NEW ZEALAND
Journal of Sports Medicine

Vol 45 • No 2 • 2018

Official Journal of Sports Medicine New Zealand Inc.

PUBLISHER
SPORTS MEDICINE NEW ZEALAND
PO Box 6398
Dunedin
NEW ZEALAND

Email: admin@sportsmedicine.co.nz
Web: www.sportsmedicine.co.nz

ISSN 0110-6384 (Print)
ISSN 1175-6063 (On-Line)

CONTENTS

CONTRIBUTORS

NZJSM Volume 45, Issue No 2

Lauren Boothby

Lauren Boothby recently completed her Honours degree in exercise and sport science at the University of Western Australia and has worked as a performance analyst in both netball and Australian football. Currently, she is employed at the North Melbourne (Kangaroos) football club, who compete in the Australian Football League.

Brian Dawson

Brian Dawson is a Professor in sport and exercise physiology at the University of Western Australia in the school of Human Sciences (exercise and sport science). He has a wide range of publications, but most particularly in performance related aspects of team sports. He is a long standing consultant with the West Coast Eagles football club, who compete in the Australian Football League, and has coached Australian football teams at State League level in Western Australia.

Patria Hume

Professor Patria Hume is a sports injury biomechanists and sports epidemiologist.

Doug King

Dr Doug King is a sports epidemiology and injury mechanisms researcher and emergency nurse.

Amitesh Kumar

Amitesh Kumar works as an Urgent Care Physician and General Practitioner at Bakerfied Medical and Urgent Care in Manukau, Auckland. Amitesh is also, actively involved with sports and exercise medicine with teams and the community

Chris McCullough

Chris McCullough is Principal Physiotherapist at Forrest Hill Physiotherapy. He has had over 36 years in private practice and sports medicine. Chris is currently President of Sports Medicine NZ having been elected in 2007. His previous roles include lead physiotherapy provide to High Performance Sport NZ, All Black physiotherapist, Olympic and Commonwealth Games therapist and is currently physiotherapist to East Coast Bays Rugby Club.

Joshua McGeown

Joshua McGeown is a PhD student studying rehabilitation on SOBI.

Chris Milne

Chris Milne is a sports physician in private practice at Anglesea Sports Medicine in Hamilton. He has been team doctor for the NZ Olympic and Commonwealth Games teams from 1990 to the present and was team doctor for the Chiefs Super Rugby team from 1997 to 2003. A past President of the Australasian College of Sports Physicians he has also served as National Chairman and is a Fellow and Life Member of Sports Medicine New Zealand.

Peter O'Donoghue

Peter O'Donoghue is a Reader in Sports Performance Analysis at the Cardiff Metropolitan University School of Sport, which he joined in 2003 after being a lecturer in sports science at the University of Ulster. He has worked as a performance analyst in Gaelic football (inter-county level) and netball (junior and senior international levels as well as in the National Superleague). He is also a member of the International Society of Performance Analysis of Sport and General Editor of the International Journal of Performance Analysis in Sport.

Peter Peeling

Peter Peeling is an Associate Professor in exercise physiology at the University of Western Australia in the school of Human Sciences (exercise and sport science). He is also an Applied Research Coordinator at the Western Australian Institute of Sport. His publications span all performance related aspects of sport, but with special interest and expertise in iron status and metabolism in athletes.

Logan Poloai

Logan Poloai is in his first year as a resident doctor at North Shore Hospital in Auckland. Having served on the University of Auckland's Sports Medicine Society as an executive throughout medical school, Logan has a strong interest in pursuing a career in Sport and Exercise Medicine.

Alice Theadom

Associate Professor Alice Theadom is a psychologist specialising in mTBI (sports included).

Karen Wallman

Karen Wallman is an Associate Professor in exercise physiology at the University of Western Australia in the school of Human Sciences (exercise and sport science). She has published widely in the field, with particular expertise in chronic fatigue syndrome and exercise, as well as ergogenic aids for sporting performance.

EDITORIAL

The movement story of many Kiwi kids - not so happy ever after?

CHRIS WHATMAN

Apologies as most of my recent editorials have focused on kids' sport – and here I go again. I recently attended a youth athlete development conference which re-ignited my interest in how kids develop movement. This was a path I started to walk when undertaking my PhD some years ago. My interest was in lower extremity movement patterns of youth and potential links to overuse injuries. This was inspired by the work of well-known American physical therapist, Dr Shirley Sahrmann and my own work as a physiotherapist with Graeme and Steve White here in New Zealand. Sahrmann's work on the diagnosis and treatment of movement impairment syndromes always appealed to me as a way to look past the diagnosis to the cause of the problem. Unfortunately, I quickly learnt that PhD proposals rely heavily on the availability of reliable tests, which were scarce in the movement world and thus the PhD focused on the development of reliable movement tests, rather than the development of kids' movement patterns!

So it was great to listen to American physical therapist Jeff Moreno talking at the youth athlete conference about what he termed a kids 'movement story'. As an aside I'm not sure when you should start referring to kids as 'athletes' rather than just kids who play sport! - but let's debate that another day. A well-known reason for kids dropping out of sport (or not engaging in the first place) is a lack of movement competency. One of Jeff Moreno's contentions is that a key indicator of good movement ability when kids are older is the amount of movement banking they do when they are younger – a significant chapter in their movement story. Movement banking was what Jeff thought occurrs during the unstructured, deliberate play (sometimes called 'free play'), that happens when kids play on the street and in the park with their mates. Nobody is there telling them what to do, they have to work out how to move effectively - the skate part was cited as an excellent example of an environment where a kid could bank a lot of movement (and probably a few fractures - all part of the learning!). We recently showed in a study of Kiwi kids that more free play may reduce the risk of overuse injury in sport. It has been suggested by others that this protective effect of free play may be the result of more diverse movement development – more deposits in the movement bank and likely a richer movement story? Jeff's thinking aligns with comments I have made before where I've likened healthy movement development to a healthy diet – you need lots of colours on your plate!

So how do we promote more movement banking in our kids so they live happily ever after? Simply put, do parents just need to get their kids to close their devices, switch off the screens, and kick them out of the house more so they can play? Probably a good start, but kids need time to engage in free play and this likely means they need to reduce the amount of structured organised sport they

participate in. I've suggested before that one way to achieve this would be for sports to delay representative team ages (congratulations to Netball NZ who have recently made a move in this direction). Young kids would then have a lot more time for movement banking at the local park with their mates! This week I've been watching the FIFA U17 women's world cup and I congratulate the team on a great achievement and creating history for NZ Football. I also recently watched my nephew run in the 200m at the Youth Olympics. Everyone at both events looked to be having a great time – but representing your country at 15, 16 years old (and as young as 12 years old in some sports!) is it really necessary – why the rush? Do these structures mean that too many young kids (note I haven't called them athletes!) end up time poor, juggling too many games, trainings and school work? Is there any time left to bank some movement with their mates at the park? An additional advantage of delaying representative selections would be to avoid the well documented relative age effect and the effects of maturation variability – delayed selection would significantly decrease the effect of both.

Jeff Moreno also suggested that movement was acquired and then learned in a similar manner to a popular theory underlying how kids learn language. The acquisition learning theory suggests language is acquired before it is learned. The acquisition stage involving a subconscious process reliant on meaningful interaction with the language. This is followed by the learning stage which is a product of more formal instruction and includes conscious processes resulting in knowledge about the language (e.g. grammar rules). According to Stephen Krashen who proposed the theory, acquisition is more important than learning. If this is true of movement development then young kids need to get out on the street and down to the park to immerse themselves in subconscious movement banking!

Movement learning is still important and perhaps we are letting Kiwi kids down here as well. Coming from a family of primary school teachers trained in the 60s my parents have often commented on the lack of quality physical education available to kids in today's primary schools. They suggest that teacher training back in their day prepared teachers to be more confident and effective in teaching movement ability, alongside maths and reading! These days it appears movement education is a very poor cousin to the three R's in our primary education system.

It seems to me there is a lot to be said for Jeff's idea of encouraging movement banking in our kids. There's a good chance it would result in more of them developing a rich and colourful movement story that has a happy ever after ending!

BEST OF BRITISH - HIGHLIGHTS FROM THE BJSM

CHRIS MILNE

HIGHLIGHTS FROM THE BJSM

This set of reviews covers the mid portion of 2018.

In the April IOC issue there was a major consensus statement from the IOC on prevention diagnosis and management of paediatric ACL injuries.[1] We know that the management is different in childhood to adult life and the IOC brought together a bunch of International experts in late 2017. They used a modified Delphi consensus process to identify the topics to be addressed. They started with injury prevention and recommend coach and athlete education on cutting and landing techniques, especially with a bent knee when landing. This is particularly relevant to our young netballers. Diagnostic testing is pretty similar to that in adults. Rehabilitation follows the type of regime we are used to seeing in adults. If surgery is undertaken, this is more complex than in adults as a surgeon has to take account of the growth plates. In essence, this is a sub-speciality area and only a few surgeons in New Zealand are regular operators in this area.

Later in the same issue, the IOC published a consensus statement on dietary supplements in the high performance athlete.[2] Although there is plenty of marketing, there is only caffeine, creatine, specific buffering agents and nitrate that have good evidence of benefits. The authors recommend that supplements intended to enhance performance should be thoroughly trialled in training or simulated competition before being used in a competitive environment. They also emphasise the very important aspect of awareness of inadvertent doping as many supplements contain banned substances.

Also in the same issue there were reports of the imaging detected acute muscle injuries in athletes participating in the Rio 2016 Olympics.[3] These numbered 11,000 odd and mostly affected the thigh muscles in athletics discipline. By contrast, there were only 156 tendon abnormalities in the Rio athletes, most commonly in track and field athletes involving the shoulder, Achilles and patellar tendons. Also, at the Rio Olympics, 25 bone stress injuries were reported, more commonly in women mostly in the lower extremities and most commonly in track and field athletes. This would concur with our experience over the years with the New Zealand team.

In the second issue in April, there was an article on red flag screening for low back pain.[4] The authors concluded that this was not consistent with best practice in low back pain management and they proposed that clinicians consider the importance of watchful waiting and the recognition that red flag symptoms may have a stronger relationship with prognosis and diagnosis. Respectfully, I would disagree with this, as it is important to recognise treatable pathology such as infection or malignancy at an early rather than a late stage and although clinical evaluation is critical, it does not give us all the answers.

Exercise has been increasingly used to treat patients with cancer. A metanalysis of randomised control trials showed that exercise interventions, especially under supervision, have small clinical benefits on self-reported quality of life and physical function in patients with cancer.

Rotator cuff related shoulder pain is very common in our community. Tim Cooke & Colleagues looked at the role of corticosteroid injections compared with local anaesthetic injections alone in the management of this problem.[5] They found that corticosteroid injections may have a short

term benefit for up to eight weeks over local anaesthetic injections alone. In my practice, I use this window to optimise compliance with a rotator cuff rehabilitation regime.

In the first of the May issues there were several papers related to hip and groin pain. The authors made the very useful point that imaging findings are only diagnostic for femoroacetabular impingement when they exist together with clinical signs and symptoms. Imaging should inform but does not necessarily dictate management. Later in the same issue, there was a paper describing the McKenzie method of treatment which involves lumbar extension exercises for chronic low back pain.[6] These authors conducted a randomised placebo-controlled trial of 148 athletes and re-evaluated them at the end of a five week treatment regime plus 3, 6 and 12 months after randomisation. They found a small and likely not clinically relevant difference in pain intensity favouring the McKenzie method. However, on reading further into the data, there is no mention made as to the patient's pain pattern. As an experienced clinician who has heard many experts talk about back pain over the years, those with flexion-related back pain are much more likely to respond to McKenzie treatment than those with extension-related pain which is likely to be related to causes other than lumbar disc pathology although that pathology may still be present. If the authors had only considered the results for flexion-related low back pain, I suspect the results would have been a lot more positive for McKenzie treatment.

The second May issue looked at patient education in patellofemoral pain. Rathleff and colleagues found that patient education for this condition was potentially potent and essential but was under-researched.[7] Later in the same issue, Callaghan looked at exercise for patellofemoral pain.[8] He concluded that which type of exercise and who benefits the most and by how much, remains unknown.

Tim Gabbett and colleagues highlighted seven tips for developing and maintaining a high performance sports medicine team.[9] These included the following:

1 Do the basics well.
2 Innovate within best practice.
3 Keep talking and laughing.
4 Define your culture.
5 Operate in unison.
6 Leverage the wisdom of crowds.
7 Maintain a proper perspective.

This is a useful article for anybody operating as a clinician in the high performance environment to consider.

Also, in this issue was an infographic by Neil Heron and other members of the Team Sky Professional Cycling Team.[10] Their team philosophy is built around marginal gains with a cycle of continual improvement and surrounding yourself with the best team. They pay meticulous attention to diet and hydration with some elements of cross training and an appropriate post-exercise recovery strategy. Although the Sky Team has been embroiled in controversies regarding potential doping issues, this infographic is an excellent two page summary of the things that matter that can be applied across a whole range of sport.

Concussion is frequently in the news these days and Martin Raftery, the Medical Director of World Rugby, convened an expert group to look at implementation of the 2017 Berlin Concussion Guidelines.[11] They have useful tables including mandatory and discretionary signs of concussion with the recommended appropriate action. The paper also emphasises the six key video review steps for the team clinician when looking at a potentially concussive event. Finally, the article concludes with an extensive list of

recurrent areas of concussion research focus in team collision sports. This list extends to most of one column of a page.

Issue 11 contained a 2018 update on the IOC consensus statement on relative energy deficiency in sport (RED-S).[12] Low energy availability underpins the concept of RED-S and is a mismatch between the athlete's energy intake and expenditure. This paper considers some new data that has emerged since the original publication on RED-S in 2014. Essentially, however, the advice remains as it was previously. There are 209 references for those who have a particular interest in this area.

Amateur boxing has been much in the news, often for all of the wrong reasons. In New Zealand in recent years, we have had several tragic deaths from people involved in charity boxing events. In 2013, there were several rule changes of which the most controversial was removal of the requirement to wear headgear in amateur boxing. The jury is still out on whether this has led to an increase in concussive or traumatic brain injury since the rule change, but to me it seems logical to put as much compressive material between your head and an opponent's fist as is practicable. In recent years, many sporting organisations have adopted a no needle policy and use of needles requires a declaration. This report indicates that 367 declarations were received from doctors representing 49 countries at the 2016 Rio Olympics.[13] The majority of the declarations were for use of local anaesthetics, glucocorticoids, NSAIDs and analgesics. Overall, the use would appear to be appropriate in the countries which declared it. However, we have no data on the remaining 150 or so countries which participated in the 2016 Olympic Games.

