005 the average treatment cost to the Accident Compensation Corporation (ACC) for an ACL reconstruction, including imaging, surgery, rehabilitation and income replacement, was $11,157 NZD (New Zealand dollars). 8 ACL injuries are particularly prevalent in high impact pivoting and jumping-sports. 13 Under an official Information Act request, ACC provided 2012/2013 figures showing that in New Zealand the three sports with the highest number of ACL injuries leading to reconstruction surgery were: rugby union (411), netball (486) and soccer (395) (Mr B Tietjens, personal communication with ACC, 17 November 2014). When stratified by gender, the sport in which female athletes sustained by far the most ACL injuries was occurring in female New Zealand netball players, increased every year over five years, with 34% more ACL reconstructions performed on female netball players in 2012/13 as compared to 2008/09 (Mr B Tietjens, personal communication with ACC, 17 November 2014). ACL injuries in female New Zealand netball players are certainly a costly and growing problem.

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Data Collection Process

The following data were extracted independently by two reviewers (OS, DR): 1) study design, 2) participant sport and competition level, 3) participant age, 4) profession of person(s) who implemented the intervention; 5) nature of intervention; 6) timing of intervention; 7) intervention frequency; 8) duration of intervention sessions; 9) intervention compliance; 10) dropout rates; 11) number of ACL injuries incurred; 12) ACL injury mechanism (contact or non-contact); 13) incidence of ACL injury per 100 sporting hours. The mean modified Downs and Black score of all studies was 18.5/28 (range 13 to 26). The mean modified Downs and Black score for studies that employed a non-randomised control group was 21.4/28 (range 13.3 to 28.0) as compared to 15.0/28 for other types of interventions.3,9,11-16,20,27 The majority of studies clearly described their objectives, outcomes, interventions and results, and used appropriate statistical tests. Seven of thirteen studies included information about participants’ characteristics,12,13,15,20,27,29,30 seven studies included sufficient descriptions of participants lost to follow-up.3,9,12,13,15,20,27 Due to the nature of the intervention, no studies were able to blind participants, while six of 13,13,15,20,27,30,31 studies attempted to blind those measuring the intervention.

Strength of the Evidence

Three of thirteen studies included power calculations and recruited enough participants to detect a 50% reduction in injuries between groups.13,15,20 All other studies either did not include a power calculation12,13,27 or failed to recruit enough participants to have meaningful power projections by their power calculations.3,9,12,13,15,17,20

Methodological Quality

The methodological quality of each paper is outlined in Table 5 and Table 6. Authors OS and DR independently reached the same score for each article. The mean modified Downs and Black score of all studies was 18.5/28 (range 13 to 26). The mean modified Downs and Black score for studies that employed a non-randomised control group was 21.4/28 (range 13.3 to 28.0) as compared to 15.0/28 for other types of interventions.3,9,11-16,20,27 The majority of studies clearly described their objectives, outcomes, interventions and results, and used appropriate statistical tests. Seven of thirteen studies included information about participants’ characteristics,12,13,15,20,27,29,30 seven studies included sufficient descriptions of participants lost to follow-up.3,9,12,13,15,20,27 Due to the nature of the intervention, no studies were able to blind participants, while six of 13,13,15,20,27,30,31 studies attempted to blind those measuring the intervention.

Evidence Synthesis

There were four studies of strong methodological quality, two of which showed statistically significantly fewer (P < 0.05) ACL injuries as compared to the control group,1,2,13 whereas the other two studies failed to show any significant effect.3,9,12 Of the eight

review

Table 2 - Categorisation of Quality Index Scores

<table>
<thead>
<tr>
<th>Total Modified Downs and Black checklist Score (28)</th>
<th>Percentage</th>
<th>Quality Index</th>
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<tbody>
<tr>
<td>21-26</td>
<td>&gt;75%</td>
<td>Strong</td>
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<tr>
<td>14-20</td>
<td>50-74%</td>
<td>Moderate</td>
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<tr>
<td>7-13</td>
<td>25-49%</td>
<td>Limited</td>
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<tr>
<td>&lt;7</td>
<td>&lt;25%</td>
<td>Poor</td>
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Adapted from Hartling et al., 2004; Hignett, 2010; and Hing et al., 2009
### Table 5

<table>
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<th>Quality Index</th>
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<td>71%</td>
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<td>50%</td>
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### Overall Score

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<td>20 14 19 14 21 15 15 25 15 13 19 24 26</td>
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</table>

### QUALITY INDEX %

|               | 71% 30% 26% 73% 54% 54% 89% 54% 46% 68% 86% 93% |

### Internal Validity

1. Were subjects involved in the specialty study clearly described? (yes = 1, no = 0, unable to determine = 0)
2. Are outcomes clearly described in the intervention groups? (yes = 1, no = 0, unable to determine = 0)
3. Are the characteristics of the patients included in the specialty study clearly described? (yes = 1, no = 0, unable to determine = 0)
4. Are the characteristics of the intervention clearly described? (yes = 1, no = 0, unable to determine = 0)
5. Are the characteristics of the patient's control group clearly described? (yes = 1, no = 0, unable to determine = 0)
6. Are the characteristics of the population clearly described? (yes = 1, no = 0, unable to determine = 0)
7. Does the study provide estimates of the random variability in the data? (yes = 1, no = 0, unable to determine = 0)
8. Have important adverse events that may be a consequence of the intervention been reported? (yes = 1, no = 0, unable to determine = 0)
9. Were study subjects randomised to intervention groups? (yes = 1, no = 0, unable to determine = 0)
10. Were losses of patients to follow-up taken into account? (yes = 1, no = 0, unable to determine = 0)
11. Were statistical tests used to assess the main outcomes appropriate? (yes = 1, no = 0, unable to determine = 0)
12. Was the statistical analysis adjusted for confounding? (yes = 1, no = 0, unable to determine = 0)
13. Were the statistical analyses performed in a blinded manner? (yes = 1, no = 0, unable to determine = 0)
14. Was the statistical analysis adjusted for confounding in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
15. Were the statistical analyses performed in a blinded manner in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
16. If any of the results of the study were based on “data dredging”, was this made clear? (yes = 1, no = 0, unable to determine = 0)
17. Did the study provide estimates of the random variability in the data for the intervention groups? (yes = 1, no = 0, unable to determine = 0)
18. Was compliance with the intervention reliable? (yes = 1, no = 0, unable to determine = 0)
19. Was an attempt made to blind study subjects to the intervention they had received? (yes = 1, no = 0, unable to determine = 0)
20. Were the patients and their caregivers informed about the results of the study? (yes = 1, no = 0, unable to determine = 0)
21. Were the criteria as defined by Van Tulder et al, 2000, met? (yes = 1, no = 0, unable to determine = 0)
22. Were the criteria as defined by Van Tulder et al, 2000, met for subsequent years? (yes = 1, no = 0, unable to determine = 0)
23. Was there adequate adjustment for confounding in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
24. Was there adequate adjustment for confounding in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
25. Was there adequate adjustment for confounding in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
26. Were the statistical analyses performed in a blinded manner in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
27. Were the statistical analyses performed in a blinded manner in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
28. Were the statistical analyses performed in a blinded manner in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
29. Were the statistical analyses performed in a blinded manner in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)
30. Were the statistical analyses performed in a blinded manner in the intervention and outcome groups? (yes = 1, no = 0, unable to determine = 0)

### External Validity

1. Is the hypothesis/aim/objectives of the study clearly described? (yes = 1, no = 0)
2. Are the interventions of interest clearly described? (yes = 1, no = 0)
3. Are the characteristics of the patients included in the study clearly described? (yes = 1, no = 0)
4. Are the characteristics of the population clearly described? (yes = 1, no = 0)
5. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (yes = 1, no = 0)
6. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (yes = 1, no = 0)
7. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (yes = 1, no = 0)
8. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (yes = 1, no = 0)
9. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (yes = 1, no = 0)
10. Are the distributions of principal confounders in each group of subjects to be compared clearly described? (yes = 1, no = 0)

### DISCUSSION

The current review shows moderate evidence that neuromuscular training interventions result in fewer ACL injuries in female athletes. The reviewed studies were heterogeneous and thus there is value in discussing trends that emerged between studies and across all studies.

### Effect of Low Power on Results

Ten of the thirteen reviewed studies, either did not include a power calculation, or failed to recruit enough participants to detect a 50% difference between groups. Although ACL injuries are devastating, they have a relatively low incidence, which this review found to be 0.15 per 1000 sporting hours. In order to have meaningful power to detect differences between groups, authors need to recruit and monitor thousands of participants and this can be logistically difficult. Therefore when assessing these studies, it is important to consider that a trend toward fewer ACL injuries may be indicative of a larger effect had enough participants been recruited.