The last issue I will review for this instalment could well be called the Walking Issue. There was an editorial entitled "Walking : A Best Buy for Public and Planetary Health".[14] The search goes right back to the seminal work of Jeremy Morris and Colleagues published back in 1953 studying the exercise habits of London bus drivers and conductors. Since then, a huge amount of research has been published and much of this is summarised in this issue. In 1997, Morris & Hardman published a walking to health review and the authors emphasised that walking has strong social roots. It is much more than merely a physical and functional activity. Increasingly, it is recognised that the local built environment can have a significant influence in walking behaviour. Tudor-Locke & Colleagues posed the question "How fast is fast enough?".[15] They used walking cadence (steps per minute) as a practical estimate of the intensity of exercise in adults. A cadence value of over 100 steps per minute appears to be a consistent answer to this question and is supported by research evidence. Later in the same Issue, was an article entitled "Walking on Sunshine : A Scoping Review of the Evidence for Walking and Mental Health".[16] Interestingly, these authors came from Edinburgh, a city not noted for its high sunshine hours. They nevertheless state that evidence suggests that walking benefits mental health although this evidence is somewhat fragmented and incomplete. Perhaps further study on the Gold Coast in Australia might be of more value in this respect.

How do we put all of this into practice? Foster and Colleagues conducted a systematic review of what works to promote walking at a population level.[17] They looked at 12 studies, mostly from urban high income countries and concluded that there were three population approaches that worked. Firstly, mass media. Secondly, environmental infrastructure or community events and thirdly environmental change approaches. They caution that the precise combination of active and effective approaches

will require further detailed outcome and process evaluation.

That is all for this issue. I will look at later issues from 2018 in a subsequent colum.

Chris Milne
Sports Physician
Hamilton

REFERENCES

1 Ardern CL, Ekås GR, Grindem H, et al 2018 International Olympic Committee consensus statement on prevention, diagnosis and management of paediatric anterior cruciate ligament (ACL) injuries *Br J Sports Med* 2018; **52**:422-438.

2 Maughan RJ, Burke LM, Dvorak J, et al IOC consensus statement: dietary supplements and the high-performance athlete *Br J Sports Med* 2018; **52**:439-455.

3 Crema MD, Jarraya M, Engebretsen L, et al Imaging-detected acute muscle injuries in athletes participating in the Rio de Janeiro 2016 Summer Olympic Games *Br J Sports Med* 2018; **52**:460-464.

4 Cook CE, George SZ, Reiman MP Red flag screening for low back pain: nothing to see here, move along: a narrative review *Br J Sports Med* 2018; **52**:493-496.

5 Cook T, Minns Lowe C, Maybury M, et al Are corticosteroid injections more beneficial than anaesthetic injections alone in the management of rotator cuff-related shoulder pain? A systematic review *Br J Sports Med* 2018; **52**:497-504.

6 Garcia AN, Costa LDCM, Hancock MJ, et al McKenzie Method of Mechanical Diagnosis and Therapy was slightly more effective than placebo for pain, but not for disability, in patients with chronic non-specific low back pain: a randomised placebo controlled trial with short and longer term follow-up *Br J Sports Med* 2018; **52**:594-600.

7 Rathleff MS, Thomsen JL, Barton CJ Patient education in patellofemoral pain: potentially potent and essential, but under-researched *Br J Sports Med* 2018; **52**:623-624.

8 Callaghan MJ Exercise is effective for patellofemoral pain, but what type, who benefits most and by how much remain unknown *Br J Sports Med* 2018; **52**:625-626.

9 Gabbett TJ, Kearney S, Bisson LJ, et al Seven tips for developing and maintaining a high performance sports medicine team *Br J Sports Med* 2018; **52**:626-627.

10 Heron N, Usher R, MacLeod D, et al Infographics: Winning road cycle races: a Team Sky perspective *Br J Sports Med* 2018; **52**:633-634.

11 Patricios JS, Ardern CL, Hislop MD, et al Implementation of the 2017 Berlin Concussion in Sport Group Consensus Statement in contact and collision sports: a joint position statement from 11 national and international sports organisations *Br J Sports Med* 2018; **52**:635-641.

12 Mountjoy M, Sundgot-Borgen JK, Burke LM, et al IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update *Br J Sports Med* 2018; **52**:687-697.

13 Davis P, Waldock R, Connorton A, et al Comparison of amateur boxing before and after the 2013 rules change and the impact on boxers' safety *Br J Sports Med* 2018; **52**:741-746.

14 Bull FC, Hardman AE Walking: a best buy for public and planetary health *Br J Sports Med* 2018; **52**:755-756.

15 Tudor-Locke C, Han H, Aguiar EJ, et al How fast is fast enough? Walking cadence (steps/min) as a practical estimate of intensity in adults: a narrative review *Br J Sports Med* 2018; **52**:776-788.

16 Kelly P, Williamson C, Niven AG, et al Walking on sunshine: scoping review of the evidence for walking and mental health *Br J Sports Med* 2018; **52**:800-806.

17 Foster C, Kelly P, Reid HAB, et al What works to promote walking at the population level? A systematic review *Br J Sports Med* 2018; **52**:807-812.

BULLET POINTS - HIGHLIGHTS FROM THE SIB

CHRIS MCCULLOUGH

HIGHLIGHTS FROM THE SPORTS INJURY BULLETIN

This is the first instalment by Chris McCullough of Bullet Points incorporating articles from December 2017 to May 2018

The December 2017 issue commenced with an article on

Lateral Epicondylitis – more commonly referred to as tennis elbow. The author Trevor Langford reviews the anatomy and biomechanics in relation to tennis players technical ability, especially the execution of the backhand stroke along with a correctly sized grip. Braces were considered to offer only a marginal benefit compared to taping, with manual therapy likely to be best in conjunction with eccentric exercises for an expected period of at least six weeks. I have personally found it is also very helpful to screen the cervico-thoracic spine along with neural tension testing. Other aspects are scapula-humeral function and tricep muscle capacity; all of which off-load the forearm.

I took a keen interest in the:

Return to Sport Psychology article! The author Tracy Ward notes there are three key elements involved in addressing an athlete's psychology in RTS.

- Autonomy – their motivation and drive
- Competence – capacity to overcome fear and build confidence
- Relatedness – their perception of interacting and belonging

Numerous questionnaires exist to try and identify fear avoidance, anxiety and general psychological readiness for RTS, along with some physical tests that can provide the clinician with some insight.

Having suffered an ACL rupture myself in a rugby tackle while at Otago University, I can personally attest to the inevitable fear following injury and the absence back in the day of any mechanical diagnostic screen, let alone psychological approach. An important element of all the injury presentations we see today.

This same issue included an article on unusual injuries, with the author Chris Mallac focusing in on the:

Deltoid Ligament. He concludes that even if mild superficial sprains occur, they will take longer to rehabilitate compared to the lateral aspect of the ankle. Clinicians are encouraged to move slowly in rehabilitation of the more significant deep deltoid ligament as the natural tendency of the foot to pronate may well lead to over-stretching and pathological chronic instability.

The first issue of 2018 in February, commenced with an opening title of

Posterior Hamstring Tendinopathy, considered to be a challenging condition to overcome for athletes and clinicians alike. Michael Lancaster provides a succinct article summarising the issues including anatomy, aetiology, assessment and differential diagnosis. I particularly enjoyed his take on the value of imaging with the mantra "treat the man, not the scan"! Running analysis highlighted the likely benefit of increasing cadence to enhance gluteal activity and potentially reduce proximal hamstring tendon compression. Load management is especially noted with progressive rehabilitation requiring careful monitoring. The research has yet to find consensus regarding best management, but common phases are:

1 Isometric loading

2 Strength isotonics

3 Isotonics followed by hip flexion

4 Energy storage

5 Elastic function with RTS

Evidence for soft-tissue techniques, dry-needling, shockwave therapy and PRP (platelet rich plasma) injections is limited and conflicting at present.

This same issue included a useful article entitled:

Posterior Shoulder Instability. Adam Smith the author works as a Physiotherapist for both Queensland Cricket and Academy of Sport – waterpolo and triathlon squads. He notes that this condition represents as little as 10% of all shoulder instability cases but cautions that it often co-exists with other shoulder pathologies so can be hard to diagnose clinically. A concise summary of the pathology and clinical examination is provided followed by an applicable treatment protocol, with phases of loading utilising exertubing to enhance scapula and head of humerus correction, cuff control and finally sports specific return.

The March issue threw the spotlight on:

Plantar Fascia Rupture with the author Chris Mallac covering the pathogenesis and treatment in some detail. Although fascia ruptures are not a common injury in athletes, if they do occur they are most commonly seen as an acute lesion on chronic plantar fasciitis. MRI is considered the most sensitive modality to determine the exact location and the extent of the fascia rupture. Conservative vs operative management in the acute phase is arbitrary, although elite athletes appear to do well conservatively. Chris highlights some useful strengthening exercises and reminds clinicians to rightly involve a quality Podiatry assessment so that the fore-foot and mid-foot achieve appropriate passive stability.

In the first of a two part series, Alicia Filley reviewed the **Anteriorlateral Knee Complex** and the role of the ACL in knee stability. The alarming global failure rates of ACL reconstruction with just over half of athletes returning to a competitive level of play has encouraged researchers to re-examine this issue. The role of the anterior lateral ligament is examined with ongoing investigations as to its role in assisting the ACL to control both internal tibial rotation and anterior tibial movement.

The April issue continues this article (part two) with Alicia evaluating the current thinking on conservative management, repair and the required rehabilitation to successfully return athletes to sport. The vexed question of operative vs conservative management is addressed with a 20 year follow up study of 50 high level athletes in the Netherlands, concluding that both approaches may be equally affective and that it could be logical to try a conservative outlook first. A concise summary of guidelines, measures and criteria for decision making is provided, concluding high level proprioception training drills that look very much like a familiar rugby lineout (aka Argy Bargy). Clearly athletes need to receive a full explanation of the risks and benefits of each approach from a Sports Physician or Orthopaedic Specialist before embarking on the rehab planning process.

Bakers Cysts: an early indication of pathology - is the top of mind title of another interesting article. Chris Mallac reminds us that our forebearers were adept at tagging their family name to any new discoveries both medical and geographical, with British surgeon William Morant Baker describing popliteal cysts as early as 1877. The incidence, clinical presentation and differential diagnoses are well described, with MRI the gold standard. In summary, this article highlights that if cysts occur in athletes, it may alert the clinician to possible underlying pathology that needs investigation. The management of a Bakers Cyst is

usually conservative as they will most likely spontaneously resolve.

This issue also has a tidy commentary by Andrew Hamilton on:

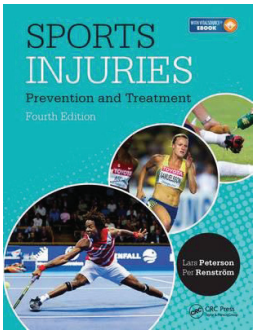
- **NSAIDs**; the good, the bad and the ugly. The process of inflammation is described with the role of NSAIDs – although their popularity amongst athletes (and some clinicians) is often not matched by an awareness of the risks of regular and/or chronic NSAID use. Age related risk is well documented along with both pre and post exercise use. The article concludes with recommendations for clinicians with the take-home message that all NSAIDs pose risks and should be used as a last resort not a first! This should be shared with all our patients.

- The **Long Head of Biceps Tendon**, its anatomy and function are explored by Chris Mallac in this part one of his two part article. Certainly, LHBT injuries are reasonably common in throwing sports and in athletes with repetitive hand above head positions. These include swimmers, tennis players, cross-fit athletes and gymnasts. The relevant anatomy, function, pathology and mechanisms of injury are reviewed. Types of injury include tendinopathy, instability, subluxation, dislocation and tendon ruptures – the latter are often seen with a forced contraction on a stretched position, such as tackling in rugby or league!

The second part of this article is in the May issue entitled

- **The Road to Recovery**. Chris commences with a clinical examination, imaging and comment that arthroscopy is the gold standard technique for diagnosis of LHBT lesions. Conservative management incorporating Physiotherapy interventions are considered, including PNF strengthening patterns. The surgical treatment is summarised and will clearly depend on the severity of the injury, the age of the athlete and type of use the athlete requires. A useful read that applies very much equally to the middle plus age group patients we often see with weekend warrior ambitions.

Chris McCullough
Physiotherapist



Sports Injuries
Prevention and Treatment
Fourth Edition

Lars Peterson and Per Renström

Publisher, CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA, 2017. 619pgs.

If I had to name the most influential sports medicine textbook that I use in my daily practice, it would be this one. Described to me as 'too simple' by my good mate Tony Edwards, I have found it to be 'just right' in terms of complexity when I deal with the good folk from Waikato as I have done over the past 30 years.

My first edition dates from 1986. The book was originally published in Swedish in 1983. This book has been so well used that the spine is held together by cellotape.

The text is good, but the real strength is in the illustrations by Tommy Eriksson and Tommy Berglund. Arguably this book marked the beginning of a sea change in the way in which sports medicine textbooks were presented. The illustrations are clear and dramatic, none more so than on page 177 of this edition showing anterior dislocation of the shoulder joint and on page 306 showing patella dislocation. The second of these has survived unaltered in the latest edition where it appears on page 450.

So do the advances in sports medicine since the 1980's get adequate recognition in the current edition? Yes, they do. I have chosen five diverse topics and compared the coverage of each of these topics compared with my understanding of the current state of knowledge as a practising clinician.

Firstly, concussion. This is described in the 1986 edition under head injuries but the word concussion does not appear. However, the coverage is appropriate for knowledge at that stage. In the last 30 years, there have been five consensus conferences that have clarified our thinking and standardised our management of concussion. We are indebted to Paul McCrory and his colleagues for this sterling work. The latest 2017 edition includes specific advice regarding children and adolescents who we know may need more time to recover from concussions. It also emphasises the principle of progressive rehabilitation and terms this the brain ladder rehabilitation schedule.

Low back injuries are endemic in society and our understanding of these have also evolved significantly since the mid-1980's. The latest edition indicates the same general diagnostic categories as were mentioned in 1986, but also includes information regarding facet joint problems, as the true extent of these has become more evident with newer imaging techniques e.g. the widespread use of MRI scanning. In the latest edition, there is appropriate emphasis on core stability, which has become a central part of modern day rehabilitation of that problem.

Moving down to the hip and groin, this has always been an area of great diagnostic confusion. Interestingly, the 1986 edition started with due emphasis on the muscle attachments around

the hemi pelvis, eg, adductor muscles, iliopsoas and rectus femoris, and to a large degree this anticipated later research culminating the Doha Consensus Agreement, published in 2015. However, back in the 1980's, there was virtually no knowledge of conditions such as labral tears and the contribution of femoral acetabular impingement. Fortunately, these are given due prominence in the latest edition. Likewise, under other causes of groin pain, there was no specific mention of carcinoma of the prostate in the earlier editions, but this is given a generous amount of consideration in the 2017 edition. This largely reflects the increasing number of masters or middle aged and older participants in modern sporting events.

Achilles tendon problems have plagued athletes so frequently that the term Achilles heel has entered the general lexicon. The earlier edition discussed the broad categories of rupture, partial tear, tendinitis, bursitis and apophysitis. However, in the last couple of decades, the term tendinopathy had gained prominence largely following on from histological studies showing a lack of inflammation in most cases. Likewise, the rehabilitation schedules published initially by Alfredson and colleagues and the concepts of mechanotransduction popularised by Karim Khan and associates have been widely accepted by clinicians.

Advances are not confined to our understanding of injury management. I also picked a physiological topic i.e. management of heat related illnesses. Traditionally these had been thought of as a spectrum starting with heat cramps, ie, mild heat illness, then heat exhaustion, a moderate heat illness and heat strokes, a severe heat illness. These terms are still used in the more recent edition but there is reference to work done in tennis where if the wet-bulb globe temperature exceeds 28°C, there are longer breaks given to allow the players a chance to recover. However, there is no mention of the commonly accepted modern rehydration strategy which is to start the event well hydrated and then drink according to thirst. Neither is there specific mention of hyponatremia which is a condition whose significance was initially recognised by Ben Speedy and colleagues. Our understanding of that condition has altered our advice regarding rehydration strategies.

In essence, the latest edition has pretty much kept up with the advances across a wide range of topics. The pictures from the early edition have been retained and these have been supplanted with some excellent photographs of modern day athletes, plus imaging results highlighting modern technology, eg, MRI and CT scanning.

If I had one quibble, it would be that many of the references are rather dated, and there is no mention of the 2015 Doha Agreement on groin pain, nor of the Berlin Consensus Conference which is the latest update on concussion. However, some of the delay may be due to the long gestation of a major textbook. By the time any textbook goes to print, further advances have always been made. Nevertheless, this book remains a triumph for its authors and the visual style of presentation should assure it of a place on any busy clinician's bookshelf. It can aid greatly in explaining conditions to people that we see in our consulting rooms.

Chris Milne
Sports Physician
Hamilton

ORIGINAL RESEARCH

Effect of travel and fixture scheduling on team performance in the Trans-Tasman Netball League

LAUREN BOOTHBY, BRIAN DAWSON, PETER PEELING, KAREN E WALLMAN, PETER O'DONOGHUE

ABSTRACT

Introduction: Home advantage, defined as the tendency of sporting-teams to have more success at their home ground, has been well documented. Notably, air travel, which can result in travel fatigue and jet lag (particularly when flying across multiple time zones) in the away team can further augment home advantage. Further, fixture scheduling factors can also affect match outcomes. The effect of air travel and fixture scheduling on team performance requires further investigation in order to assist coaches and players in responding strategically to the impact of these factors.

Aim: To assess the impact of travel, team ability and fixture scheduling characteristics on game outcomes (n=584) in the Trans-Tasman Netball League across nine seasons (2008-2016).

Study design: Analytical study that examined differences in goal margin between home versus away games, distance and direction of travel when playing away, number of days break between games, previous game location and playing consecutive away games, while also accounting for team ability.

Setting: Trans-Tasman (ANZ Championship) Netball League.

Participants: Elite netballers from five Australian and five New Zealand teams competing in the Trans-Tasman Netball League.

Results: Overall, teams won 59% of games at home and had a theoretical +2 goal advantage. Team ability was the strongest predictor of match goal margin, suggesting better teams will more likely win, regardless of where they play. Distance travelled was also a significant negative predictor of match goal margin; the greater distance travelled resulted in a greater disadvantage to the travelling team.

Conclusions: 'Home advantage' does exist in the Trans-Tasman Netball League. Travel direction, days break between games, previous game location and playing consecutive away games did not change the theoretical advantage of playing at home.

Key words: Home advantage; distance; team sport; match outcomes

See end of article for author affiliations.

Correspondence

Karen Wallman

School of Human Sciences (Exercise and Sport Science) M408

The University of Western Australia

Crawley, 6009

Australia

Email: karen.wallman@uwa.edu.au

Mobile : +61 409847808

INTRODUCTION

In sport, home advantage, defined as the tendency of sporting teams to have more success at their home location, has been documented for many team games.[11,19,20] For example, an analysis of the Australian A-League soccer competition found that across seven seasons, 60% of all competition points were gained by the home team.[11] The potential reasons for this phenomenon remain somewhat unclear, but Courneya and Carron[8] have attributed home advantage to four potential factors; the effect of crowd support, familiarity with local conditions, specific rules that favour the home team and the adverse effects of travel on the away team. Notably, Nevill and Holder[18] also reported numerous instances of home advantage in competitions where travelling long distances was not required, while other studies have provided compelling evidence that air travel can augment home advantage due to general travel fatigue experienced by the away team, as well as symptoms of jet lag caused by disruptions to circadian rhythms when crossing multiple time zones.[4,11,14,23]

Commonly, eastward travel has been found to be more detrimental to athletic performance than westward travel, due to the human body finding it more difficult to adjust to a shortened day, and consequently experiencing more severe jet lag symptoms.[13,14,16] Extensive literature has also linked increased flight distance/duration with impaired athletic performance.[3,5,11] Specifically, an analysis of World Cup soccer matches, where the average distance travelled was ~1700 km, suggested that home advantage was significantly related to distance travelled, where the further a team travelled, the greater their performance decreased in terms of goals scored for and against the travelling team.[5] Of interest, teams travelling for national competitions within Australia are often required to travel more than double the average distance than that of the aforementioned World Cup analysis. As such, the increased travelling distance required within Australian sport may further affect a team's (away) match outcomes. In addition, fixture scheduling factors, such as varying days break between games, previous game location and playing consecutive away games could also affect match outcomes. In particular, fixture congestion in elite soccer competitions has been identified as a factor potentially affecting team and individual player physical and technical performance.[6,9] These factors are now commonplace in Australian elite sporting competitions, but very little research has investigated these potential effects. In a recent Australian Football League (AFL) report, it was noted that the winning percentage for travelling teams in 2012 and 2013 was greatest when both competing teams had an equal number of days break between games; it was also found that in 2013 the winning percentage for travelling teams playing consecutive away games went from 48% (first week) to only 20% (second week).[3]

While it is accepted that the distance travelled and the number of time zones crossed that away teams must face cannot be easily changed, other fixture scheduling factors (such as days break between matches and consecutive away games) could potentially be adjusted by competition administrators to decrease the common impact of home advantage. Understanding more about travel and fixture scheduling characteristics and likely effects could also assist in strategy and tactics planning so that teams can attempt to limit expected theoretical performance decrements in their away competition fixtures. To date, only limited research exists regarding the effects of travel and fixture scheduling characteristics on match outcomes within elite Australian sporting competitions. Therefore, this study aimed to investigate the impact of team travel and match scheduling characteristics (days break, previous game location and consecutive away games) on goal margin and match outcomes in the Trans-Tasman (ANZ Championship) Netball League.

METHODS

At the request of one club, historical data from nine seasons (2008-2016) of the Trans-Tasman Netball

League were analysed (excluding finals matches). In all seasons, the competition included 10 teams, with five teams representing mainland states in Australia and five teams representing groupings of adjacent regions in New Zealand. Each season of the league consisted of 14 home and away matches, where each team played the other teams from their country twice, and teams from the other country once. Each team played at least six home games and had one bye (ie, no scheduled game) during rounds five to nine. In total, there were 584 games available for analysis (including 10 draws). All data used here were freely available for public access. Data for seasons 2009-2016 were obtained from anz-championship.com;[2] for season 2008 data was obtained from wikipedia.com.[22] The data was initially collated and categorised by:

- Season
- Round
- City location
- Home/away team
- Home/away team final scores and match goal margin (the difference in goals scored between the winning and losing team)

The analysis then focused on measuring how game performance (win/loss and match goal margin) was affected by fixture scheduling and travel factors. These factors were:

- Direction of travel (east, west, and north/south)
- Flight distance (km)
- Number of days break between games
- Previous game location

For classifying direction of travel, the predominant direction was used, eg, north-east travel was recorded as north or east, based upon the major directional shift taken. For example, flying north-east (1379 km) from Melbourne (Victoria) to Brisbane (Queensland) was classified as northward travel, as this directional shift (~1000 km) is greater than the eastward movement (~400 km) experienced.

Air flight distance was calculated according to a team's assumed flight path using an online flight calculator (https://www.distancecalculator.net/); distance travelled was arbitrarily categorised as 0 km (home games), <2500 km, 2500-4000 km and >4000 km. The number of days break between games was arbitrarily categorised as <5 days, 5 days, 6 days, 7 days, 8 days, >8 days and the previous game location was categorised as home-home, home-away, away-away and away-home. It was assumed that all teams travelled home between two consecutive away games, except for when a) West Coast Fever (Perth team) and the Thunderbirds (Adelaide team) had two consecutive away games in New Zealand, which usually occurred once each season for each team, and b) when a New Zealand based team travelled to Perth or Adelaide (Australia) to play, they generally played another game in Australia before returning home. The actual time of day that the match was played was also sought, but was not available on the databases that were used here. This project was granted an exemption from ethics assessment by the University of Western Australia human ethics office (RA/4/1/8754).

Home advantage was analysed by calculating the percentage of wins for home and away games. One-way between-group analysis of variance (ANOVA) was used to determine significant match goal margins in selected variables; these included home versus away games, distance travelled when playing away, direction of travel when playing away, number of days break between games and previous game location. Fisher's Least Significant Difference (LSD) post-hoc tests were then used to determine where significant differences existed.

A sub-analysis of the results of Australian teams only was also implemented, to facilitate further analysis of the impact of team ability. For 2008-16, only one of the five New Zealand teams qualified for the grand final, for one win from three attempts. In comparison, four of the five Australian teams qualified for the grand final (on multiple occasions) across the nine seasons analysed, suggesting that the Australian teams were generally superior to the New Zealand

teams. Variables that were considered to define team ability (qualifying season match goal margin average, ladder position and premiership points) were then assessed for strength of association using a Pearson product moment correlation coefficient. Analysis of covariance (ANCOVA) were subsequently used to control for the likely influence of team ability on all of the aforementioned variables. Finally, a stepwise multiple regression was used to determine the strongest contributing variables to the dependent variable of match goal margin. Data was analysed using IBM SPSS Statistics 22 (SPSS: an IBM company, Amarouk, NY), with significance accepted at $p < 0.05$.

RESULTS

Team Ability

The markers of team ability (qualifying season match goal margin average, ladder position and premiership points) all recorded strong, significant associations to one another (r=0.899 to 0.967, p<0.001): season match goal margin average was duly used to account for team ability, as it was considered a more sensitive measure than the others, and was subsequently added to the analysis as a covariate.

Home and Away Advantage

Across all nine seasons (n=574 games, excluding 10 draws), teams playing at home won 337 (59%) games and 237 (41%) games when playing away. Overall, considering wins, losses and draws (n=584), the home mean match goal margin was significantly (p<0.001) higher than the away mean match goal margin, as teams playing at home had a (mean ± SD) +2 ± 12 goal advantage. After accounting for team ability, the home mean match goal margin was still significantly (p<0.001) higher than the away mean match goal margin, with teams playing at home having a +2 ±10 goal advantage.

Distance and Direction of Travel

The home (0 km travelled) mean match goal margin (+2 ± 12 goals) was significantly higher (p<0.001) than when teams travelled. There was a -1 ± 12 goal disadvantage after travelling <2500 km, a -3 ± 13 goal disadvantage after travelling 2500-4000 km and a -7 ± 11 goal disadvantage after travelling >4000 km. After accounting for team ability, teams that travelled <2500 km were disadvantaged by -1 ± 10 goals; teams that travelled 2500-4000 km were disadvantaged by -4 ± 10 goals and teams that travelled >4000 km were disadvantaged by -3 ± 10 goals.

For direction of travel for all teams, it was found that teams travelling west had a significantly greater disadvantage than teams that travelled east or north/south (p<0.001) (see Table 1), but average match goal margin for teams travelling east was not significantly different to north/south travel (p=0.897). After accounting for team ability, teams travelling west still had a significantly greater disadvantage than for east or north/south travel (p<0.001). In addition, teams travelling east also had a greater disadvantage than for north/south travel.

In contrast, when New Zealand teams were excluded from the analysis, Australian teams travelling west had a significantly (p<0.001) greater average match goal margin advantage than teams travelling east or north/south (see Table 1).

Table 1: Mean (±SD) match goal margin for teams that travelled east, west, or north/south, separated as all teams and Australian teams only, and accounting for team ability.

	Goal Margin	Goal Margin (Team Ability)
All teams		
Eastward (n=174)	-1 ± 12 [a]	-2 ± 10 [a b]
Westward (n=175)	-6 ± 14	-6 ± 10 [b]
North/South (n=235)	-1 ± 10 [a]	-0 ± 10 [a]
Australian Teams		
Eastward (n=174)	-1 ± 12 [a]	-1 ± 10 [a b]
Westward (n=64)	6 ± 11	4 ± 10 [b]
North/South (n=54)	-1 ± 9 [a]	-3 ± 10 [a]

[a] = significantly different to travelling west (p<0.001);
[b] = significantly different to travelling north/south (p<0.05).

However, average match goal margin for Australian teams travelling east was not significantly different to north/south travel (p=0.985). When team ability was accounted for, Australian teams travelling west still had a significantly greater match goal margin advantage than teams travelling east or north/south (p<0.001). In addition, teams travelling east had a greater advantage than for north/south travel.

Table 2: Overall mean (± SD) match goal margin for number of days break between games, separated as all games, home and away games, and accounting for team ability.

	<5 days	5 days	6 days	7 days	8 days	>8 days
All games	(n=111)	(n=222)	(n=376)	(n=193)	(n=82)	(n=94)
Goal margin	1 ± 14	-1 ± 13	0 ± 12	0 ± 12	0 ± 12	0 ± 13
Goal Margin (Team ability)	0 ± 10	-1 ± 10	0 ± 10	0 ± 10	1 ± 10	0 ± 10
Home games	(n=48)	(n=114)	(n=188)	(n=97)	(n=38)	(n=53)
Goal margin	3 ± 13	2 ± 12	3 ± 11	1 ± 13	4 ± 14	2 ± 13
Goal Margin (Team ability)	3 ± 10	2 ± 10	2 ± 10	2 ± 10	5 ± 10	1 ± 10
Away games	(n=63)	(n=108)	(n=188)	(n=96)	(n=44)	(n=41)
Goal margin	-1 ± 14	-4 ± 13	-2 ± 12	-1 ± 11	-2 ± 10	-3 ± 13
Goal Margin (Team ability)	-1 ± 10	-4 ± 10	-2 ± 10	-1 ± 10	-2 ± 10	-2 ± 10

Days Break and Previous Game Location

For all games, there was no significant (p=0.697) difference in the average match goal margin when the number of days break (<5 to >8 days) between games was considered (Table 2). When separated into home and away games, there were still no significant differences between the days break categories (home: p=0.874; away: p=0.385). Similarly, after accounting for team ability, there were no significant (p=0.504) differences between the average match goal margins for each days break category for all games, and also when separated into home and away games (home: p=0.553, away: p=0.268).

When analysing for previous game location (home/away), average match goal margins were significantly greater for home-home games and away-home games, compared to away-away games and home-away games (p<0.001), showing that goal margin was greater when playing at home, irrespective of whether the previous game was home or away (Table 3). Significant differences for average match goal margin were found for home-home games compared to home-away games; similarly, there was a significant difference between away-away games compared to away-home games (p<0.05). After accounting for team ability, the same significant differences for average match goal margins still existed when considering the team's previous game location (p<0.001). Additionally, when analysing for two consecutive away games (n=222, excluding 5 draws), away teams won 94 (41%) games in the second week.