### Effect of Interventions on All Knee Injuries and/or Lower Limb Injuries

Although not the main purpose of this review, ten of 13 studies also captured incidence of overall lower limb and/or all knee injuries (see Table 7). Of these, four found statistically significantly fewer injuries, two found a trend toward decreased overall injuries, and three found no effect. Lower limb sprains and strains have a much higher incidence that ACL injuries, and thus were represented in much higher numbers in the results. A large-scale, high quality cluster RCT conducted by Soligard et al. in Norwegian soccer players demonstrated that a comprehensive warm-up programme significantly reduced the risk of overall injuries, overuse injuries and severe injuries. In reality, the goal of implementing an injury prevention program...
programme is not just to prevent ACL injuries but to prevent all injuries. This review shows there is also moderate evidence to support that neuromuscular training is effective in decreasing the number of all knee/lower limb injuries in female athletes.

Effect of the Intervention by Age

The reviewed studies included female athletes of varying ages and skill-levels. However, a direct comparison can be made between Mandelbaum et al and Gilchrist et al, which both employed the Santa Monica Prevent Injury and Enhance Performance Program. There were 5703 participants in Mandelbaum et al, aged 14 to 19 from a California youth soccer league. Gilchrist et al studied 1435 university-aged players in NCAA Division I collegiate soccer teams. Mandelbaum et al showed a statistically significant reduction in non-contact ACL injuries in athletes utilising a NM warm-up programme, with an 88% reduction in injury in year one and 74% in year two. There were 6-fold fewer non-contact ACL injuries for intervention participants. They found statistically significantly fewer non-contact ACL injuries, with an intervention group ACL injury incidence of 0.03 per 1000 soccer hours versus 0.11 for control group players. In comparison, Gilchrist et al found an 41% fewer non-contact ACL injuries in the intervention group and this result did not reach significance. Gilchrist et al found an intervention group non-contact ACL injury incidence of 0.03 per 1000 soccer hours versus 0.09 for control group players. The authors postulated that the ‘PEF’ programme had a greater effect with younger, less-skilled players as they were likely to initially have poorer strength and neuromuscular control as compared to top level university players.  

The training effect by age is supported by a meta-analysis by Myer, Sugimoto, Thomas & Hewett, which analysed the influence of age on the effect of female ACL prevention neuromuscular interventions. They found that interventions had the greatest effect when performed by athletes aged 14 to 18, as compared to athletes aged 18 to 20, or over 20. They found a statistically greater knee injury risk reduction for athletes ≤ 18 years of age, as compared to those > 18 year of age. However, these and other authors have argued that the ideal time to commence neuromuscular training is before females begin puberty, before they commence their ‘growth spur’ or period of peak height velocity.  

Knee injury rate between males and females have been shown to be similar prior to puberty. For both boys and girls, during puberty at the time of peak height velocity the tibia and femur grow rapidly, and there is an increase in height of their centre of mass.  

There is also a corresponding increase in height and body mass increasing load on the joints. This makes trunk and knee control more difficult during rapid movements.  

During adolescence boys demonstrate increased power, strength and coordination which matches their maturational phase, whereas girls show little change in these characteristics.  

For example, boys’ vertical jump heights increases, whereas girls do not have a corresponding increase.  

Authors have demonstrated that in females the relative lack of hip abductor strength and trunk stability, during and immediately after this time of growth, leads to decreased knee control and increased knee valgus movement patterns.  

These are the movement patterns that have been shown to put athletes at risk of ACL injury.  

Indeed the peak rate of ACL injuries in females was shown to be at age 16.  

Thus, it could be concluded that neuromuscular training programmes would have a greater effect if they were first implemented before puberty at age 11 or 12, and continued throughout adolescence. Therefore when designing future studies, researchers may need to target interventions at the grassroots club level or middle school/early high school athletes. It would be helpful if future research into NM warm-up interventions were targeted for younger age groups, or results were stratified by age of athlete.  

Effect by Intervention Adherence

A recent meta-analysis by Sugimoto et al, which analysed the compliance data for six of the studies included in this review, showed a clear inverse dose–response relationship between adherence to the neuromuscular intervention and incidence of ACL injury. Haugland, Asrodt, Wagnberg and Walden evaluated the adherence data from the Walden et al.  

The authors stratified results in terriles with participants who had low, moderate and high compliance to the intervention. They found that players in the high compliance tertile had 88% fewer ACL injuries as compared to controls, while those in the low compliance group had ACL injury rates similar to that of the control group.  

When analysing compliance data, Soligard et al found that players with high compliance to the FIFA 11+ neuromuscular warm-up programme had a 35% lower risk of all injuries as compared to those with moderate compliance. They found that the greatest factor associated with high compliance was a positive attitude of the coach towards the benefit of the programme for preventing injuries.  

Similarly, Steffen et al found over 80% adherence to the coach-led FIFA 11+ following education at a coaching workshop. These studies highlight that the key to adherence is ‘buy-in’ and consistent implementation by the coach.  

Future research needs to be done around the best ways to educate coaches in the value of a NM warm-up programme, and how to best provide ongoing support that encourages coaches to continue to deliver the intervention.  

For example, with increasingly ubiquitous presence of communication technology, future research could be done into how best to use technology like smartphone apps, to help support coach-led initiatives.  

Cost Effectiveness of an ACL Injury Prevention Intervention

Apart from the injury prevention benefits, there could be potentially large cost savings benefits to ACC by implementing NM ACL prevention warm-up programmes. Labella et al did a cost–benefit analysis of a coach-instructed NM ACL prevention warm-up intervention. They found that the cost of training a group of 20 coaches was the equivalent of $124 NZD per coach. They calculated that 189 players would need to be exposed to the warm-up to prevent one ACL injury resulting in surgery, which equated to training 16 basketball coaches or 11 soccer coaches.  

The cost of training 16 coaches was $1984, which is significantly less than the ACC reported surgical cost for one ACL reconstruction of $11,157 NZD.  

Indeed, for the cost of one ACL reconstruction, 139 coaches could be trained which could have trickle-down effects to over 1500 athletes.  

Stuart et al performed a cost-effectiveness analysis of ACL prevention programmes for young athletes, which found universal neuromuscular training of all athletes was more cost-effective than triaging all athletes and implementing interventions for high risk athletes. They determined that as compared to doing nothing and paying surgical costs for ACL reconstructions, universal neuromuscular training implemented with all young athletes would save the equivalent of $155 NZD per player per season.  

NM Warm-up Interventions in Relation to Jump-Land Sports

NM warm-up interventions target the strength deficiencies, lack of neuromuscular control and poor movement patterns that have been identified in young female athletes. This review shows that this multi-modal approach with coach, physiotherapist or trainer, feedback is effective. However, the majority of NM warm-up programmes have been designed for soccer players, and this review finds they were more effective with soccer players as compared to other types of sports. Although the underpinnings of all sports are similar, the movement patterns of soccer are very different to those of jump–land sports of basketball and netball. It is recommended that future research investigate if a NM warm-up intervention that specifically targeted the movement patterns of a jump–land sport would increase the preventative effectiveness for athletes in these sports. This would be particularly appropriate in a New Zealand context, given the high numbers of participation in netball by young females and the currently high ACL incidence rate.  

Limitations

The authors acknowledge the following limitations of this systematic review. A meta-analysis was not performed due to the inclusion of non-randomised trials. Unpublished studies and PhD theses were not included. Only studies in English were included.  

CONCLUSION

ACL injuries have a relatively low incidence rate but a high financial cost and personal cost to athletes. A review of the literature found 13 prospective studies which employed a neuromuscular training intervention to prevent ACL injuries in female athletes. Four studies were of strong methodological quality, eight were of moderate quality and one was of limited quality. Studies varied substantially in all aspects of study design, types of interventions, outcome measures and populations studied. Due to lack of heterogeneity of studies, more research is required to come to strong conclusions. Overall, there is moderate level of evidence for the efficacy of neuromuscular interventions in preventing ACL injuries in female athletes. All female team sport athletes should participate in a supervised 15 to 25 minute NM warm-up before all training sessions and games.
### Table 4: Characteristics of Individual Studies