Table 3: Mean (±SD) match goal margin depending on the previous game location, and accounting for team ability.

	Goal Margin	Goal Margin (Team Ability)
Home-home (n=226)	2 ± 12	3 ± 10
Away-away (n=227)	-2 ± 12 [a]	-2 ± 10 [a]
Home-away (n=313)	-2 ± 13 [a]	-2 ± 10 [a]
Away-home (n=312)	2 ± 13	2 ± 10

[a] = significantly different to home-home and away-home (p<0.001).

Table 4: Stepwise multiple regression analysis of match goal margin.

	Adjusted R^2	Intercept	Beta value
Model 1			
Season Margin Average	0.299	-2.065	0.55*
Model 2			
Season Margin Average	0.318	0.269	0.55*
Distance Travelled (km)			-0.14*

*Significantly related to match goal margin (p<0.001).

Regression Analysis

Stepwise regression revealed further insight into predictors of goal margin (see Table 4). The first

model accounted for 'season goal margin average' (team ability), with this variable explaining 29.9% of the variance in goal margin ($p<0.001$). The second model accounted for 'season match goal margin average' (team ability) and distance travelled to the playing destination, explaining 31.8% of the variance in match goal margin ($p<0.001$). The direction the teams travelled and the number of days break between games failed to meet the selection criteria for inclusion in the regression analysis ($p>0.05$).

DISCUSSION

The primary aim of this study was to investigate the magnitude of home advantage in the Trans-Tasman Netball League (ANZ Championship), and to examine how aspects of travel distance and direction and fixture scheduling characteristics may contribute to game outcomes in this competition (with the influence of team ability accounted for). Overall, it was found that home teams had a +2 goal advantage, that longer distances travelled tended to increase the goal disadvantage for away teams and that the number of days break between matches and previous game location did not influence goal advantage/disadvantage. The direction of travel (east, west or north/south) was strongly influenced by team ability (described here as season match goal margin average), which proved to be the major factor (found by regression analysis) for the prediction of match goal margin. Therefore, a small but significant home advantage exists for the Trans-Tasman Netball League, and team ability was found to be the most important factor in explaining game outcomes, with a small influence of distance travelled also being recorded.

Here, across the nine seasons examined, home teams won 59% of games; these results are consistent with previous literature examining home advantage in different sporting competitions.[1,7,17,20] More recently, Pollard and Gomez[20] investigated the existence of home advantage in the national basketball leagues of Europe, finding that, across all countries, 61% of games played at home were won. Additionally, across seven seasons of the Australian A-league soccer competition, the home teams gained 58% of competition points.[11]

Many reasons for the existence of home advantage have been postulated,[8,18] but our focus here was to examine the impact of distance and direction of travel, as well as fixture scheduling charateristics (days break between games and previous game location) on this effect. Firstly, and in agreement with previous research,[4,5,11] results indicated that a greater distance travelled resulted in a significantly greater (match goal margin) disadvantage. These results could suggest that symptoms associated with jet lag and travel fatigue may have some deleterious effects on away team performances within the Trans-Tasman Netball League. However, in regard to jet lag, at least two to three time zones need to be crossed before this may have any pronounced effect on circadian rhythms and subsequently, athletic performance.[13,15] Teams in the Trans-Tasman Netball League rarely cross three or more time zones, with the exception of the New Zealand teams travelling to Western Australia, and the Western Australian team travelling to New Zealand. These teams represent all of the data in our analysis for >4000 km travelled, where the away team recorded the greatest match goal margin disadvantage of -7 goals (which reduced to -3 goals when accounting for team ability). These teams were also less successful than the other Australian east coast based teams, with only one New Zealand team playing in the grand final (three times, for one win) and the Western Australian team qualifying for finals in one season only. Consequently, it is more likely that for most of the fixtures in this competition, the away disadvantage associated with distance travelled may be related more to general travel fatigue, rather than jet lag. In future studies of this nature, having match starting times available for consideration and analysis may assist in determining the influence of travel related factors on performance.

With regard to direction of travel, with all teams included it was found that teams travelling west had a significantly greater match goal margin disadvantage than teams travelling east or north/

south. This contradicts the commonly-held notion that eastward travel is more detrimental to athletic performance than westward travel.[14,16] Theoretically, a decline in athletic performance is expected after travelling east, as the day is shortened, which is termed a phase advance; when travelling west the day is lengthened, which is termed a phase delay, in which the body usually adapts more quickly to the crossing of multiple time zones.[14] Interestingly, a recent AFL report also found that teams who travelled west generally performed worse and had poorer match outcomes compared to teams travelling east or north/south.[3] These consistent disadvantages noted when travelling west, in both the AFL and the Trans-Tasman Netball League, may in part reflect that not enough time zones were crossed for the theory of circadian disruption and phase advance/delay to influence match outcomes and disadvantage the teams travelling east, and also that the western-based teams are more accustomed to travelling further distances than the Australian eastern states-based and New Zealand teams. However, it is most likely that team ability overrode any influence of travel direction in this analysis, as most teams travelling west were the weaker New Zealand teams, as discussed earlier. When the New Zealand teams were excluded from the analysis, the results changed dramatically, to now show that Australian teams that travelled west (the usually stronger east-coast based teams) had a significantly greater match goal margin advantage than Australian teams that travelled east or north/south. Therefore, the influence of travel direction was not pronounced and much less important than team ability.

Given the presence of home advantage in elite sport, it is topical to examine factors, other than travel, which could also impact on the outcome of games, such as number of days break between matches, previous game location and consecutive away games. Such fixture scheduling characteristics have not been widely examined, but might either mitigate or enhance home advantage. Bedford et al.[3] reported that in the AFL, the travelling (away) team with fewer days break between games was further disadvantaged (by an additional 2 goals, which equals 12 points) in comparison to the home team. Individual AFL player performance indicators have also been reported to be highest after a 12 day break (mid season bye) than after 5-8 days, but match outcomes were not analysed in this study.[12] However, in the present study, no differences in match goal margin were recorded when analysing the number of days break a team had between games, regardless of whether the games were grouped as home or away and after accounting for team ability. These conflicting results between Australian football and netball may be due to certain characteristics of each sport. Australian football games (~120 min) and seasons (22-26 games) are much longer than for Netball (~60 min and 13-16 games), and also involve much body contact, which could (progressively) slow the rate of recovery between games.[12,21] More research is needed to assess whether home advantage is influenced by days break between games, and to determine whether players in 'non-contact' sports may be better able to maintain physical performance when presented with a shorter break between games.[6,10]

Similarly, with regard to the effect of previous game location, our results indicated that regardless of whether a team played at home or away the previous week, teams now playing at home had a +2 goal advantage and away teams had a -2 goal disadvantage. Furthermore, no additional disadvantage was found when travelling for two consecutive away games, as teams still won 41% of games when playing away in consecutive weeks. In contrast, Bedford et al.[3] reported that for AFL teams travelling for two consecutive away matches, the winning percentage went from 48% in the first week to only 20% for the second consecutive away game. However, this data is based on only one season, where there were 5 instances of consecutive away games: in our study, there were 222 instances (excluding draws) of teams playing consecutive away games across nine seasons, showing no additional effect on home advantage for this fixture scheduling characteristic. Lastly, it may also be

the case that umpiring styles and interpretations (especially between Australia and New Zealand) may have influenced the results of matches, but this potential factor could not be controlled or accounted for here.

With the existence of home advantage established here for the Trans-Tasman Netball League, we were interested to test for the best predictors of match goal margin, as this information may help inform team strategy for away matches. A regression analysis revealed that 'season match goal margin average' (as a marker of team ability) emerged as a significant predictor, accounting for ~30% of the variance in match goal margin, suggesting that team ability is the best predictor of game outcomes, overriding any travel and fixture scheduling influences. In short, it is most likely that teams of greater ability will be more likely to win, regardless of whether they play at home or away. Additionally, distance travelled did also emerge as a small, significant negative predictor of match goal margin, accounting for ~2% of the variance, with greater travel distance resulting in a greater disadvantage. The other factors tested here, namely travel direction, days break between games, previous game location and playing consecutive away games did not add to the prediction value of the model.

Lastly, while the findings of this study revealed useful information regarding home advantage and the influence of travel and fixture scheduling characteristics in the Trans-Tasman Netball League, these findings should be considered within the context of the study's limitations. Firstly, precise flight details for all 10 competing teams over the nine seasons analysed were unobtainable, therefore the flight paths and distances travelled were assumed. However, any discrepancies here between actual and assumed data would have likely added (rather than subtracted) distance, so the same trends in results would have been seen. Whether the same players were used in consecutive home or away games is not known, and represents another study limitation. Similarly, it was also assumed that teams travelled home between consecutive away games, except when a) West Coast Fever (Perth team) and the Thunderbirds (Adelaide team) played in New Zealand and b) when a New Zealand based team travelled to Perth or Adelaide (Australia) to play. Future research of this type should endeavour to obtain specific flight times and routes, and match starting times to assist with accurate determinations of the effects of travel on game outcomes. Nevertheless, despite having to assume the distances travelled by away teams, a large data set of nine seasons was analysed and team ability was accounted for in the results, so it is believed that the data presented here accurately reflects the effects of travel and fixture scheduling on home advantage in the Trans-Tasman Netball League.

CONCLUSION

As found with many other sports, a home advantage (+2 goals) does exist within the Trans-Tasman Netball League, with home teams winning 59% of matches. A small influence of distance travelled was found, with greater distance increasing the theoretical disadvantage for the away team. However, team ability (defined here as season match goal margin average) was shown to be the best predictor of match outcome, indicating that the better teams were more likely to win, irrespective of whether playing at home or away. Direction of travel, number of days break between games, previous game location and playing consecutive away games did not change the theoretical advantage of playing at home.

Practical Implications

- As teams travel further, they are disadvantaged more, and therefore may need to consider their travel schedules carefully, by employing strategies to attempt to limit these effects.
- Coaches may apply different game tactics when their teams are travelling long distances for away games, to limit the theoretical goal margin disadvantage.
- There is no evidence within this study to suggest that a shorter or longer number

of days break between games provides an advantage or disadvantage.

- There is no additional disadvantage for teams playing two consecutive games away from home.

ACKNOWLEDGEMENTS

The assistance of the West Coast Fever Netball Club with this project is gladly acknowledged.

DECLARATION OF CONFLICTING INTERESTS

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

FUNDING

The authors received no financial support for the research, authorship and/or publication of this article.

AUTHOR AFFILIATIONS

Lauren Boothby BSc(Hons)
School of Human Sciences (Exercise and Sport Science)
The University of Western Australia, Crawley, Australia

Brian Dawson BPE, MPE, Phd
School of Human Sciences (Exercise and Sport Science)
The University of Western Australia, Crawley, Australia
West Coast Eagles Football Club, Subiaco Australia

Peter Peeling BSc(Hons), PhD Sc
School of Human Sciences (Exercise and Sport Science)
The University of Western Australia, Crawley, Australia
Western Australian Institute of Sport, Perth Australia

Karen E Wallman BEd, BSc, PhD
School of Human Sciences (Exercise and Sport Science)
The University of Western Australia, Crawley, Australia

Peter O'Donoghue BSc(Hons), MSc Inform Tech, MSc, Sport, Exercise & Leisure, DPhil
Cardiff Metropolitan University, Cardiff, Wales

REFERENCES

1 Alexandros L, Panagiotis K, Miltiades K. The existence of home advantage in volleyball. *Int J Perform Anal Sport* 2012; **12**(2): 272-281.

2 ANZ Championship. Fixtures and Results. Retrieved from: http://www.anz-championship.com/Fixtures-Results

3 Bedford A, Kondo E, O'Bree B. Measuring the impact of travel on performance. School of Mathematical and Geospatial Sciences Report 2014; RMIT University, Melbourne Australia.

4 Bishop D. (2004). The effects of travel on team performance in the Australian national netball competition. *J Sci Med Sport* 2004; **7**(1): 118-122.

5 Brown TD, Raalte JL, Brewer BW, Winter CR, Cornelius AE, Andersen MB. World Cup soccer home advantage. *J Sport Behav* 2002; **25**(2): 134-144.

6 Carling C, Gregson W, McCall A, Moreira A, Wong D, Bradley P. Match running performance during fixture congestion in elite soccer: Research issues and future directions. *Sports Med* 2015; **45**(5): 605-613.

7 Clarke S. Home advantage in the Australian Football League. *J Sports Sci* 2005; **23**(4): 375-385.

8 Courneya KS, Carron AV. The home advantage in sport competitions-literature review. *J Sport Exerc Psych* 1992; **14**: 13-27.

9 Dellal A, Lago-Peñas C, Rey E, Chamari K, Orhant E. The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. *Br J Sports Med* 2015; **49**(6): 390-394.

10 Dupont G, Nedelec M, McCall A, McCormack D, Berthoin S, Wisloff U. Effect of 2 soccer matches in a week on physical performance and injury rate. *Am J Sports Med* 2010; **38**(9): 1752-1758.

11 Goumas, C. Home advantage in Australian soccer. *J Sci Med Sport* 2014: **17**: 119-123.

12 Hiscock D, Dawson B, Heasman J, Peeling P. Game movements and player performance in the Australian Football League. *Int J Perform Anal Sport* 2012; **12**: 531-545.

13 Jehue R, Street D, Huizenga R. Effect of time zone and game time changes on team performance: National Football League. *Med Sci Sports Exerc* 1993; **25**(1): 127-131.

14 Leatherwood WE, Dragoo JL. Effect of airline travel on

performance: a review of the literature. *Br J Sports Med* 2013; **47**(9): 561-567.

15 Lee A, Galvez JC. Jet lag in athletes. *Sport Health* 2012; **4**(3): 211-216.

16 Lemmer BR, Kern RI, Nold G, Lohrer H. Jet lag in athletes after eastward and westward time-zone transition. *Chronobiol Int: J Biol Med Rhythm Res* 2002; **19**(4): 743-764.

17 Morley B, Thomas D. An investigation of home advantage and other factors affecting outcomes in English one-day cricket matches. *J Sports Sci* 2005; **23**(3): 261-268.

18 Nevill AM, Holder RL. Home advantage in sport. *Sports Med* 1999; **4**: 221-236.

19 Pollard R. Worldwide regional variations in home advantage in Association Football. *J Sports Sci* 2006; **24**(3): 231-240.

20 Pollard R, Gómez M-Á. Variations in home advantage in the national basketball leagues of Europe. *Revista de Psicología del Deporte* 2013; **22**(1): 263-266.

21 Singh TK, Guelfi KJ, Landers G, Dawson, B, Bishop D. A comparison of muscle damage soreness and performance following a simulated contact and non-contact team sport activity circuit. *J Sci Med Sport* 2011; **14**(5): 441-446.

22 Wikipedia. 2008 ANZ Championship season. Retrieved from: https://en.wikipedia.org/wiki/2008_ANZ_Championship_season

23 Winter C, Hammond W, Green N, Zhang Z, Bliwise D. Measuring circadian advantage in Major League Baseball: A 10-year retrospective study. *Int J Sports Physiol Perform* 2009; **4**: 394-401.

COMMENTARY

Sports-related concussion, mild traumatic brain injury or sport-originated brain injury (SOBI): A more useful term

PATRIA A HUME, DOUG KING, JOSHUA MCGEOWN, ALICE THEADOM

See end of article for author affiliations.

Correspondence:
Patria Hume
Sports Performance Research Institute New Zealand (SPRINZ)
Faculty of Health and Environmental Science
Auckland University of Technology,
Auckland, New Zealand
Email: patria.hume@aut.ac.nz

Traumatic brain injury (TBI) has been reported to be the one injury that will surpass many other diseases as the major cause of death and disability by 2020.[1] There has been a big focus within the sports medicine arena on the incidence and effects of concussions that occur from participation in sporting activities.[2] It has been reported that concussions affect reaction time,[3] memory,[3-5] balance[6] and planning skills.[5] Previous concussions also place the individual athlete at a 1.4-11.1 higher risk of sustaining a subsequent concussion.[7-9]

Sport-related concussion (SRC) or sport-related mild traumatic brain injury (mTBI) are terms often used interchangeably to describe those brain injuries that occur in sport, with concussion more commonly being a non-medical term.[2] Athletes and coaches have used other non-medical terms like "head knock" and "bell ringer" for concussion which minimise the significance of brain injury. Moving away from using the term concussion would be beneficial towards abandoning this entrenched stigma.

Concussion has been described as being a subset of mTBI.[10,11] This is due to the classification of the acute injury characteristics being at the less severe end of the brain injury spectrum reflecting no neurosurgical significance of a pathological injury.[12,10,11] However, although all concussions are mTBIs, not all mTBIs are concussions. Describing an injury to the brain as mild may cause athletes, members of the general public, and policy makers to misinterpret the seriousness of these injuries, and falsely perceive them as inconsequential.

Attitudes have shifted in the last decade from considering SRC as an insignificant minor injury with no long-term repercussions to a more serious brain injury that requires active monitoring and treatment. These changes in perceptions have been driven mostly by the rapidly evolving evidence within the literature regarding the epidemiology of, underlying mechanisms, symptoms, assessment, rehabilitation/return to play, and potential long-term repercussions of a history of sport related concussion.

To improve the understanding of the seriousness of any brain injury that can result from sport, and to improve clarity surrounding the implications of mTBI and concussion resulting from sporting activities, we have coined the easily remembered abbreviation SOBI for sport-originated brain injury. The term SOBI can be used to describe the mechanical loading and deformation of brain tissue that occurs as a result of impacts to the head or body and transmitted to the head that can occur during sport participation. This loading can then trigger the secondary cascade of neurophysiological impairments resulting in the player presenting clinically with somatic, cognitive, and emotional symptoms.[13,14]

Traditional terminology for SRC had been based upon the grading of the severity of the injury. Although some of these grading scales are still utilised[15,16] it was recommended over several international conferences on concussion in sport[17-19] that the use of grading scales be removed.

Although in 2008[19] it was reported that the terms 'simple' and 'complex' were recommended, the following conference (2012)[20] rejected the terminology as it did not fully define the entities of concussion.[19] However, instead of reporting on the complexity of the injury, by utilising the SOBI terminology, the incorporation of terms such as expected and complicated resolution of SOBI are more appropriate than fast/slow or simple/complex given the terms expected and complicated can be adapted as new evidence emerges within the literature.

Similar to sports injury definitions, to fully understand the extent and nature of SOBI it is necessary to consider the various definitions that have been used for the collation and assessment of head injuries in sport. Studies reporting on the incidence of SOBI have varied in two main areas: (1) the definitions being utilised, and (2) the methodologies being undertaken.[21-25] As a consequence of these variations between studies, the results and conclusions that have been obtained and reported often have some important differences.[21,23-29] A fundamental process, and typically the first step behind the injury prevention process, is ongoing injury surveillance.[21,24,30,31] However, inter-study comparisons may prove to be difficult due to the inconsistencies in the definitions provided and the methodological approaches undertaken.

Van Mechelen et al[21] and Finch[31] have both identified that the use of ongoing injury surveillance is a fundamental process behind successful injury prevention. However, this has proven to be elusive in major sports partially because of the difficulties in forming consistent injury definitions, especially in terms of head injuries.[24,32] The lack of consensus between researchers in terms of methodological approaches, technologies utilised and the definition being utilised have severely limited the ability to compare injury rates between countries.[30] Although several team sports (cricket,[30] football/soccer[33] and rugby union[34]) have published injury consensus statements in an attempt to obtain more consistent and comparable results from studies undertaken in these sporting activities, there has been no consensus statement for the methodological approaches towards the recording and reporting of SOBI.

The definition of a sports injury has been a frequently debated topic[35,36] and, to date, there has been no universally accepted injury definition for a sports injury[22,37,38,36] nor a sports related concussion.[2] Even though the Concussion In Sport Group (CISG) reports have been supported by several international sporting bodies, and have produced an SRC definition and assessment tool (Sports Concussion Assessment Tool [SCAT]),[18,20,39,19] there have been other definitions published.[40,17,41,42,18,19,43-48,11] Until a universally accepted definition is established, the epidemiological incidence of these injuries will be a challenge.

We recommended that sport-originated brain injury (SOBI) should be the term used to describe an injury to the brain resulting from mechanical loading and deformation of brain tissue as a result of impacts due to sporting activities. This recommendation is based on our experience in talking with patients and health professionals and from our review of terminology used in the literature.

AUTHOR AFFILIATIONS

Patria A Hume

Sports Performance Research Institute New Zealand (SPRINZ), Faculty of Health and Environmental Science, Auckland University of Technology, Auckland, NZ.
National Institute of Stroke and Applied Neuroscience
Faculty of Health and Environmental Science, Auckland University of Technology, Auckland, NZ.

Doug King

Sports Performance Research Institute New Zealand (SPRINZ), Faculty of Health and Environmental Science, Auckland University of Technology, Auckland, NZ.
School of Science and Technology
University of New England, Armidale, NSW, Australia.

commentary

Joshua McGeown

Sports Performance Research Institute New Zealand (SPRINZ), Faculty of Health and Environmental Science, Auckland University of Technology, Auckland, NZ.

Alice Theadom

National Institute of Stroke and Applied Neuroscience Faculty of Health and Environmental Science, Auckland University of Technology, Auckland, NZ.

REFERENCES

1 Hyder A, Wunderlich C, Puvanachandra P, Gururaj G, Kobusingye O. The impact of traumatic brain injuries: A global perspective. *NeuroRehabilitation*. 2007; **22**(5):341-53.

2 King D, Brughelli M, Hume P, Gissane C. Assessment, management and knowledge of sport-related concussion: Systematic review. *Sports Med.* 2014; **44**(4):449-71. doi:10.1007/s40279-013-0134-x.

3 Covassin T, Stearne D, Elbin III R. Concussion history and postconcussive neurocognitive performance and symptoms in collegiate athletes. *J Athl Train*. 2008; **43**(2):119-24.

4 Iverson G, Gaetz M, Lovell M, Collins M. Cumulative effects of concussion in amateur athletes. *Brain Inj.* 2004; **18**(5):433-43.

5 Matser E, Kessels A, Lezak M, Jordan B, Troost J. Neuropsychological impairment in amateur soccer players. *JAMA*. 1999; **282**(10):971-3.

6 McCrea M, Guskiewicz K, Marshall S, Barr W, Randolph C, Cantu R et al. Acute effects and recovery time following concussion in collegiate football players: the NCAA Concussion Study. *JAMA*. 2003; **290**(19):2556-63.

7 Delaney J, Lacroix V, Leclerc S, Johnston K. Concussions among university football and soccer players. *Clin J Sport Med*. 2002; **12**(6):331-8.

8 Guskiewicz K, Weaver N, Padua D, Garrett W. Epidemiology of concussion in collegiate and high school football players. *Am J Sports Med* 2000; **28**(5):643-50.

9 Guskiewicz K, McCrea M, Marshall S, Cantu R, Randolph C, Barr W et al. Cumulative effects associated with recurrent concussion in collegiate football players: The NCAA concussion study. *JAMA*. 2003; **290**(19):2549-55.

10 Harmon K, Drezner J, Gammons M, Guskiewicz K, Halstead M, Herring S et al. American Medical Society for sports medicine position statement: Concussion in sport. *Br J Sports Med*. 2013; **47**(1):15-26. doi:10.1136/bjsports-2012-091941.

11 Harmon KG, Clugston JR, Dec K, Hainline B, Herring S, Kane SF et al. American Medical Society for Sports Medicine position statement on concussion in sport. *Br J Sports Med*. 2019; **53**(4):213-25. doi:10.1136/bjsports-2018-100338

12 McCrory P, Meeuwisse W, Echemendia R, Iverson G, Dvořák J, Kutcher J. What is the lowest threshold to make a diagnosis of concussion? *Br J Sports Med*. 2013; **47**(5):268-71. doi:10.1136/bjsports-2013-092247.

13 Giza C, Hovda D. The neurometabolic cascade of concussion. *J Athl Train*. 2001; **36**(3):228-35.

14 Giza C, Hovda D. The new neurometabolic cascade of concussion. *Neurosurg*. 2014; **75**(S4):S24-S33. doi:10.1227/NEU.0000000000000505.

15 Patton D, McIntosh A, Kleiven S, Fréchède B. Injury data from unhelmeted football head impacts evaluated against critical strain tolerance curves. *Proc Inst Mech Eng O J Sports Eng Technol*. 2012; **226**(3-4):177-84. doi:10.1177/1754337112438305.

16 Miller J, Wendt J, Potter N. Implications for concussion assessments and return-to-play standards in intercollegiate football: How are the risks managed? *J App Sport Mang*. 2011; **3**(1):91-103.

17 Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Johnston K, Kelly J et al. Summary and agreement statement of the First International Conference on Concussion in Sport, Vienna 2001. *Br J Sports Med* 2002; **36**(1):3-7.

18 McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, Dvorak J et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Br J Sports Med* 2005; **39**(4):196-204.

19 McCrory P, Meeuwisse W, Johnston K, Dvorak J, Aubry M, Molloy M et al. Consensus statement on concussion in sport-the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *J Sci Med Sport* 2009; **12**(3):340-51.

20 McCrory P, Meeuwisse W, Aubry M, Cantu R, Dvořák J, Echemendia R et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med.* 2013; **47**(5):250-8. doi:10.1136/bjsports-2013-092313.

21 van Mechelen W, Hlobil H, Kemper H. Incidence, severity, aetiology and prevention of sports injuries: A review of concepts. *Sports Med*. 1992; **14**(2):82-99.

22 Brooks J, Fuller C. The influence of methodological issues on the results and conclusions from epidemiological studies of sports injuries: Illustrative examples. *Sports Med*. 2006; **36**(6):459-72.

23 Finch C. An overview of some definitional issues for sports injury surveillance. *Sports Med* 1997; **24**(3):157-98.

24 Ekstrand J, Karlsson J. The risk for injury in football. There is a need for a consensus about definition of the injury and the design of studies. *Scand J Med Sci Sports* 2003; **13**(3):147-9.

25 Gissane C, White J, Kerr K, Jennings S, Jennings D. Health and safety implications of injury in professional rugby league football. *Occ Med*. 2003; **53**:512-7.

26 Gabbett T. Science of rugby league football: A review. *J Sports Sci* 2005; **23**(9):961-76.

27 Orchard J, Seward H. Epidemiology of injuries in the Australian football league, seasons 1997 - 2000. *Br J Sports Med* 2002; **36**(1):39-45.

28 Hodgson Phillips L, Standen P, Batt M. Effects of seasonal change in rugby league on the incidence of injury. *Br J Sports Med* 1998; **32**(2):144-8.

29 Gabbett T. Incidence of injury in junior and senior rugby league players. *Sports Med* 2004; **34**(12):849-59.

30 Orchard J, Newman D, Stretch R, Frost W, Mansingh A, Leipus A. Methods for injury surveillance in international cricket. *Br J Sports Med* 2005; **39**(4):e22.

31 Finch C. A new framework for research leading to sports injury prevention. *J Sci Med Sport* 2006; **9**(1):3-9.

32 Orchard J. Concussion: How do we reconcile risk-averse policies with risk-taking sports? In: Khan K, editor. BJSM group Blogs2012.

33 Fuller C, Ekstrand J, Junge A, Andersen T, Bahr R, Dvorak J et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med* 2006; **40**(3):193-201.

34 Fuller C, Molloy M, Bagate C, Bahr R, Brooks J, Donson H et al. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *Clin J Sports Med* 2007;**17**(3):177-81.

35 Hodgson L, Gissane C, Gabbett TJ, King DA. For debate: consensus injury definitions in team sports should focus on encompassing all injuries. *Clin J Sports Med* 2007; **17**(3):188 - 91.

36 Orchard J, Hoskins W. For debate: Consensus injury definitions in team sports should focus on missed match playing time. *Clin J Sports Med* 2007; **17**(3):192-6.

37 King D, Gabbett T, Gissane C, Hodgson L. Epidemiological studies of injuries in rugby league: Suggestions for definitions, data collection and reporting methods. *J Sci Med Sport* 2009;**12**(1):12-9.

38 Hodgson L, Gissane C, Gabbett T, King D. For debate: consensus injury definitions in team sports should focus on encompassing all injuries. *Clin J Sports Med* 2007; **17**(3):188-91.

39 McCrory P, Meeuwisse W, Dvořák J, Aubry M, Bailes J, Broglio S et al. Consensus statement on concussion in sport - The 5th international conference on concussion in sport held in Berlin, October 2016. *Br J Sports Med*. 2017; **51**(11):838-47. doi:10.1136/bjsports-2017-097699.

40 American Congress of Rehabilitation Medicine. Definition of a mild traumatic brain injury. *J Head Trauma Rehabil*. 1993; **8**(3):86-7.

41 Cushman J, Agarwal N, Fabian T, Garcia V, Nagy K, Pasquale M et al. Practice management guidelines for the management of mild traumatic brain injury: The EAST practice management guidelines work group. *J Trauma*. 2001; **51**(5):1016-26.

42 Kirkwood M, Yeates K, Wilson P. Pediatric sport-related concussion: A review of the clinical management of an oft-neglected population. *Pediatrics*. 2006;**117**(4):1359-71.

43 Pearce J. Observations on concussion. *Euro Neurol*. 2008; **59**(3-4):113-9.

44 Powell J, Barber-Foss K. Traumatic brain injury in high school athletes. *JAMA*. 1999; **282**(10):958-63.

45 State of Colorado. Rule 17 Exhibit 10: Traumatic Brain Injury Medical Treatment Guidelines. In: Department of Labor and Employment, editor. Division of Workers' Compensation: State of Colorado; 2006.

46 Vos P, Battistin L, Birbamer G, Gerstenbrand F, Potapov A, Prevec T et al. EFNS guideline on mild traumatic brain injury: report of an EFNS task force. Eur J Neurol. 2002;9(3):207-19. doi:10.1046/j.1468-1331.2002.00407.x.