| Study | Design | Participants | Intervention | Study Results | Total Modified Downs and Black Checklist Score (Max) | Quality Index % |
|-------|--------|--------------|--------------|---------------|-----------------------------------------------|----------------|-------------|
| Glavind & al (2000) | Prospective randomized control trial | collegiate volleyball/ basketball (US high school) | YEP programme | ACL injuries = 7 (0.19) 1000h ae = 0.00 (0.00) | 20/28 71% | 71% |
| Health & al (2000) | Perspective RCT | US high school | Time per season not specified | Knee injury as defined by injury that caused player to seek care for an acute injury that made him/her unable to participate in his/her sport for at least 5 days off training/games. | Overall injury rates were significantly lower in intervention group as compared to control group (p = 0.0005). | 14/28 50% | 50% |
| Hewett & al (1999) | Prospective non-randomized cohort | collegiate soccer/ volleyball | jump training, strength training | Knee injury was defined as an injury that caused the player to seek care for an acute injury that made him/her unable to participate in his/her sport for at least 5 days off training/games. | Overall injury rates were significantly lower in intervention group as compared to control group (p = 0.0005). | 14/28 50% | 50% |
| Kubi & al (2010) | Prospective non-randomized cohort | collegiate volleyball (US high school) | Pre-season and intervention | Knee injury was defined as an injury that caused the player to seek care for an acute injury that made him/her unable to participate in his/her sport for at least 5 days off training/games. | Overall injury rates were significantly lower in intervention group as compared to control group (p = 0.0005). | 14/28 50% | 50% |
| Ladaba & al (2011) | Prospective RCT | collegiate soccer/ volleyball/ low school | YEP programme | Knee injury was defined as an injury that caused the player to seek care for an acute injury that made him/her unable to participate in his/her sport for at least 5 days off training/games. | Overall injury rates were significantly lower in intervention group as compared to control group (p = 0.0005). | 14/28 50% | 50% |
| Mandell & al (2005) | Prospective randomized control trial | youth soccer (UK youth league) | YEP programme | Knee injury was defined as an injury that caused the player to seek care for an acute injury that made him/her unable to participate in his/her sport for at least 5 days off training/games. | Overall injury rates were significantly lower in intervention group as compared to control group (p = 0.0005). | 14/28 50% | 50% |
| Perras & al (2009) | Prospective RCT | youth soccer league | | Knee injury was defined as an injury that caused the player to seek care for an acute injury that made him/her unable to participate in his/her sport for at least 5 days off training/games. | Overall injury rates were significantly lower in intervention group as compared to control group (p = 0.0005). | 14/28 50% | 50% |

Note: ACL, anterior cruciate ligament; AE, athletic exposure; C, control group; d, wk, day per week; h, hours; I, intervention group; NCA, National College Athletic Association; NM, neuromuscular; PA, physical activity; min, minutes; RR, risk ratio; RCT, randomized controlled trial; SD, standard deviation; US, United States
### Table 4: Characteristics of Individual Studies (Continued)

<table>
<thead>
<tr>
<th>Author</th>
<th>Study Design</th>
<th>Sport/Level</th>
<th>Group Size</th>
<th>Ages of Participants in Years</th>
<th>Intervention duration</th>
<th>Comments on Compliance, Adherence and Drop-out</th>
<th>Total ACL Injuries</th>
<th>Total Other Knee Injuries</th>
<th>Study Results</th>
<th>Total Modified Downs and Black Checklist Score (12)</th>
<th>Quality Index %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hvidsten et al (2008)</td>
<td>Prospective randomized, controlled trial</td>
<td>UK high school league</td>
<td>C = 6 teams (148)</td>
<td>Mean age = 14-18</td>
<td>1 - 15 sessions</td>
<td>65±19</td>
<td>Knee injury as defined as any injury that lead to non-participation in following game/training session. No difference between groups.</td>
<td>ACL injuries = 4 (3)</td>
<td>Knee injuries = 37</td>
<td>Not reported</td>
<td>24/28 86%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C = 54 teams (1077)</td>
<td>Mean age = 15.4±0.8</td>
<td>10 - 15 sessions</td>
<td>23 ±9 (SD)</td>
<td>Total Modified Downs and Black Checklist Score (12)</td>
<td>ACL injuries = 0.08 (0.03)</td>
<td>Knee injuries = 30</td>
<td>Not reported</td>
<td>26/28 93%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C = 10 teams (140)</td>
<td>Mean age = 15.4±5.4</td>
<td>10 - 15 sessions</td>
<td>6 ±10 (SD)</td>
<td>No significant higher number of ACL ruptures in the intervention group as compared with control group (p = 0.05).</td>
<td>ACL injuries = 5 (5)</td>
<td>Knee injuries = 9</td>
<td>Not reported</td>
<td>15/20 68%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C = 10 teams (140)</td>
<td>Mean age = 15.4±5.4</td>
<td>10 - 15 sessions</td>
<td>9 ±3 (SD)</td>
<td>Knee injury as defined as any injury that lead to non-participation in following game/training session. No difference between groups for knee injuries or overall lower extremity injuries.</td>
<td>ACL injuries = 0.08 (0.04)</td>
<td>Knee injuries = 30</td>
<td>Not reported</td>
<td>15/20 68%</td>
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<tr>
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<td>Knee injury as defined as any injury that lead to non-participation in following game/training session. No difference between groups for knee injuries or overall lower extremity injuries.</td>
<td>ACL injuries = 0.07 (0.02)</td>
<td>Knee injuries = 37</td>
<td>Not reported</td>
<td>24/28 86%</td>
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Note: ACL, anterior cruciate ligament; AE, athletic exposure; C, control group; d, day per week; h, hours; I, intervention group; NCA, National Collegiate Athletic Association; NM, neuromuscular; physics, therapist; min, minutes; RR, risk ratio;RCT, randomised controlled trial; SD, standard deviation; US, United States.
REFERENCES


**ABSTRACT**

**Aim**

Rugby sevens is a physically demanding sport often leaving players fatigued and sore. This study aimed to quantify the short-term changes in biochemical and haematological variables of inflammation and haemolysis induced by a two-day women’s rugby sevens tournament in State and National representative players, and explore the relationship between on-field movement patterns and select biomarkers.

**Study Design**

Cross-sectional study.

**Setting**

Australian Women’s Rugby Sevens National Championships.

**Participants**

State (n = 10, 24.4 ± 4.3 y, 1.67 ± 0.03 m, 66.1 ± 7.9 kg) and National (n = 12, age 22.3 ± 2.5 y, height 1.67 ± 0.04 m, mass 65.8 ± 4.6 kg) female rugby sevens players.

**Outcome Measures**

Running movement patterns and impacts were recorded using 15 Hz GPS units over a two-day tournament. Biochemical and haematological variables were measured before and after the tournament.

**Results**

While national players completed greater on-field movements (effect size (ES) = 0.53-0.97), post-tournament leukocyte count increased similarly (10-50%) in both State (ES = 1.95) and National players (ES = 1.52). Neutrophil count positively correlated (r = 0.57-0.89) with all on-field movements for both groups. Haptoglobin concentration were 94% higher at baseline in National players (ES = 1.33), but declined >20% in both groups. Creative kinase increased 4 fold in State players, and 2.5-fold in National players (ES = 2.86-4.10), while creatinine increased moderately (10-14%) in both groups.

**Conclusion**

Greater haemolysis and muscle damage in State level players might be a consequence of lower strength and fitness, and being less accustomed to the contact demands of competition. Effective preparation and careful post-tournament management of players should promote improved game performance and enhanced recovery.

Keywords: football, female, leucocytosis, muscle damage, creatinine

**INTRODUCTION**

Rugby sevens is a unique sport compared to other football codes. While rugby sevens games are shorter in duration (14-20 min) compared with rugby union (80 min), they are played in a tournament format, with up to three games played per day, over two to three consecutive days. The short duration of rugby sevens games, combined with the relatively greater amount of space available per player (seven on-field players compared to 15 within the same sized playing-field) yields a higher work-to-rest ratio.1,23 Rugby sevens tournaments might therefore elicit greater inflammation, haemolysis and muscle damage in players compared to other football codes, based on the high-speed running demands on players. As both men’s and women’s rugby sevens will be making their Olympic debut in 2016, understanding the biochemical and haematological changes that occur over a typical two-day rugby sevens tournament could be important in the preparation for and recovery from tournaments.

To date, only one study has quantified the degree of inflammation after consecutive rugby sevens match play, with a cumulative inflammatory response occurring from one game to the next.13 However, a single game of men’s rugby union produces a greater inflammatory response than two games of rugby sevens, and post-game neutrophil counts correlated to the number of contacts and tackles players experience.4 Given that rugby sevens tournaments include up to six games over two days, it is likely that a cumulative inflammatory response arises from the combination of the physical intensity of match play, total playing duration, and high work to rest ratios (both within- and between-games). However, the extent of inflammation following a rugby sevens tournament, and how that might influence recovery and subsequent match preparation is currently unknown.

In addition to inflammation, haemolysis and muscle damage also occur following competitive team sports. While muscle damage is greater in individuals of a lower training status,24 haemolysis can be independent of athlete status, competition level,25 VO2 max or marathon finish time.6 Haemolysis, indirectly measured by a decline in serum haptoglobin concentration, is increased in response to exercise.12 Research on haptoglobin has mainly been in male athletes and few studies have investigated haemolysis in female team-sport athletes. While a competitive game of women’s soccer elicited no substantial change in haptoglobin concentration,2 a single field-based training session yielded a 13% decrease.26 Interestingly, goalkeepers, who ran 40% less distance and completed very few or no efforts at high-speed had similar results. Other activities, such as jumping, diving and tackling may have contributed to the haemolysis observed in goalkeepers, in contrast to the higher running load of field players. This assertion is of particular interest to women’s rugby sevens. Therefore, players spend a substantial portion of a match in high physical impact situations (tackling, wrestling). However, the presence of haemolysis and the contribution of running and physical impacts has yet to be addressed in women’s rugby sevens.