47 Kelly J, Nichols J, Filley C, Lillehei K, Rubinstein D, Kleinschmidt-DeMasters B. Concussion in sports: guidelines for the prevention of catastrophic outcome. *JAMA*. 1991;266(20):2867-9. doi:10.1001/jama.1991.03470200079039.

48 Committee on Head Injury Nomenclature of Congress of Neurological Surgeons. Glossary of head injury, including some definitions of injury to the cervical spine. *Clin Neurosurg*. 1966;**12**:386–94.

CASE REPORT

Greater trochanteric pain syndrome in a 50 year-old female patient: A common, potentially debilitating problem in which evidence-based treatment is lacking

LOGAN POLOAI

SUMMARY

This report depicts a 50-year-old female patient, whom after a period of prolonged standing at work, developed greater trochanteric pain syndrome (GTPS). The report highlights the high prevalence of GTPS among women of menopausal and postmenopausal age and considers the effects of hormonal status on the gluteal tendons involved in GTPS. It discusses the impact that GTPS can have on patients' lives and how the recently developed Victorian Institute of Sport Assessment-Gluteal tendon (VISA-G) questionnaire can help clinicians to quantify disability and perhaps improve monitoring and the evaluation of treatment strategies. Finally, the report discusses the apparent lack of high-quality evidence for the various conservative and surgical management options for GTPS, highlighting the need for further research into this area.

BACKGROUND

GTPS is common, particularly in women around the time of menopause and postmenopause. The current understanding of GTPS is that pain arises from alterations in the gluteus medius and minimus tendons, and from distension of bursae in the trochanteric region. Additionally, there is evidence to suggest a possible contribution of hormonal changes to tendons during and after menopause. Importantly GTPS can run a chronic course and have a considerable impact on patients' lives. Whilst there are a multitude of conservative and surgical interventions used in clinical practice, there is currently no evidence-based protocol for the management of GTPS.

CASE PRESENTATION

A 50-year-old female presented with a six-month history of left lateral hip pain which came on after a period of prolonged standing at work. She was standing up to nine hours a day for five days a week. Intermittently, she would experience pain radiating down her leg when it was severe, but the majority of her pain was located on the lateral hip region. She had pain walking upstairs but no night time pain. Her past medical history was unremarkable, and she was on no regular medications. She was initially seen by a physiotherapist who facilitated gluteal strengthening exercises and her pain had been slowly improving through this approach.

On examination she had a positive Trendelenburg sign on the left and was tender on palpation over the trochanteric region. She had weakness on resisted gluteal activation. The range of motion of the left hip and examination of the lumbar spine were normal, and a pelvic x-ray demonstrated only subtle arthritic changes in the left hip joint.

She was referred for an ultrasound of the left hip which revealed a flat gluteus medius tendon that was attenuated posteriorly, suggesting a gluteus medius insertional tendinopathy or tear. This was accompanied by a small effusion in the subgluteus maximus bursa and within the anterior hip joint. Gluteus minimus and the iliotibial band had normal appearances.

A plan was made to continue gluteal strengthening exercises. A cortisone injection was considered, but due to early improvement it was not used at that point.

OUTCOME AND FOLLOW UP

At 1 month follow up, the patient had responded well to strengthening exercises with pain scores reduced to 1/10. Additionally, she had resumed her normal exercise routine.

DISCUSSION

GTPS has a reported incidence of 1.8 per 1000 patients per year in primary care and accounts for an estimated 10-20% of the pain experienced by all patients presenting to their general practitioner with hip region problems.[1] Importantly GTPS has been found to affect women over three times more than it does men and is particularly common around the time of menopause and postmenopause in which a prevalence of up to 23.5% in community-dwelling women between the ages of 50 and 79 has been demonstrated.[2]

With regards to the pathophysiology of GTPS, a multitude of MRI and US studies have shown that this syndrome arises as a result of changes within the gluteus medius and minimus tendons, and in bursae within the trochanteric region, particularly the subgluteus maximus bursa.[3,4] Common MRI findings in GTPS are gluteal tendon tears, tendinopathy, and distension of the subgluteus maximus bursa.[3,4] In the setting of overuse, these findings are thought to arise as a result of repetitive compressive loading from the overlying iliotibial band on these structures.[5] Pathology often starts in the tendon attachments to the greater trochanter with secondary involvement of the bursae.[5] In terms of the increased prevalence in women, altered biomechanics associated with anatomical differences of the pelvis are thought to play a role in the development of this condition.[5]

Despite the particularly high prevalence of GTPS in women of postmenopausal age, the impact of perimenopausal and postmenopausal hormone status on tendons in general is an area that has received minimal attention in the literature.[6] Whilst there is evidence to suggest that oestrogens interact with tendons through several pathways and may have an effect on collagen synthesis, stiffness, failure load, and healing, the majority of these studies have been animal or ex vivo studies.[6,7] Between two recent literature reviews of the effects of oestrogen on musculoskeletal tissues which considered over 6000 studies, only four of these were in vivo studies looking at the tendons of postmenopausal women.[6,7] Two of these studies found a statistically significant smaller tendon cross sectional area in postmenopausal women whom were exercising and receiving oestrogen supplementation compared to those who were exercising and not receiving treatment.[8,9] This difference was not apparent in postmenopausal women who were not exercising, suggesting a protective effect of oestrogen that is limited to the active postmenopausal population.[8,9] With respect to other findings of these studies, oestrogen supplementation had no effect on tendon synthesis of type 1 collagen.[10] Of note, all four studies were small, looked at only the achilles and patellar tendons, and used varying forms of oestrogen and methods of application.[6,7] There have been no human studies on postmenopausal women assessing tendon stiffness, failure load and healing.[6,7] Considering the influence that oestrogen after menopause has been shown to have on other musculoskeletal tissues, particularly on bone, it is clear that further research into the effects on tendons at a mechanical, morphological and molecular level is necessary.[6,7] This is especially so considering the high prevalence not only of GTPS, but also of other tendinopathies in the postmenopausal population.

Although not apparent in the case presented, of crucial importance is the considerable impact that GTPS can have on patients' lives. A 2014 study evaluated the quality of life of 39 women with GTPS and found low levels of full-time employment, high levels of pain and physical impairment, and poor quality of life.[11] These results were indistinguishable from a comparison group of patients with severe hip osteoarthritis awaiting hip arthroplasty.[11] Furthermore, a 2005

study of 164 patients with GTPS, 80% of which were female with a mean age of 55, looked at prognosis at 1 and 5 years after recruitment.[1] At 1 year, 76% of patients still suffered from lateral hip pain and at 5 years, 63% did.[1] Although the authors recognized that these results were likely influenced by selection bias, following further analysis they concluded that no lower than 29% of patients still suffered at 5 years, demonstrating the chronicity that can be associated with GTPS.[1]

In light of the high prevalence and disability of GTPS, the VISA-G questionnaire was developed in 2015 to help clinicians measure the severity of disability associated with GTPS.[12] VISA questionnaires are widely used in clinical practice for tendinopathies of the achilles, patellar and hamstring tendons.[12] In addition to quantifying disability, they have been used to monitor and evaluate treatment strategies over time.[12] The VISA-G has demonstrated good reliability, content and construct validity, and compares favourably with the other VISA questionnaires.[12] Moreover, it has been shown to be more specific to GTPS pathology compared to the previously used Harris Hip Score and Oswestry disability index.[12] Perhaps underutilized in clinical practice, the VISA-G also serves as an objective method of measuring changes in GTPS patients, potentially adding weight to the results of future research.

Regarding management options for GTPS, a 2016 systematic literature review yielded just four randomized controlled trials (RCTs).[13] The first of these compared home training, low energy shockwave therapy and a single cortisone injection in 229 patients.[13] The primary outcome was a return to activity.[13] Interestingly shockwave therapy was the most effective with 64% of patients returning to activity at 4 months compared to 49% of those who received a cortisone injection and 34% who underwent home training.[13] Of note is that shock wave therapy has multiple variables such as energy density and frequency, and a specific protocol for the treatment of GTPS has yet to be established.[13] The second RCT in this review assessed the effect of cortisone injections compared to analgesics as required in 120 patients and found a statistically significant improvement in the cortisone injection group at 3 months.[13] Importantly, there was no significant difference at 12 months, demonstrating the effect of cortisone primarily as short-term pain relief.[13] The two other RCTs compared ultrasound guided cortisone injections to landmark guided cortisone injections in a total of 125 patients and found no significant differences in scores related to pain, activity and quality of life, suggesting that the benefit from cortisone injections comes from its influence on peri-trochanteric tissues rather than the subgluteus maximus bursa specifically.[13] In addition to this, a 2017 systematic review of conservative treatments for GTPS revealed a lack of high-quality research with only one out of eight studies included having a low risk of bias.[14] The authors concluded that there are large gaps in the literature on the various conservative and surgical management options for GTPS and hence, the lack of any evidence-based guidelines for management.

In 2018 the LEAP trial was released which looked at education and exercise compared to corticosteroid injection, and a wait and see approach, in the management of gluteal tendinopathy.[16] This RCT included 204 patients, 82% of which were female with an age range of 35-70.[16] The median duration of pain among participants was 24 months.[16] Primary outcomes were global rating of change and pain intensity scores.[16] There were numerous secondary outcomes, one of which was the VISA-G score. Patients randomized to the education and exercise group completed 14 sessions over 8 weeks with a physiotherapist.[16] Education was provided on load management as is the case for other tendinopathies, and the exercise component involved daily hip abductor strengthening and functional exercises.[16] In terms of the results, at 8 weeks 77% of patients in the education and exercise group had an improvement in the global rating of change score compared to 58% of those receiving a cortisone

injection and just 29% in the wait and see group.[16] The number needed to treat to yield a significant difference in success rate was 5 between education plus exercise and corticosteroid injection.[16] Pain intensity scores at 8 weeks followed a similar trend. Moreover, at 52 weeks there was a 78.6% success rate in global improvement for education plus exercise compared to 58.3% for corticosteroid injection and 51.9% for wait and see.[16] Once again, the number needed to treat was 5 to see a difference between the exercise and corticosteroid injection groups.[16] In contrast however, there was no difference seen between these two interventions in pain intensity at 52 weeks with mean scores of 2.1 and 2.3 out of 10 respectively.[16] Both still compared favourably to the wait and see approach in which the mean pain score was 3.2.[16] Of relevance to this case report, there was no statistically significant difference in VISA-G scores at 52 weeks.[16]

Overall the LEAP trial provides solid evidence for an exercise-based approach over a wait and see approach and suggests a possible benefit of an exercise-based approach over corticosteroid injection alone, particularly in the short term but perhaps also after a year. Importantly the trial appeared to be of high quality with a follow up rate of 93% at 52 weeks. I think that it shows promise for the eventual formation of an evidence-based management protocol for GTPS with a component of education and exercise, as is the case for many other tendinopathies.

Also of promise is an ongoing RCT in Melbourne, Australia which is comparing hormone replacement therapy, exercise and a combination of both in the management of GTPS in postmenopausal women.[15] In the study design the authors have outlined a plan to recruit 116 patients.[15] Interventions will be 12 weeks in duration and outcomes will be examined at 12 and 52 weeks with the primary outcome being the VISA-G score.[15] This RCT will consider many of the important features of GTPS discussed above and may have a significant impact on the way in which GTPS is managed in clinical practice.

Lastly, it is important to note that there have been no RCT's comparing the different surgical options. Authors of the 2017 systematic review discussed above concluded that such trials would be particularly useful given the high success rates from case reports.[13]

The case presented above depicted a 50-year old woman who developed GTPS after a period of prolonged standing. She received a diagnosis promptly after presentation to a specialist and achieved a good outcome through physiotherapy. While pain improved significantly after a month in this case, the literature suggests that GTPS can run a chronic course in which pain can be debilitating and significantly impact quality of life. Considering this, assessment using the recently designed VISA-G questionnaire may help clinicians to quantify disability and monitor progress. When it comes to treatment, recent evidence supports a combination of education and exercise over a cortisone injection. In cases refractory to these approaches, shockwave therapy appears to be a promising intervention to consider before moving to surgical options. Moreover, in postmenopausal women, hormone replacement therapy in combination with exercise may have a role in management. Overall this case report serves to raise awareness on GTPS, a common and potentially debilitating condition which is perhaps underappreciated in clinical practice and is certainly under researched. Through better understanding of the current evidence on GTPS, clinicians may be able to set more realistic expectations for patients and make more informed decisions regarding management.

Learning points:

- GTPS is common, particularly in postmenopausal women in which a prevalence of up to 23.5% in community-dwelling women between the ages of 50 and 79 has been demonstrated
- The effects that oestrogen has on tendons in

general are poorly understood however there is evidence to suggest a possible contribution of declining oestrogen levels after menopause to the development of tendinopathy.

- GTPS can have a considerable impact on quality of life, likened to that experienced by patients with severe hip osteoarthritis awaiting arthroplasty. Additionally, GTPS can run a chronic course with in one study, almost a third of patients still experiencing pain at 5 years.
- The VISA-G questionnaire designed in 2015 can help clinicians to measure the severity of disability associated with GTPS. The VISA-G can also be used to evaluate and monitor treatment strategies over time
- There is currently no evidence-based protocol for the management of GTPS with only a handful of RCTs in the literature. Recent evidence suggests a benefit of education plus exercise over cortisone injection both in the short and long term. There is also data to suggest a role for SWT. Of promise is an ongoing RCT looking at hormone therapy in combination with exercise in the treatment of GTPS in postmenopausal women.

REFERENCES

1 Lievense A, Bierma-Zeinstra S, Schouten B, Bohnen A, Verhaar J, Koes B. Prognosis of trochanteric pain in primary care. *Br J Gen Pract*. 2005 Mar **1**;55(512):199-204.

2 Segal NA, Felson DT, Torner JC, Zhu Y, Curtis JR, Niu J, Nevitt MC. Greater trochanteric pain syndrome: epidemiology and associated factors. *Archives of physical medicine and rehabilitation*. 2007 Aug **1**;88(8):988-92.

3 Bird PA, Oakley SP, Shnier R, Kirkham BW. Prospective evaluation of magnetic resonance imaging and physical examination findings in patients with greater trochanteric pain syndrome. *Arthritis & Rheumatism: Official Journal of the American College of Rheumatology*. 2001 Sep;**44**(9):2138-45.

4 Kong A, Van der Vliet A, Zadow S. MRI and US of gluteal tendinopathy in greater trochanteric pain syndrome. *European radiology*. 2007 Jul **1**;17(7):1772-83.

5 Williams BS, Cohen SP. Greater trochanteric pain syndrome: a review of anatomy, diagnosis and treatment. *Anesthesia & Analgesia*. 2009 May **1**;108(5):1662-70.

6 Leblanc DR, Schneider M, Angele P, Vollmer G, Docheva D. The effect of estrogen on tendon and ligament metabolism and function. *The Journal of steroid biochemistry and molecular biology*. 2017 Sep **1**;172:106-16.

7 Ganderton C, Semciw A, Cook J, Pizzari T. The effect of female sex hormone supplementation on tendon in pre and postmenopausal women: A systematic review. *Journal of musculoskeletal & neuronal interactions*. 2016 Jun;**16**(2):92.