Understanding the short-term changes in creatinine concentration following rugby sevens tournaments is also important for the practitioner. Serum creatinine concentration correlates with individuals’ muscle mass but can also be influenced by creatine supplementation and intense exercise.14 Given that creatinine is commonly measured to assess renal health, understanding the acute changes induced by a two-day rugby sevens tournament is important to be able to differentiate a clinical health issue with a normal acute response to demanding physical activity. Knowledge on the extent of inflammation and haemolysis from a rugby sevens tournament is important to the clinical management of players presenting with substantial post-tournament fatigue or soreness by providing adequate recovery interventions and appropriate prescription of training following competition.

In progressing athletes to an elite level of competition, understanding how the physical demands differ between elite and sub-elite players is important to ensure the correct management and development of players. The aims of this study were to quantify the short-term changes in biochemical and haematological variables of inflammation and haemolysis induced by a two-day women’s rugby sevens tournament in State and National representative players, and explore the relationship between on-field movement patterns and select biomarkers.

**METHODS**

**Experimental Approach to the Problem**

This study was a cross-sectional study comparing haematological and biochemical changes in State and National level Women’s Rugby Sevens players. This study was completed over a single two-day tournament where National level players competed in their respective State teams, while State players were all part of the same team. Changes in haematological and biochemical measures were analysed over the two-day tournament to determine relationships with on-field performance measures and athlete playing level.

**Subjects**

National (n = 12, age 22.3 ± 2.5 y, height 1.67 ± 0.04 m, mass 65.8 ± 4.6 kg; mean ± SD) and State (n = 10, 24.4 ± 4.3 y, 1.67 ± 0.03 m, 66.1 ± 7.9 kg) representative Women’s Rugby Sevens players participated in this study. Players were made aware of the purpose, methodology, benefits and risks of this study prior to obtaining their written informed consent, and were free to withdraw at any time without penalty. This study was approved by the Australian Institute of Sport Ethics Committee and the University of Canberra Human Research Ethics Committee.

**Procedures**

Players presented themselves to the Australian Institute of Sport physiology laboratory on the afternoon prior to, and the evening following the two-day women’s rugby sevens National Championships (outdoor ambient temperature 22-26°C). Post-tournament blood samples were collected within three hours of the completion of players’ final game of the tournament. National players also returned one week after a follow-up blood sample. Players were rested in a supine position for several min prior to blood collection. Venous blood draws were obtained from trained phlebotomist. A total of 4 mL of blood (one x 2 mL, serum separator tube, one x 2 mL EDTA tube) was taken from a forearm vein. Haematological parameters (leukocytes, erythrocytes (RBCs), haemoglobin (Hb), haematocrit (Hct), platelet count, and mean cell volume (MCV) were analysed using a Sysmex XT-2000i (Roche Diagnostics, Australia). Biochemistry analysis was performed on a Cobas Integra 400 plus (Roche Diagnostics, Australia) and serum samples analysed for iron, transferrin (Tf), ferritin (Fer), transferrin saturation (%TfSat), creatine kinase (CK), haptoglobin, and creatinine. All analytes underwent internal and external quality control checks prior to analysis.

On-field game movement data was collected throughout the tournament using 15 Hz GPS units (SPI HPU, GPSports Systems, Canterbury, Australia), which are considered valid and reliable for use in team-sports.13,14 These units also contain a 16 Gbyte GPS receiver, which allows for measuring the impact forces on players. Each unit was positioned within a specialised harness worn underneath the playing jersey. For analysis, the half time interval was excluded so that only on-field playing time was included. Due to injury, coach selection and finals progression, players competed in 3-6 games over the two-days, resulting in 64 game files for National players and 51 game files for State players. Two National players who did not play on the second day due to injury were not included in post-tournament data analysis. GPS variables reported include total playing time, total distance, distance covered at high-speed (>5 m∙s-1), total number of impacts and impacts >10 g.

The use of recovery modalities and non-steroidal anti-inflammatory drugs (NSAIDs) were not controlled within this study. All players had access to cold water immersion but it was up to their team management as to the frequency and duration. A minimum of 3 players used cold water immersion following games on the first day of the tournament, but some players also reported using them between...
at any time point, however levels of CK increased almost four-fold in State players and increased –2.5 fold for National players over the tournament. At baseline, haptoglobin was 94% greater in National compared to State players (ES = 1.13, ±0.58), however, levels fell 20-40% over the tournament in both groups, with no significant difference between the two groups post-tournament.

One week post, National players had moderate to large increases in RBC, Hb and Hct (7-2% ± 2.9%; mean ± SD) compared to baseline, while lower Hb (4%, ES = -0.66, ±0.68, mean ± 90% CI), Hct (-3%, -0.57, ±0.66), iron (-16%, -0.45, ±0.58) and tHfSat (-35%, -0.99, ±0.58) at baseline, while TIR was higher (28%, ±2.16, ±02). No clinical or practically important changes in MCV, platelet count, basophils or eosinophils were apparent. No substantial difference between groups was observed for CK or creatinine concentration.

Table 1 - Biochemical and haematological response in State and National level female rugby sevens players following a two day tournament.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Pre (n=10)</th>
<th>Post (n=10)</th>
<th>ES, ±90% CI</th>
<th>Qualitative Outcome</th>
<th>Pre (n=15)</th>
<th>Post (n=15)</th>
<th>ES, ±90% CI</th>
<th>Qualitative Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leucocyte Count (10⁹ L⁻¹)</td>
<td>7.24 ± 1.26</td>
<td>10.56 ± 2.75</td>
<td>1.95, ±0.62</td>
<td>Large</td>
<td>8.25 ± 1.85</td>
<td>11.78 ± 3.20</td>
<td>1.52, ±0.29</td>
<td>Large</td>
</tr>
<tr>
<td>Neutrophil Count (10⁹ L⁻¹)</td>
<td>4.95 ± 1.05</td>
<td>7.72 ± 2.38</td>
<td>2.04, ±0.46</td>
<td>V Large</td>
<td>5.14 ± 1.72</td>
<td>9.05 ± 2.21</td>
<td>1.67, ±0.29</td>
<td>Large</td>
</tr>
<tr>
<td>Lymphocyte Count (10⁹ L⁻¹)</td>
<td>2.14 ± 0.56</td>
<td>1.95 ± 0.57</td>
<td>0.66, ±0.66</td>
<td>Moderate</td>
<td>2.33 ± 0.26</td>
<td>1.81 ± 0.43</td>
<td>-2.25, ±1.24</td>
<td>Moderate</td>
</tr>
<tr>
<td>Monocyte Count (10⁹ L⁻¹)</td>
<td>0.51 ± 0.10</td>
<td>0.87 ± 0.36</td>
<td>2.03, ±0.80</td>
<td>V Large</td>
<td>0.62 ± 0.21</td>
<td>0.88 ± 0.26</td>
<td>1.03, ±0.43</td>
<td>Moderate</td>
</tr>
<tr>
<td>Red Blood Cells (10¹² L⁻¹)</td>
<td>4.45 ± 0.26</td>
<td>4.27 ± 0.25</td>
<td>-0.08, ±0.38</td>
<td>Moderate</td>
<td>4.32 ± 0.25</td>
<td>4.26 ± 0.23</td>
<td>-0.24, ±0.36</td>
<td>Small</td>
</tr>
<tr>
<td>Haemocrit (ratio)</td>
<td>3.82 ± 2.1</td>
<td>3.66 ± 1.8</td>
<td>-0.99, ±0.42</td>
<td>Moderate</td>
<td>3.63 ± 1.86</td>
<td>36.1 ± 1.9</td>
<td>-0.47, ±0.42</td>
<td>Small</td>
</tr>
<tr>
<td>Haemoglobin (g·dl⁻¹)</td>
<td>12.8 ± 0.5</td>
<td>16.0 ± 0.5</td>
<td>0.07, ±0.47</td>
<td>Moderate</td>
<td>16.1 ± 3.5</td>
<td>19.2 ± 4.2</td>
<td>0.96, ±0.55</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ferritin (µg·L⁻¹)</td>
<td>62.1 ± 37.0</td>
<td>85.0 ± 45.7</td>
<td>0.56, ±0.34</td>
<td>Small</td>
<td>43.2 ± 16</td>
<td>61.2 ± 20.0</td>
<td>0.66, ±0.20</td>
<td>Moderate</td>
</tr>
<tr>
<td>haematocrit (ratio)</td>
<td>38.2 ± 2.1</td>
<td>36.6 ± 1.8</td>
<td>-0.99, ±0.42</td>
<td>Moderate</td>
<td>36.3 ± 1.86</td>
<td>36.1 ± 1.9</td>
<td>-0.47, ±0.42</td>
<td>Small</td>
</tr>
<tr>
<td>red blood cells (10¹² L⁻¹)</td>
<td>43.2 ± 17.0</td>
<td>61.2 ± 20.0</td>
<td>0.66, ±0.20</td>
<td>Moderate</td>
<td>45.2 ± 16</td>
<td>61.2 ± 20.0</td>
<td>0.66, ±0.20</td>
<td>Moderate</td>
</tr>
<tr>
<td>neutrophil count (10⁹ L⁻¹)</td>
<td>2.60 ± 0.25</td>
<td>2.49 ± 0.26</td>
<td>-0.27, ±0.21</td>
<td>Small</td>
<td>3.28 ± 0.61</td>
<td>3.33 ± 0.65</td>
<td>0.07, ±0.13</td>
<td>Trivial</td>
</tr>
<tr>
<td>leukocyte count (10⁹ L⁻¹)</td>
<td>17.7 ± 2.7</td>
<td>1119 ± 55.9</td>
<td>41.0, ±0.77</td>
<td>V Large</td>
<td>249 ± 155</td>
<td>1031 ± 570</td>
<td>0.86, ±0.34</td>
<td>V Large</td>
</tr>
<tr>
<td>creatinine (µmol·l⁻¹)</td>
<td>76.6 ± 11.0</td>
<td>84.4 ± 9.7</td>
<td>0.64, ±0.24</td>
<td>Moderate</td>
<td>83.5 ± 9.2</td>
<td>92.3 ± 16.4</td>
<td>0.10, ±0.45</td>
<td>Moderate</td>
</tr>
<tr>
<td>creatinine (µmol·l⁻¹)</td>
<td>492.9 ± 37.0</td>
<td>33.5 ± 19.2</td>
<td>-1.93, ±1.92</td>
<td>Large</td>
<td>436.6 ± 28.1</td>
<td>583 ± 37.1</td>
<td>-1.46, ±1.26</td>
<td>Large</td>
</tr>
</tbody>
</table>

Figure 1 - Percent change in haematological and biochemical values from baseline to 1 week post a two-day women’s rugby sevens tournament. Data are presented as mean ± SD. Magnitude of change is represented as small (**), moderate (**), large (**), or very large (**).
exercise response of leukocytes. 18 One week post-competition, a comparatively light training week (three field sessions and two gym sessions), National players leukocyte counts were below baseline. While this may suggest an adaptive response to competition, a more reasonable explanation may be that these players entered the tournament with some degree of residual inflammation (given both WBC count and CK were higher in National than State players at baseline). These outcomes are important findings for specialists working in rugby sevens and show that, despite an athletes’ competition level or fitness, a substantial amount of exercise-induced inflammation can occur following a rugby sevens tournament, and that one week of reduced training load is sufficient for adequate recovery. Further research is needed to document the typical time-course for recovery following rugby sevens tournaments in both men and women. Attention should also be given to the potential effects of recovery modalities such as cold water immersion and compression garments to promote recovery after physically demanding tournaments. Although the inflammatory response was similar between playing-levels, the degree of muscle damage and haemolysis were markedly higher for State players. Despite similar between playing-levels, the degree of muscle damage and haemolysis were markedly higher for State players. Despite modest changes in this study. National players tended to have higher creativity levels both pre and post tournament, likely due to differences in the muscle mass of National and State players, although body composition was not directly quantified in this study. Understanding that the high physical demand of rugby sevens does not place any excess stress or demand on the renal system as observed in a normal, healthy population is advantageous information for the clinician. Blood tests conducted for health reasons can exclude the possibility of clinically high creatinine levels being related to rugby sevens game play, however, modest elevations can be expected, particularly in athletes with larger muscle mass. In conclusion, both State and National level players exhibit a similar change in haematological markers of inflammation following a two-day women’s rugby sevens tournament. Despite differences in off-field play, markers of haemolysis and muscle damage increased more in State players, possibly due to poorer physical strength and fitness and being less accustomed to the physical demands of rugby sevens. This information may be useful for the physical development of players for optimal performance, clinical management of players, and prescription of training following a tournament. Future research with increased participant numbers and careful selection of anthropometric, physical and physiological measures is needed to explore the results of this study. Understanding the influence of NSAIDs and recovery modalities such as cold water immersion and compression garments will also be beneficial for coaches and support staff to promote recovery of their players post-tournament.

PRACTICAL APPLICATIONS
Given that post tournament markers of inflammation correlated with the total on-field movements of players, irrespective of playing level, recovery following tournament should be tailored to individuals based on their own playing duration and intensity. Physical fitness and a greater familiarity with the high demands of rugby sevens reduces the changes in markers of muscle damage and haemolysis resulting from a tournament. As such, strength and conditioning staff should focus as well as following them accustomed to the high physical contact load in order to reduce physiological disturbance and subsequent recovery time required post tournaments.

ACKNOWLEDGEMENTS
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original research

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original research


COMMENTARY

James McGarvey

This study takes a solid if simple design and applies it capably. However the sample size is very small (22 athletes over a single event) and this means all correlations derived from this study are questionable. If the results are taken at face value the next issue faced by clinicians reading the paper is how this changes clinical practice. The lack of change of creatinine related to a severe trauma could be useful knowledge. The changes seen in other blood parameters however do not really allow any more accurate prescription of recovery, training load or game play. Activity causes inflammation and haemolysis, we know this, and the individual variation in blood parameter responses means that in my opinion blood testing does not add to simple clinical assessment of where an athlete is at physically. Possibly creating a ‘biological passports’ type system where each individuals blood response was monitored over multiple exercise events could be more useful. This would then give individual baseline data, which might be accurate enough to more readily interpret subsequent results. However this would be laborious, invasive and have no guarantees. In general I think it is counterproductive to add any fuel to the obsession of some athletes and regular medications, allergies or significant medical history.

AUTHORS’ RESPONSE

Although the sample size of this study was modest the substantial effects of elevations in haemolysis and muscle damage are noteworthy in exploring the demands of women’s rugby sevens. The observed correlations can be interpreted in light of the confidence limits which indicate the likely (true) range of the mean effect in the population. Clearly routine testing of blood parameters only yields limited results, and more importantly the outcomes here are for the benefit of clinicians, strength and conditioning specialists, and recovery staff, who work directly with players during and after football games and tournaments.

INTRODUCTION

Pseudoaneurysm of the superficial temporal artery is an unusual but not uncommon sequelae of blunt trauma to the forehead. It can be iatrogenic but is more commonly encountered during contact or collision sports. This case report details the diagnosis in a young soccer player, its investigation and management.

CASE REPORT

A 22 year old soccer player presented with a small (~1cm) lump on the left side of his forehead. He had been elbowed in the forehead whilst playing soccer or 6 or 7 days prior to presentation. On the evening of the impact, he noticed a small firm swelling in the area. The lump had persisted, was mildly sore and was causing cosmetic inconvenience. The patient was referred to vascular surgeons where local anaesthetic infiltration revealed a pulsation in the lump. However, further examination of the lump prior to infiltration revealed a pulsation in the lump. The intended aspiration was aborted, and the diagnosis of a traumatic false or pseudoaneurysm was made. The diagnosis was confirmed on ultrasound (figure 2).

The patient was duly referred to vascular surgeons where local anaesthetic infiltration revealed a pulsation in the lump. However, further examination of the lump prior to infiltration revealed a pulsation in the lump. The intended aspiration was aborted, and the diagnosis of a traumatic false or pseudoaneurysm was made. The diagnosis was confirmed on ultrasound (figure 2). The patient was referred for further investigations to exclude an underlying cause.

The patient was referred for further investigations to exclude an underlying cause. However, a recent injection and radiological intervention had probably only yielded limited results, and more importantly the outcomes here are for the benefit of clinicians, strength and conditioning specialists, and recovery staff, who work directly with players during and after football games and tournaments.

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Take care of the steroid flare

BRUCE HAMILTON, MEGAN MUNRO, JAKE PEARSON, LOUISE JOHNSON, JORDAN SALSA, DANIEL EXETER, CHRIS MILNE

INTRODUCTION

For over 50 years, corticosteroid injections have been utilised in sports medicine to reduce inflammation in joints, bursae and around tendons. Some authors have proposed that they are also beneficial in managing acute soft tissue injuries such as muscle strains, although this remains controversial. 1,2 While their efficacy in reducing inflammation is well recognised, corticosteroid injections are not without potential adverse effects. Adverse effects may be defined as “an adverse event for which the causal relation between the intervention and the event is at least a reasonable possibility”. 3,4 However, as a result of the heterogeneity of research into adverse outcomes, a recent systematic review of the adverse-effects of extra-articular corticosteroid injections was unable to establish the incidence of adverse outcomes, but did highlight a wide range of possible adverse outcomes. (Table 1). In addition to these relatively minor and frequent outcomes, severe allergic reactions, tendon rupture, hyperglycaemia in diabetics and infections have been reported. 3,5 A delayed increase in pain following both intra and extra-articular corticosteroid injections, known as a steroid or cortisone flare, may occur in up to 30% of patients, but paradoxically is only rarely reported in the literature. 6,7 The following case highlights features of the post-injection steroid flare.