8 Finni T, Kovanen V, Ronkainen PH, Pollanen E, Bashford GR, Kaprio J, Alen M, Kujala UM, Sipila S. Combination of hormone replacement therapy and high physical activity is associated with differences in Achilles tendon size in monozygotic female twin pairs. *Journal of Applied Physiology*. 2009 Apr;**106**(4):1332-7.

9 Cook JL, Bass SL, Black JE. Hormone therapy is associated with smaller Achilles tendon diameter in active postmenopausal women. *Scandinavian journal of medicine & science in sports*. 2007 Apr;**17**(2):128-32.

10 Pingel J, Langberg H, Skovgaard D, Koskinen S, Flyvbjerg A, Frystyk J, Kjaer M, Hansen M. Effects of transdermal estrogen on collagen turnover at rest and in response to exercise in postmenopausal women. *Journal of Applied Physiology*. 2012 Jul **5**;113(7):1040-7.

11 Fearon AM, Cook JL, Scarvell JM, Neeman T, Cormick W, Smith PN. Greater trochanteric pain syndrome negatively affects work, physical activity and quality of life: a case control study. *The Journal of arthroplasty*. 2014 Feb **1**;29(2):383-6.

12 Fearon AM, Ganderton C, Scarvell JM, Smith PN, Neeman T, Nash C, Cook JL. Development and validation of a VISA tendinopathy questionnaire for greater trochanteric pain syndrome, the VISA-G. *Manual therapy*. 2015 Dec **1**;20(6):805-13.

13 Reid D. The management of greater trochanteric pain syndrome: a systematic literature review. *Journal of orthopaedics*. 2016 Mar **1**;13(1):15-28.

14 Barratt PA, Brookes N, Newson A. Conservative treatments for greater trochanteric pain syndrome: a systematic review. *Br J Sports Med*. 2016 Nov 10:bjsports-2015.

15 Ganderton C, Semciw A, Cook J, Pizzari T. Does menopausal hormone therapy (MHT), exercise or a combination of both, improve pain and function in post-menopausal women with greater trochanteric pain syndrome (GTPS)? A randomised controlled trial. *BMC women's health*. 2016 Dec;**16**(1):32.

16 Mellor R, Bennell K, Grimaldi A, Nicolson P, Kasza J, Hodges P, Wajswelner H, Vicenzino B. Education plus exercise versus corticosteroid injection use versus a wait and see approach on global outcome and pain from gluteal tendinopathy: prospective, single blinded, randomised clinical trial. bmj. 2018 May 2;361:k1662.

CASE REPORT

Supracondylar fracture

AMITESH KUMAR

INTRODUCTION

Supracondylar fracture is the second most common fracture in the upper limb of children. About 55 to 75% of all elbow fractures are supracondylar fractures,[1] with a mean age for injury of 5-10 years. The most common way of sustaining this fracture is falling on an outstretched hand causing hyperextension at the elbow.[2] The supracondylar region contains thin and weak bone at the distal humerus. During hyperextension the olecranon acts as a fulcrum and directs force on the distal humerus resulting in fracture. The non-dominant arm is more frequently involved and rare flexion type injuries may occur due to a fall on a flexed elbow or direct trauma to the posterior aspect of the distal humerus.

If not properly managed, supracondylar fracture can lead to complications such as vascular or nerve injuries, malunion (cubitus varus or gunstock deformity), stiffness of the elbow, Volkmann's ischaemic contracture, myositis ossificans and compartment syndrome.[3] Brachial artery injury is associated with type II and III fractures. Posterolateral displacement may involve the median nerve and its anterior interosseous branch whereas the radial nerve may be involved with posteromedial displacement.

Remodeling of supracondylar area occurs during 6-7 years of age and hence the slender cortex is at risk of fracture. The pneumonic 'CRITOE' is a good way of remembering ossification of the distal humerus as summarised in table 1.[4]

This case was interesting as it highlighted the shift of seeing more supracondylar fractures in toddlers. Relevant to this case was the playing equipment at daycare which if not properly used or supervised can lead to a fall with subsequent injuries like supracondylar fractures.

Table 1: Ossification of the distal humerus

Part of distal humerus	Ossifying age (years)
Capitulum	1
Radial head	4-5
Internal (Medial) epicondyle	4-5
Trochlea	8-9
Olecranon	8-9
External (Lateral) epicondyle	10

CASE

A mother brought in her 17 month old daughter to an Urgent Care Clinic after a fall on her left arm. She fell approximately 1m from a playground at day care. According to the mum the actual fall was unwitnessed by the teachers. After the impact the daughter was given paracetamol as pain relief while waiting to be collected from day care. There was no head injury, vomiting or weakness.

Upon arrival at the clinic, it was noted that the child's left arm was adducted with 10 degrees of flexion at the elbow. There were normal vital signs with no fever or tachycardia and it was a closed injury. She was not actively moving her left arm and was trying to guard it as much as possible, right arm function appeared normal. Her left wrist movements were observed to be within normal range, and there was no tenderness over the clavicle, shoulder and wrist joints. There was some swelling and tenderness over the elbow and supracondylar area. Distally examination, identified no neurovascular compromise. She was placed in a sling for comfort at 90 degrees flexion and was fast tracked for an x-ray (see figure 1 and 2). At this stage the differential diagnosis included supracondylar fracture, radial head/neck fracture, radial head subluxation and elbow contusion.

X-rays confirmed a Gartland Type II supracondylar

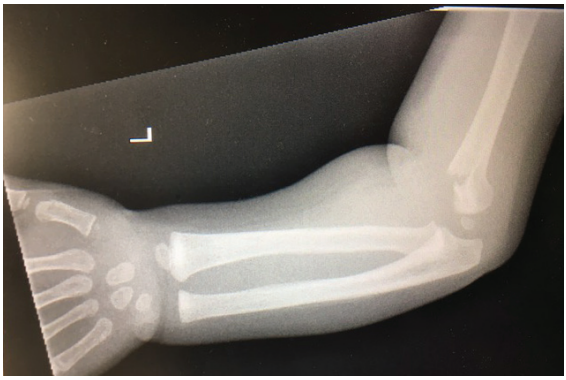


Figure 1: Lateral view of Left Distal Humerus

fracture. The case was discussed with the orthopaedic team on call at the hospital and was accepted for review and further care. She was transferred with an above elbow back slab at 90 degrees flexion in place. She ended up having K wire fixation the next day.

DISCUSSION

This is one of youngest patients I have seen with a supracondylar fracture. The case was appropriately managed with a good outcome. The history clearly highlighted the mechanism of a fall onto the left arm and raised the suspicion of a fracture. Physical examination findings of supracondylar swelling, restricted movements and intact neurovascular status directed management towards radiographic assessment. Anteroposterior (AP) and lateral views of forearm were required. On AP view, carrying angle is evaluated by using Baumann's angle, while on lateral view, anterior humeral line, radio-capitular line, fish tail sign, anterior and posterior fat pad signs are used. Posterior fat pad sign (sail sign) may signify occult fracture and should be treated as with a supracondylar fracture with above elbow cast with x-rays repeated in 7-10 days.[5]

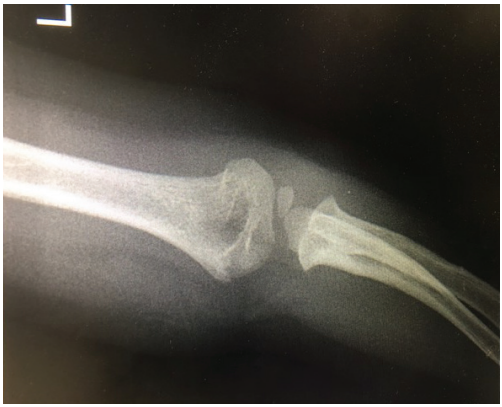


Figure 2: AP view of Left Distal Humerus

Table 2: Modified Gartland classification for extension fractures [4]

Fracture Type	Classification
I	Undisplaced
II	Displaced with angulation but with intact posterior cortex
IIA	Angulation
IIB	Angulation with rotation
III	Completely displaced with no cortical contact
IIIA	Intact medial periosteal hinge; distal fragment goes posteromedially
IIIB	Intact lateral periosteal hinge; distal fragment goes posterolaterally
IV	No periosteal hinge, unstable both in flexion and extension ~multidirectional instability

There are various ways of classifying a supracondylar fracture. These include, open or closed, displaced or undisplaced, complicated or uncomplicated, extension (95%) or flexion (5%) and Gartland's classification for extension type fractures (see Table 2).

The management of supracondylar fractures depends on the type sustained. Suspected supracondylar fracture or occult fractures are treated as a Type 1 fracture and a

repeat x-ray in 7-10 days is recommended to rule in or out the fracture and further management is dictated from there.[6] Type I fractures are usually stable and need above elbow back slab immobilisation at 90 degrees of flexion for 3 weeks. This is supported with a collar and cuff or broad arm sling. Generally, a repeat x-ray is not required but is done at times to assess displacement.[7] Elbow flexion at more than 90 degrees may lead to neurovascular compromise. Within 24 hours a cast check is done to assess cast suitability and to assess for impending neurovascular complications. After removal of cast in the 3rd week, gradual range of motion exercises can be resumed. Generally, referral to physiotherapy is not indicated and full elbow extension and stiffness may not settle until 3 months. Early orthopaedic referral is needed for varus or valgus deformity and acute referral in the presence of neurovascular compromise.

Type II fractures need referral to orthopaedic services. They are managed with closed reduction and above elbow casting at 90 degrees of flexion. If more than 90 degrees of flexion is required then pinning with K wiring is required to achieve stabilisation. This reduces complications associated with increased elbow flexion. This is similar to what happened to the patient in the case study. Usually, overnight observation for potential neurovascular complications is needed. Type II injuries with coronal plane deformity requires orthopaedic review. Most of the emergency departments across New Zealand manage displaced type I and some type II fractures, and refer accordingly to fracture clinics. If closed reduction is not well stabilised or if there are any concerns then an orthopaedic referral is made. Urgent care clinics manage most of the type I fractures with follow-up in the community.

All type III fractures need to be referred to orthopaedic services, as many require urgent reduction (closed or open) and percutaneous pinning.[8] Type IV fractures are very unstable and highly likely to have complications. They are managed with acute orthopaedic review entailing reduction and percutaneous pin fixation.

Indications for surgical interventions are listed below:[4]

1 Open fractures
2 Failed closed reduction
3 Unstable fractures
4 Neurovascular compromise before or after reduction
5 If vascular exploration is required
6 All type II and III fractures requiring >90 degrees flexion
7 All type IV fractures
8 Polytrauma

Usually, the pins and cast are removed around 3-4 weeks post injury. Thereafter, active range of motion exercises are commenced. Formal physiotherapy has not shown to improve the outcome of mobility in cases with intact neurovascular supply. However, physiotherapy is recommended when there is neurovascular compromise or persisting contractures for 3-4 months. The British Orthopaedic Association Standards for Trauma 11 (BOAST 11) guidelines provides best practice for supracondylar fracture management.[9]

This case study highlights a supracondylar fracture in a toddlers compared to the mean age range of 5-10 years suggested in the literature.

There has been minimal research done on prevention strategies for supracondylar fractures in various age groups.[10] However, it could be based on a similar type of model used to prevent other paediatric fractures in sports. The model is based on the '3E's', which are (a) education or behavioral modifications; (b) environmental changes and (c) enforcements (such as legislative interventions).[11] For instance, in this case the risk of fall or fracture from a playground could be minimised by: advising children to take turns, increased supervision by teachers, restriction on the height of the playground, re-evaluation of surfaces that playgrounds are built on. Further

local and international research is needed in this field to inform prevention strategies and safety guidelines.

Two learning points:

1 Type I fractures can be easily managed in the community, but there needs to be an awareness of potential complications.

2 Be active in looking for possible red flags and indications for surgical interventions, as appropriate referral to orthopaedic services will reduce the chances of complications.

Amitesh Kumar
Urgent Care Physician/GP
Auckland

REFERENCES

1 Carvalho RA, Filho NF, Neto AB, Reis GD, Dias MP. Supracondylar fracture of the humerus in children: Fixation with two crossed kirschner wires. *Rev Bras Ortop*. 2015;**47**(6):705-709.

2 Kular PS, Kaur S. A comparative study of management of supracondylar fractures of humerus by open reduction versus closed reduction in a tertiary hospital. International *Journal of Medical Science and Public Health*. 2016; **5**(4):794-798.

3 Dabis J, Daly K, Gelfer Y. Supracondylar fractures of the humerus in children: Review of management and controversies. Orthop Muscular Syst. 2016; **5**(1):206.

4 Kumar V, Singh A. Fracture supracondylar humerus: A review. *J Clin Diagn Res*. 2016; **10**(12):RE01-RE06.

5 Parmar T, Roman-Colon A, Tangen C. Paediatric elbow assessment: An urgent care approach. https://www.jucm.com/pediatric-elbow-assessment-urgent-care-approach/. Accessed October 25, 2018.

6 Accident Compensation Corporation, New Zealand. Treatment profiles - closed fracture of distal humerus, supracondylar. https://baynav.bopdhb.govt.nz/media/1168/acc-treatment-profile-index-2001.pdf. Updated 2001. Accessed October 25, 2018.

7 The Royal Children's Hospital, Melbourne, Australia. Clinical practice guideline on supracondylar fracture of the humerus - emergency department. https://www.rch.org.au/clinicalguide/guideline_index/fractures/Supracondylar_fracture_of_the_humerus_Emergency_Department/. Accessed October 25, 2018.

8 Gowda PM, Mohammed N. A study of supracondylar fractures of humerus in children by open reduction and internal fixation with kirschner wires. *Indian Journal of Clinical Practice*. 2014; **25**(6):572-576.

9 British Orthopaedic Association Standards for Trauma. BOAST 11: Supracondylar fractures of humerus in children. https://www.boa.ac.uk/wp-content/uploads/2015/01/BOAST-11.pdf. Accessed October 25, 2018.

10 Holt JB, Glass NA, Shah AS. Understanding the epidemiology of pediatric supracondylar humeral fractures in the united states: Identifying opportunities for intervention. *J Pediatr Orthop*. 2018; **38**(5):e245-e251.

11 Michael J, John L, Les B. Paediatric fracture in sports: Epidemiology and strategies for prevention. http://www.rheumatologynetwork.com/articles/pediatric-fractures-sports-epidemiology-and-strategies-prevention/page/0/2. Updated 2008. Accessed October 25, 2018.

Selected Abstracts from the 2018 Sports Medicine New Zealand Conference

Nelson | 26 & 27 October

TEN YEAR REVIEW OF LOWER EXTREMITY NETBALL INJURIES IN NEW ZEALAND

Suzanne Belcher[1,2], Chris Whatman,[1] Matt Brughelli,[1] Robert Borotkanics[1]

[1]*Sports Performance Research Institute New Zealand, School of Sport and Recreation, Faculty of Health and Environmental Sciences, Auckland University of Technology, NZ*

[2]*Netball New Zealand*

Aim: To review epidemiological data collected for netball lower extremity injuries by the Accident Compensation Corporation (ACC) between 2008 and 2017.