CASE REPORT

PC is an elite Paralympic swimmer who sustained an acute injury to her left shoulder while training, approximately 8 weeks prior to a major competition. Clinically, symptoms and signs were suggestive, but not conclusive for a gleno-humeral intra-articular pathology. Relative rest, physiotherapy and non-steroidal anti-inflammatories (NSAIDs) had little impact. Imaging, including and MR Arthrogram of her shoulder was inconclusive, and therefore based on a clinical impression of an impingement and in an effort to advance her training status, a radiologically guided gleno-humeral injection of triamcinolone acetonide (40mg) was performed. The injection also included a “very small” amount of omnipaque 300 (to confirm the location) and ropivacaine 0.75% (2mls). Immediately post injection, her pain score moved marginally from 5/10 to 4/10. PC was fully informed of the goals, risks and benefits of the procedure and the infiltration and immediate post injection period was unremarkable. The Athlete was advised to have 4–5 days off swimming, and to have a clinical review prior to returning to training. As a result of this training down time, PC returned to her home town (at a distance from the treating practitioners) immediately post injection.

The day following the injection procedure, PC awoke feeling unwell, with “flu-like” symptoms, was nauseous and had a headache. She felt hot and had a bright red flush over her face, neck, left shoulder and chest. Her shoulder was extremely painful both at rest and with any movement. On contacting her treating Physician, she was immediately referred into her local General Practitioner for a clinical review. PC was afibrile, and was haemodynamically stable. She was diagnosed with a “post-steroid flare” and was prescribed an NSAID and paracetamol for the pain. PC spent a day in bed, with her “flu-like” symptoms, flushing and headache gradually resolving over 24 hours. Her flare of shoulder pain lasted for approximately 10 days.

Ultimately, the corticosteroid injection had little impact on her shoulder symptoms, and she continued to be treated with oral anti-inflammatory drugs and physiotherapy, with symptoms and signs slowly but steadily improving enabling a graduated return to full training.

DISCUSSION

This case highlights an adverse effect of an intra-articular corticosteroid injection in an elite Paralympic swimmer. The delayed onset of increasing shoulder pain experienced in this case was typical of a “steroid flare”, although the general malaise, and widespread skin flushing are rarely described in the literature in direct relation to a steroid flare. 8,9 While the adverse impact was ultimately of short duration, the outcome of the procedure may have been substantially different, had injection been performed in an immediate pre-competition period. A 2002 clinical guide, highlighted that corticosteroid injections should not be used without a clear diagnosis, and that physicians should resist the use of corticosterone injections to expedite a return to play. 10 As this case illustrates, without a clear diagnosis, injected corticosteroids may be of little benefit, and that even with the best of intentions, adverse outcomes will occur.

A steroid flare typically begins 2-3 hours after an injection and is self-limiting, resolving after about 24 hours. It is thought to result from a crystal induced synovitis, caused by preservatives in the injectate. While there appears little clinical evidence, it is believed that the type and volume of corticosteroid injected may relate to the risk of a flare reaction, with short acting glucocorticoids and larger injectate volumes having greater risk (Table Three). While not based on any available empirical evidence, reduction in the rate of flare reactions may be achieved by utilising a slow rate of injection, the application of ice post injection, and the prophylactic prescription of non-steroidal anti-inflammatory drugs. A recent trial showed no benefit from utilising a buffer in the injectate in reducing the incidence of post injection flare. 4 The possibility of post injection sepsis, or a reaction to another of the injection components, should always be considered. After excluding other potential causes of the symptoms, the treatment of the steroid flare is expectant, managing the synovitis with non-steroidal anti-inflammatories (oral prednisone is a consideration in severe cases), and simple analgesia for additional pain. Relative rest, intermittent ice to the affected area will assist in pain management.

PC continues to have shoulder pain related to swimming, which is being actively managed with Physiotherapy, strengthening, posture and stroke correction. While the injection appeared to have little immediate benefit and indeed appeared to delay the planned training progression, it is possible that the depot injection of corticosteroids (unrelated to the intra-articular location it was deposited) has had a sustained clinical benefit. The dramatic nature of this steroid flare raises concerns regarding any future use of corticosteroid injections in this athlete. Repeat corticosteroid injections in the future do not appear to be contra-indicated, but at the very least, repeat administration of the offending corticosteroid should be avoided.

REFERENCES

I

In this example, we have a patient who has a desire to change the direction of his well-being. He has gone so far as to make and attend an appointment with someone who is outside his primary healthcare team. This is a positive indication of his level of motivation to address his issues.

Before assessing the patient in any way, there is some basic information that needs to be collected in the waiting room. This includes collecting the patient’s ethnicity (this then needs to be confirmed with the patient during the consultation), and getting an agreement to share information with his GP.

Ethnicity data is important in all medical environments because of ethnic health discrepancies which can only be successfully addressed when the ethnicity is correctly recorded. Maori patients in particular suffer poor health outcomes in New Zealand and it is important that as we as medical practitioners assess how we can be a part of the solution rather than part of the problem. According to my understanding of New Zealand literature our practice outcomes for both cardiovascular and respiratory statistics, so this is doubly relevant in this example.

A starting point for this sort of consultation might be to understand the motivation. The patient presents wanting to get “fit”. In his opinion, what is “fit”, or “fit for what”? Remembering that fitness is discipline specific, and you get fitter at what you do, and at what you don’t do. The word “fit” is a euphemism for wanting to lose weight. It might also be a euphemism for not dying from cardiovascular disease in the next decade. Irrespective of what the motivation is, it is a good marker of the belief system of the patient and can be explored quite extensively to understand how the patient could enhance their life experience. Understanding the motivations, and why the patient is presenting now, is a key part of the first consultation.

Having identified the patient’s objective, and ideally the motivation, fears and beliefs behind that motivation, I would tend to look at what currently exists in the patient’s world. I use the following headings to address this context for the patient and their presentation: Exercise, Work, Financial pressures, Family, Life, Injury/Medical needs. These first six relate to elements that require energy and attention. However, the following elements may loosely be described as what nourishes the patient: sleep, rest, nutrition, psychology/thoughts, spirituality. Going through these categories individually with the patient identifies what is normal for the patient, and what the current situation is. The patient will quickly see how interrelated they are; for example injury or knee pain may reduce the exercise capacity, reduction in exercise means for some people the loss of an effective stress management (psychology) pathway, which subsequently results in an increase in a perception of stress which may originate from home or work life. Not finding relief of stress can affect sleep, which leads to tiredness and malaise, “comfort eating” or “boredom” which can result in weight gain. Work gain in the context of injury will further reduce fitness and will often appear like a Catch-22. Advice to exercise to lose weight in this context would be counter-productive unless it addresses the specific context. Hence, any solution must interrupt the above negative cycle for the body to ‘heal’ or find ‘health’.

Once the practitioner has an understanding of how things inter-relate for the individual, it will be easier to create a plan that addresses the patient’s reality. In my view it is also critical to understand when in the patients’ life did major life changes occur. Most major health changes are tied into significant life events. For example, people’s weight changes when they get bullied, get depressed, lose loved ones, get stressed and overworked. Heart attacks occur when there are earthquakes, family sports, career changes.

Drawing a time line for this patient might help with the understanding of what changed for him from the ages of 25 to 44 years, and what some of the factors are that have affected his well-being over time. With this sort of approach, it is possible to target the two or three areas that need the most attention for now. For the above patient, it might be finding a way to combine a regular and appropriate exercise with time spent with his two children. He might identify the stressful thoughts which are affecting his sleep and make an agreed plan to address those issues. He might identify gaps in his nutrition knowledge or he might identify risky times when despite good understanding, he makes a choice to eat food with little nourishment.

There is some further information which is needed in this case and it includes some of the specific medical tests which would be accepted as normal in this presentation. Such things as heart rate and rhythm, blood pressure, blood glucose level, renal function tests in addition to the cholesterol levels already taken can be used to stratify cardiovascular risk in someone undertaking exercise. The "knowyournumbers.co.nz" website can be a useful tool for the patient to understand some of these risks.

Having now identified the patients objective and motivation, the reasons behind that objective may be explored for the discussion, and having formulated a clear plan that identifies what steps might be taken, a plan for monitoring is needed. Medically, that monitoring will be important, but it is also important that the monitoring relates to the objectives that have been set, not just measuring what we can measure. If the patient is in a sporting and active environment, to relieve stress, get fitter with regard to playing touch rugby next season, and setting a good example of healthy living to members of the family, then using body weight as a marker of progress is not necessarily helpful.

Ultimately it must be the patient who decides what their intervention needs to be to fit their needs, but only after they have a clear understanding of what stands between them and well-being.

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NAT ANGLEM

Sports Physio, Christchurch
Athletes with a spinal cord injury: Musculoskeletal issues and remedies

MEGAN MUNRO, JUSTIN RALPH, JAKE PEARSON

True / False

1. Spinal Cord Injury (SCI) wheelchair using athletes report higher rates of shoulder pain than non-athlete wheelchair users.
2. Para-cycling athletes with a SCI are more likely to sustain upper limb injuries than non-athletes who use wheelchairs.
3. The musculoskeletal assessment of an athlete with a spinal cord injury is different to that of an able-bodied athlete.

The previous article in this series covered the key medical issues for athletes with a SCI. This article will discuss some of the musculoskeletal issues that need to be considered in an athlete with a SCI, with a particular emphasis on swimming and cycling athletes.

The shoulder tends to function as a weight bearing joint for wheelchair propulsion and transferring - a role for which it is not anatomically designed. As a result, the shoulder is the most commonly injured body part in the overall wheelchair SCI population with a reported incidence of 30 to 73%, and athletes are no exception to this. For example, a study of female wheelchair basketball players found that shoulder and upper extremity pain was reported by over 90% of the subjects interviewed. Interestingly however, some studies have reported that non-athlete wheelchair users may actually be at a higher risk of shoulder pain, due to lower levels of physical conditioning. Current use of the shoulder for propulsion and transferring results in exposure to both higher intra-articular pressures and the abnormal distribution of forces across the subscapularis muscle. The prevalence of shoulder pain in able-bodied swimmers is well documented in the literature and reported to be as high as 91%. Coupling continuous manual wheelchair propulsion with the demands that swimming places on the shoulders, results in an increased risk of rotator cuff pathology, impingement, and stress across the AC joint and distal clavicle. Even if an athlete has an incomplete SCI and does have some kicking ability in the water, the arms remain the dominant propulsive force. As a result, SCI athletes who swim tend to have excessively dominant shoulder abductors and relatively weak external rotators. Scapulothoracic stabilisers may be weak due to the sitting and propelling posture in the wheelchair (as well as potential neurological compromise depending on the level of spinal cord lesion). Complete rest of the shoulders is not really an option for this athletic population, but physiotherapy can minimise muscle imbalance issues of the glenohumeral joint and improve both scapulothoracic stabilisers and thoracic mobility. Care must be taken when an athlete transfers on and off a plinth as depending on the level of lesion the athlete will have reduced sitting balance and core muscle activation. With a lesion of T6 and below, the therapist should expect some compromise of trunk stability. SCI athletes should have a well-considered strength and conditioning dry land programme, and complete specific movement preparation and mobility exercises to perform prior to warming up in the pool. Examples of these are active seated thoracic rotation stretches, thoracic extension stretches over a foam roller, active shoulder range of movement stretches, thoraband resisted exercises for the rotator cuff, latissimus dorsi, serratus anterior and rhomboids and prone holds and side plank holds for abdominal activation. The main aim of the dry land program is to minimise the injury risk to the shoulders.

Swimmers with a SCI are eligible to swim all four strokes – freestyle, back stroke, breast stroke and butterfly. They are assessed on their muscle power on dry land and their functional ability in the pool. If they have full power in their arms and trunk, they will have a higher classification status. Swimmers with a complete SCI are unlikely to swim breast stroke due to the legs being the main propelling force in this stroke. Swimmers with an incomplete SCI shoulder lesion should be able to get some propulsive force from the legs. Stairs, turns and finishes can all be altered depending on an athlete’s functional ability and is assessed and recorded as part of their classification status. An example of this would be using the assistance of a support staff member whilst on the diving blocks for testing position, most commonly in supine or seated. Athletes are likely to compensate with certain movements and special care should be taken to place them in the correct position to isolate the desired muscles or movements. Following specific musculoskeletal assessment a functional component is carried out (this is also the way athletes are classified for competition). For example, an athlete with a lower thoracic SCI will retain some dynamic trunk stability, reducing the risk of shoulder injury, whereas an athlete with a higher spinal cord injury will be more at risk due to loss of trunk stability.

Balance or only having to ‘show intent’ to touch the wall with two hands on a breast stroke finish. Para-cycling is a sport in which athletes with a SCI compete on a recumbent handcycle using their upper limbs to power the bike and, depending on the SCI level, their trunk to help them stabilise. Unfortunately, studies reporting the incidence of injuries specifically in handcycling athletes are currently non-existent. However, studies have suggested that shoulder joint forces generated during handcycling are less than in hand- rim propelled wheelchairs. Hence, from a rehabilitation perspective handcycling has been recommended as a good alternative to handrim propelled wheelchairs. However, since elite handcyclists produce a significantly higher amount of power at significantly higher cadences (up to 125 revolutions per minute) for sustained periods of time, they would seem at risk for overuse injuries of the upper limb and shoulder joint in particular. Shoulder load is also affected unilaterally in those handcyclists who have a scoliosis related to altered trunk muscle function depending on their level of injury. The handcyclist’s posture can therefore mean that one shoulder is further from the pedal than the other, increasing the strain on that side.

To help minimise these injuries, athletes are set up on the handcycle in such a way that both full elbow extension and flexion are avoided, thereby helping maintain a stable position of the shoulder. Handcycles are complex, and seat position, crank length and crank width can all be modified to help attain an optimal position on the handcycle.

In the musculoskeletal assessment of a SCI athlete a significant emphasis must be placed on the subjective assessment, gaining an understanding of the athlete’s functional capacity associated with the level of their SCI. The level of spinal cord injury will determine which muscles are expected to function and therefore where the assessment should be focused. It is important to determine a

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Photo credit: Katrina Robinson Photography

Follow ing a musculoskeletal assessment an appropriate exercise programme will likely include components of rotator cuff, scapulohumoral and trunk stability exercises, depending on the level of SCI and what specific issues the assessment has highlighted. The primary aim of this intervention is to prevent overuse injuries in the upper limb. Working closely with SCI athletes allows the identification of their functional ability and capacity, and helps guide specific training volumes and intensity, and any rehabilitation required, to minimise the risk of injury in this group of athletes who challenge their bodies on a daily basis.

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Freeski and snowboard: Park and pipe injury rates, patterns and prevention

A New Zealand/USA perspective

GINNY RUTLEDGE

As part of a Prime Ministers Scholarship, I recently attended both the ACSM in San Diego and visited the USSA Centre of Excellence (COE) training centre in Utah. The USSA COE is the equivalent of the HPSNZ national training centre for USA Winter Sports. This was an opportunity to explore and compare injury rates, patterns and prevention strategies across the NZ and US park and pipe programmes, and this report captures that comparison.

Background to Park and Pipe: The Evolution of an Olympic Sport

While snowboard halfpipe was first seen in the Nagano Olympic Games in 1998, it was not until 2011 that freeski (FS) halfpipe as well as freeski and snowboard (SB) slopestyle was added to the Olympic programme. Sochi 2014 was the showcase for these sports on the Olympic stage. As a result of this being a new Olympic sport, in 2011 there was notable variation in strength and conditioning backgrounds of many of the athletes competing in these events, with a number having only a limited training period prior to inclusion into the NZ team.

For example, in 2012 USSA compared the relative strength of this new group of limited training age athletes against mogul skiers who have similar sport demands. The strength ratios of the free ski women (2.18 x Kg/BW) were found to be well below that of the mogul skiers (2.7 kg/BW) (Figure 1). Prior to 2014, both the USA and NZ were faced with the challenge of developing strength and neuromuscular control, as well as safe landing patterns, teaching training, recovery and competition strategies in a relatively short timeframe leading into the Olympic competition.

Injuries in Freeski and Snowboard

Injury data capturing information collected around the time of injury may help direct staff toward the greatest area of modifiable risk. This data includes weather and snow conditions, injury mechanisms, physical condition, fatigue and other factors. Both NZ and USA have aligned this with International Federation of Ski who have an existing injury surveillance system that cover world cup events. In the 2014 New Zealand park and pipe programme, 13 funded athletes suffered a total of 25 injuries that required time off snow. Our total time loss to injury for the year was a staggering 680 days with the average days lost being 27.2 days per athlete. Fifty per cent of all reported injuries occurred in general training, with 25% occurring in competition training or during competition. USA, with a larger group of (freeski) athletes (27) reported 3800 days’ time loss to injury from September 2013 to April 2015. This equates to a staggering 10 years of injury time loss over a two year period.

As NZ has only a small pool of carded athletes (13) our current data can be used as a snapshot only with two major injuries; one season ending and one career ending significantly influencing our data. Thirty-six per cent of injuries to the NZ team in 2014 were knee injuries, however the percentage of total lost days attributed to knees was 57%. The average days off for a knee injury being 43 days. If we compare this to FIS (International Federation de Ski) ski and snowboard athletes competing in world cup 1^4 44% of injuries occurred to the knee. This is lower than is reported in alpine whereby at world cup level 68% of all injuries are reported as knee injuries.2

Prior to the 2014 winter Olympics, 3 out of 13 New Zealand team freeski and snowboard athletes had suffered an anterior cruciate ligament (ACL) injury with one athlete having also sustained a recurrent ACL injury. Subsequent to Sochi another of this same group ruptured an ACL making a total of 5/13 ACLs in this small group. USA report similar eye-opening statistics.

With the 2011 decision to include freeski into the Olympics in 2014, there was a jump in the total number of ACL injuries in the 2012 season. In USA, 9 out of 20 freeski athletes (45%) experienced season ending injuries with the majority of these being ACL injuries.

Where do freeski park and pipe ACL accidents occur?

Currently, there is limited research into mechanisms of park and pipe freeski and snowboard ACL injury. However USA surveyed athletes post ACL injury and reported that the majority of accidents unsurprisingly occurred during landing from an aerial trick. The three most common landing positions that resulted in (ACL) knee injuries include landing in the back seat (or on the tails of the ski), coming up short on landings (thereby landing on a flat surface) and finally overshooting a jump and landing beyond the “sweet spot”. Less common was landing on the deck of the half pipe or landing flat in the half pipe.

By comparison with freeski, alpine ski racing has recently been intensively studied, with three distinct ACL injury mechanisms being described by Bire et al.1 20 cases of ACL injury reported through the International Ski Federation Injury Surveillance System for 3 consecutive world cup seasons (2006-2009) were obtained on video. Video footage was then reviewed in an effort to more clearly understand the loading mechanisms that may cause injury.

In alpine skiing, 50 per cent of ACL injuries occurred via a mechanism referred to as the “slip catch”, described as occurring during a turn before or without falling. The racer loses the pressure on the outside ski while extending the knee to regain grip the inside edge of the downhill ski catches abruptly forcing the knee into internal rotation and valgus causing injury.

A second mechanism described is referred to as “back weighted” which can be explained by a skier landing on the tails of the ski with near straight or extended knees. This may occur if a skier is out of balance backwards over a jump. While still unclear, the loading mechanism may be a boot induced anterior cruciate mechanism. The knee is out of balance backwards and inwards and at the time of injury the skier is in a deep dynamic snowplough. The injuring knee rolls from the outside to the inside edge catching in the snow thereby forcing the knee into internal rotation and valgus. This is similar to that described in the slip/catch mechanism.2

Confounding Variables in Skiing Injuries

Confounding variables which may play a part in injury causation in free skiing injuries, include course conditions, visibility and weather. It is important that we keep a good database around these factors, but it may not play as important a part as we think. Specifically, it may be that athletes modify their tricks to adjust to the conditions, thus difficulty of tricks encouraging athletes to progress within their skill capability.

Development of Snowboard and Freeski

The rate of progression of tricks within the sport is extraordinary. In snowboarding in 2010 double corks-1080s (combination of flips and spins equalling three rotations) were the highest tricks achieved. If we move to 2015, triples, 1620s are being performed with a phenomenal 4.5 rotations. In 2015 a Great Britain slopestyle snowboard athlete had completed the first quad cork (four aerial rotations) setting the benchmark higher again (Figure 2).

Freeski has had a similarly fast progression progressing to triples with complicated spin direction and changes in axis as well as technical grabs.

Increasing amplitude (vertical height measured from the lip of the pipe) is required to deliver increasingly more challenging number of rotations or inversions. Figure 3 illustrates the gradual increase in amplitude demonstrated by a NZ free half pipe athlete as compared to the Sochi gold medalist between 2012 and 2015. The NZ athlete demonstrates an increase in amplitude of 4.5 feet to 7.2 feet during that period.

Baseline Testing and Return to Snow following ACL Injury

The current SSNZ return to snow criteria following an ACL injury, includes successful completion of the lower limb range of motion (ROM), thigh girth, strength measures (isometric mid-thigh pull and handheld dynamometry), balance testing (Y Balance test), International Knee Documentation

 Figure 1: USA data on Isometric Squat and Body weight. Reproduced with permission of USSA Ski and Snowboard Association

Figure 2: Benchmarking tricks and rotations: 2006 to 2010 in Men’s Snowboard Half Pipe with predictions leading up to 2018 (Reproduced with permission of Snow Sport’s New Zealand.

Figure 3: Progression of Amplitude in Half Pipe freestyle. Olympic and NZ Athlete example. Reproduced with permission of Snow Sport’s New Zealand.
CONFERENCE REPORT

**Bike Fit Myths**

**Reflections from the 2015 Medicine of Cycling Conference**

**MARK HARRIS**

A long side the increased popularity of cycling there has been a surge in the services offered to cyclists including custom bike fit. For anybody who has worked with cyclists or athletes that use cycling as a training modality you will know how important bike fit is for reducing injury risk and for comfort of the rider. There is however a lack of consensus in all aspects of bike fit and many myths that still pervade the bike fit world. Compounding this is a lack of up to date good quality research to inform current practice. There are some of the reasons that the Medicine of Cycling (MOC) group was formed and a subgroup tasked with looking at improving the standards and delivery of bike fit. MOC has now published a Bike Fit Consensus Statement (Medicine of Cycling, 2013) as a starting point to help address these issues. MOC runs an annual conference and in 2015 had a Bike Fit stream alongside the main conference. This was designed as another forum to build consensus, understanding and present literature and data to Bike Fit. The following is a summary of some of the highlights from this section of the conference.

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Why not combine a bit of CME with some fun and exercise? There are several organisations arranging these expeditions now, and as I read through the "Medicine On The Edge" (MOTE) website, the Perú conference caught my eye. I'd wanted to see Machu Picchu since I can remember: throw in some interesting topics and the chance to trek for 5 days at high altitude and after briefly considering that the chance of dying was slim, I booked the tickets.

The topics sounded intriguing: everything from high altitude syndromes and their treatment, to lightning strike, avalanche medicine, and why we live or die when things go wrong in the mountains. There was also the added bonus of the trekking and camping sessions, with the opportunity to tramp to 5000 m and see how it felt. I'd never been higher than the South African rugby venues (Ellis park sits at 1810 and Bloemfontein at 1400 metres above sea level), so I had no idea how my particular physiology would cope with exercise and altitude.

I write this from the perspective of a humble colorectal surgeon, one physiotherapist, one occupational hygienist, and an emergency physician. The lectures included allergy (especially in those who react to sulphur drugs), diuretics, (fairly universal, and not surprising as it is a diuretic, but can be a bit annoying) paraesthesiae in the extremities, (these seem to be intermittent and happen at random times) altered taste , decreased appetite, and nausea. The medication can be stopped after 2-3 days at peak altitude, though I chose to continue taking it until I left Cusco on my way home. The conference was also planned to coincide with Inti Raymi (Festival of the Sun, where the locals celebrate the return of the Sun God at winter solstice) so we were treated to the city in all its finery, with many sections of the community represented in full local dress, dancing and parading through the streets.

After a long drive passing through the Sacred Valley, and a couple of hours of tramping, the first nights camping was at 4000 m. We were just across the valley from the majestic Salcantay (Wild Mountain) and listened to the nearby avalanches which occurred at frequent intervals. During the night the full moon and the frost on the ground made the place look magical. The next day at the Salcantay pass (4950 m) a pulse oximeter was produced, and we were all treated to the sight of our oxygen saturations at levels which would normally be alarming. From that point on, it was either steeply down or steeply up, or "Inca flat" (meaning not quite as steep and either down or up but never flat). The path is well defined, and for much of the way consisted of rocks which had been placed to form the path. On day 4 we joined the Inca Trail, where the rocks continued but the symptoms resolved by recommencing the medication or in one case after arriving back at sea level at Lima on her way home. The group had two cases of gastroenteritis, and one severe knee contusion after falling and landing directly on a patella on the rocky path. While two of our porters were also treated by the team, they did appear to be supermen - racing ahead of us carrying enormous loads at twice the speed we were progressing, setting up the camp, and producing amazing carbohydrate laden meals out of what had been carried in. They do stop to rest, and we did note in several of them the signs of chronic oxygen deprivation - barrel chests and clubbed fingers. Only a few seemed to be chewing coca leaves; loud music played over it and drink coca tea - everyone else does.

The top of the Salcantay Pass, stopping for chocolate and waiting for the rest of the group.

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As we progressed there were more Inca ruins to see, lots of very photogenic sites, until finally after a day of seemingly endless descents and switchback walks, we reached the ultimate site of Macchu Picchu. There are no campsites in Macchu Picchu, so the accommodation is in the town of Aguas Calientes, in the valley below, where we had the first showers since we'd left Cusco and a celebratory "Pisco Sour". Bliss!

The Inca Trail section has to be done as part of a guided group - there is no freedom walking any more and numbers are strictly regulated

The Inca Trail is great, Macchu Picchu is as incredible as it sounds, but the Salcantay was more amazing for the views, and much less frequented. I'd definitely recommend doing it if you are even mildly interested. MOTE uses a really helpful travel agent, the hotels at the beginning and end were comfortable, and our guide Pepe was extremely knowledgeable about everything from the trail itself, the Inca ruins and the flora and fauna on the trail.

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