Methods: Data was sourced by the ACC, covering the key search criteria: Count of new netball related claims by body site, cost and age groups. The data was divided into 5 equal year groups (2008/9, 2010/11, 2012/13, 2014/15, 2016/17), and 3 age groups (Group 1= 10 to 14 years, Group 2= 15 to 19 years and Group 3= 20 to 24 years old). These age groups were chosen as they ranked the highest for ankle, knee and lower extremity injuries over the 10-years. Injury incidence and rate of cost was calculated as number of netball injuries per 1000 affiliated membership population. All costs given by ACC were corrected for the effect of inflation using consumer price index (CPI) rates for each year. Affiliated member numbers were sourced by Netball New Zealand (NNZ) and the number of affiliates for each age group calculated to mirror the age brackets displayed in the ACC data. All comparisons between age groups were performed using a Cuzick test (adapted Wilcoxon test for trend) and a Poisson regression test to compare across years for each age group.

Results: In 2017 of all netball injury claims against ACC, 61% were to the lower extremity, costing NZD$20,051,919. Ankle and knee injuries constitute 47% of all injury claims a year, but more significantly in 2017, 66% of the cost to the public at NZD$18,049,370. The youngest age group (10-14 years old) showed the highest percentage increase in injury rate between 2008 and 2017 for both ankle (98% increase) and knee injuries (150% increase), compared to Group 2 ankle (51% increase) and knee injuries (60% increase) and Group 3 ankle (15% decrease) and knee injuries (23% increase). However, the reverse is seen for rate of cost per 1000 members between 2008 and 2017, Group 3 had the highest increase in rate (73%), compared to Group 2 (50%) and Group 1 (42%). There was a statistically significant difference between age groups ($p=0.001$) in the average injury rate across the 10-year period. The older age group (20-24 years) had the highest injury rate (ankle=77.8, knee=71.6 injuries/1000 players) compared to Group 2 (ankle=71.6, knee=34.8 injuries/1000 members) and Group 1 (ankle=38.2, knee=19.4 injuries/1000 members). Finally, there was a significant difference between groups in the average cost of all lower extremity injuries ($p = 0.005$), Group 1 (cost = $21,880/1000 members), Group 2 (cost = $93,731/1000 members) and Group 3 (cost = $182,406/1000 members). There was a noticeable trend pattern for increasing ankle injuries in group 1 and 2 ($p = 0.072$) and knee injuries in group 1 ($p = 0.072$), but no trend pattern was significant.c

Conclusion: These results suggest that for the ACC and NNZ the focus of injury prevention should continue to be directed at prevention of lower extremity injuries. Particular focus should be on younger players (10-14 years) as they have had the highest percentage increase in lower extremity injuries from 2008-2017. Additionally, as they have the highest current injury rate and cost, older players (20-24 years) should also be a key target group. The limitations of ACC database injury definitions and the exposure data used in this study need to be acknowledged.

A 12 MONTH RETROSPECTIVE INJURY SURVEILLANCE OF COMPETITIVE NEW ZEALAND SWIMMERS

Sibi Walter, Carl Petersen, Arindam Basu
School of Health sciences, University of Canterbury Christchurch, New Zealand

Aim: To quantify the shoulder injury prevalence among New Zealand's nationally competitive swimmers.

Method: A 12 month retrospective self-reporting injury surveillance was conducted among male and female competitive swimmers in New Zealand aged 18 and above. The survey consisted of two parts; firstly questions were asked about swimming profile, rest days, training and race history. Then, questions covered the acute, recurrent and overuse injuries experienced over the past twelve month period.

Results: The survey had a response rate was 33% (27/80) and comprised of 67% male and 33% female swimmers. The responded swimmers had a mean age of 27.8 +- 9.9 years, and 66.7% swimmers mainly competed in distances up to 200 meters. A total of 50 injuries, 52% (27) acute injuries and 48% (24) classified overuse injuries were reported. More than half (59%) of the acute injuries happened during swimming training and 40% of all reported injuries were of soft tissue origin. The most injury prone body areas were the shoulder (45.1%, 23), knee (13.7%, 7) and lower back (9.8%, 5). The shoulder area experienced (27.5%, 14) overuse and (17.6%, 9) acute injuries. Shoulder injuries also had the highest recurrence rate (55.6%).Wrist and hand injuries (52.3%) accounted for the highest number of training and race days missed due to an injury, followed by shoulder injuries (26.8%).

Discussion: We found that New Zealand's nationally competitive swimmers have a high injury prevalence rate and identified the shoulder as the most injury prone area. This survey highlights that swimming training itself is a common cause of shoulder injury. Swimming training logs will help in monitoring the training workload to identify the injury predisposing factors.

Conclusion: Increased swimming training workload has been highlighted as a predisposing factor for overuse shoulder injuries.[1] Long term injury surveillance will help understand the correlation between swimming training workload and injury incidence. Implementation of an evidence based shoulder injury prevention programme might also help decrease their injury incidence.

Reference

1 Hellard, P., Avalos, M., Guimaraes, F., Toussaint, J. F., & David, P. (2015). Training-related risk of common illnesses in elite swimmers over a four-year period. Medicine and Science in Sports and Exercise, 47(4), 698-707. doi:10.1249/MSS.0000000000000461

FATIGUE AND VITAL SIGN MONITORING FOR OFFSHORE SAILING CREWS

Brian Russell,[1] Patria Hume,[1,2] Andrew McDaid,[3] Stacy Sims[4]

[1] Sports Performance Research Institute New Zealand (SPRINZ), Auckland University of Technology (AUT), Auckland; [2] National Institute of Stoke and Applied Neurosciences (NISAN), AUT, Auckland; [3] School of Engineering, University of Auckland; [4] The University of Waikato, Hamilton.

Introduction: Cognitive and physical fatigue in multi-day adventure sport is key to performance and safety. Real world testing in the field can incorporate responses to risk and other factors that cannot be simulated in the lab. However, field-based research brings challenges in data collection, validation and practical considerations on support and compliance to the protocol in the presence of work load, danger and fatigue. Monitoring crews while off shore sailing with sensors is challenging as the crew is under stress and confined. Jetlag for international crew and sea sickness adds to the challenges. Multi day cognitive and physical assessment requires a protocol that can be adjusted for work shifts and circadian rhythms.

Aim: To determine challenges of multi-day in-field research using tablet-based assessments, questionnaires and sensor data for a four-person crew over a 12-day offshore sailing passage.

Methods: The Stroop test (Egner & Hirsch, 2005) was used as it has been shown, using functional magnetic resonance imaging (fMRI) testing, to "stimulate left middle front gyrus (GFm) and superior frontal gyrus (GFs), and decreased activity in the bilateral prefrontal and partial cortices" which are indicated in high level perception and motor processes. The Finger Tap Test (FTT) was used for neurological (Amer et al., 2012), motor skills and neuromuscular fatigue measurement (Leyla & Kiziltan, 2016). The Borg Scale for Rating of Perceived Exertion (Borg, 1982) was used to indicate influence of central factors such as heart rate and peripheral factors such as blood lactate. The Borg scale of 16 approximates a heart rate of 160 bpm.). A daily test battery of questions and tests was performed along with prolonged daily donning of a BioHarness (Medtronic MDT, formerly Zephyr) sensor with periods of non-use for charging and data down load. The BioHarness sensor was selected as it was comfortable for long term use by the crew and accurately measures vital signs and has an Inertial Measurement Unit (IMU). The test battery included questions asked and recorded to Excel (Microsoft Corp MSFT) and an iPhone (Apple Inc AAPL) with a different application for each test. Post analysis consisted of concatenating daily files, aligning date and time between sensor and questionnaires, and analysing vital sign data for features such as variability and entropy. A time- based windowing analysis was performed to determine the best length for comparison to questionnaire data points. Sensor features where time aligned to questionnaire data. Correlation analysis between sensor features and questionnaires was performed.

Results: Compliance to the test and sensor protocol was not sufficient for a generalisable model between sensor and questionnaires. The questionnaires were performed by different applications which lead to undue effort for participants and researchers. Some data were lost during the upload process. The study showed a sensor should have sufficient data storage and battery life time for a multiple day event without depending on multi-step uploading and erasing. Vital sign variation and features did not correlate with previously validated cognitive assessments. Each individual adapted to the environment differently, negating any generalisations across the test population. Multi crew events in the field cannot assume subjects adapt in a similar manner and carry out tasks at the same time of day (e.g. sleep cycles, work shifts and circadian rhythms may be misaligned). Assessments need to be regular to capture time sensitivity and variation between subjects.

Conclusions: In multiday field events, research devices and protocols require a simplicity and reliability above that in the lab due to two main factors; there is no support in the field and the subjects and researcher are cognitively fatigued as part of the mission. Cognitive tests and questionnaires need to be hourly to provide sufficient information for correlation to sensor data and capture inter subject differences. Baselining before and after the event is required to separate fatigue effects from training and recovery effects. Cognitive tests should be on a single device with single application, with simple user input and minimisation of redundant steps between sessions, such as single login and only entering demographic data once for the entire research period. Inter-subject testing should minimise the likelihood of cross subject test data contamination. Sensors should be wearable for the entire event with no recharging, donning/doffing or downloading/erasing required. Battery management should ideally not require recharging of tablets and sensors for the entire multiday event.

NEW ZEALAND RUGBY COMMUNITY CONCUSSION STRATEGY

Danielle Salmon and Ian Murphy
New Zealand Rugby Union

Concussions are currently one of the most prominent medical concerns in contact/collision sports at all ages and levels of competition due to increased susceptibility of concussed players to future injuries and potential for long-term health problems[1,2] including memory problems, depression, and cognitive impairments.[3,4] Concussions in rugby have recently been documented as the most common match injury (RFU Report, 2016), with an overall incidence rate of 2.43 - 6.8 concussions per 1000 player match hours at the community level.5,6 In NZ, ACC data indicates that the highest

rates of concussion are sustained in the 13-18 year old demographic, with 1 in 4 concussions in school sports related to rugby. Since 2011 concussion in NZ high school sports has increased by 128 per year, except for high school in low socioeconomic areas. This finding likely reflects an under reporting of concussion in these areas, due to financial restrictions around accessing medical doctors (2016 ACC Concussion Report). Concussion in young athlete is particularly concerning due to the developmental stage of the brain at this age and the potential increased risk these individuals may have while participating in collision based sports.

To help address these concussion related concerns NZR and ACC are taking a pro-active stance to better manage concussions that occur at the community level. We have modelled this community strategy off the current Head Injury Assessment protocol employed at the professional level of the game. The goals of this pilot project are to inform players and parents around the need to see a doctor, to provide doctors with a tools to assist with their clinical decision making around concussions and to provide resources to doctors around the NZR concussion guidelines and mandatory stand down period.

The concussion management pathway includes an electronic health record-based clinical decision support tool designed to streamline the concussion management process, from identification of a suspected concussion through to diagnosis and treatment. The clinical decision support tool can be accessed both in a field setting (during play) through a smartphone application and in a clinical setting for primary care providers through an online web-based portal. The concussion management process includes: 1) initial player concussion baseline testing (modified child SCAT5); 2) identification and reporting of a suspected rugby-related concussion by the designated team lead using smartphone application; 3) automated concussion email notifications to the player (and their parents or caregivers), coaches, team leads, and regional sport or rugby representatives; 4) providing players and/or parents/caregivers with a unique identifier code that they are able to pass along to their PCP which will enable them to access that players' baseline concussion score through the online portal; 5) clinical concussion diagnosis by the PCP; 6) and eventual medical clearance and safe return-to-play.

References

1 Benson BW, McIntosh AS, Maddocks D, Herring SA, Raftery M, Dvořák J. What are the most effective risk-reduction strategies in sport concussion? *Br J Sports Med*. 2013; **47**(5):321-6.

2 Lisman P, Signorile JF, Del Rossi G, Asfour S, Eltoukhy M, Stambolian D, et al. Investigation of the effects of cervical strength training on neck strength, EMG, and head kinematics during a football tackle. *Int J Sports Sci Eng*. 2012; **6**:131-40.

3 Alexander DG, Shuttleworth-Edwards AB, Kidd M, Malcolm CM. Mild traumatic brain injuries in early adolescent rugby players: Long-term neurocognitive and academic outcomes. *Brain Injury*. 2015; **29**(9):1113-25.

4 Hume PA, Theadom A, Lewis GN, Quarrie KL, Brown SR, Hill R, et al. A comparison of cognitive function in former rugby union players compared with former non-contact sport players and the impact of concussion history. *Sport Med.* 2017; **47**(6):1209-20.

5 Mc Fie S, Brown J, Hendricks S, Posthumus M, Readhead C, Lambert M, et al. Incidence and factors associated with concussion injuries at the 2011 to 2014 South African rugby union youth week tournaments. *Clin J Sport Med*. 2016; **26**(5):398-404.

6 Roberts SP, Trewartha G, England M, Stokes KA. Collapsed scrums and collision tackles: what is the injury risk? *Br J Sports Med*. 2014.

AN UPDATE ON SPRINZ SPORTS RELATED TRAUMATIC BRAIN INJURY RESEARCH

Patria Hume,[1,2] Enora Le Flao1, Joshua McGeown,[1] Doug King,[1,3] Alice Theadom,[2] Stephen Kara,[1,4] Mark Fulcher,[4] Ken Quarrie,[1,5]

[1] *Sports Performance Research Institute New Zealand (SPRINZ), Auckland University of Technology (AUT), Auckland, New Zealand*

[2] *National Institute of Stoke and Applied Neurosciences (NISAN), AUT, Auckland, NZ*

[3] *School of Science and Technology, University of New England, Armidale, NSW, Australia*

[4] *Axis Sports Medicine Clinic (Axis Clinic)*

[5] *New Zealand Rugby Union, Wellington, NZ*

The demand for information about how to prevent and manage mild traumatic brain injury (mTBI) in sport is unprecedented. Researchers aim to develop better understanding of injury mechanisms and identification of risk factors, to help guide development of injury prevention countermeasures. AUT's SPRINZ staff, postgraduate students, and science and medicine collaborators, actively engage in applied injury biomechanics, injury prevention and rehabilitation research with the aim of understanding sports related head impacts.

Concussions may have adverse long-term health implications as indicated in results from the NZ Rugby Health study. It is thought that linear and rotational head accelerations resulting from an impact are the main injury mechanisms. Head impacts in sport can be monitored with wearable sensors. However, the use of acceleration measurements is not validated and therefore is currently not supported by the Concussion in Sport Group. From a biomechanical point of view, head movement resulting from an impact can damage the brain. The question is: Are acceleration measurements useful for detecting, monitoring or predicting sports related head impacts and brain injury? Enora Le Flao has been developing new methods for analysis of acceleration signals for head impacts monitoring in rugby. Analysis of laboratory impact data, collected on an instrumented headform equipped with head impact sensors, is providing validation of the sensors. Prospectively collected field head impact acceleration data of rugby games using instrumented mouthguards is allowing comprehensive and innovative analysis of injurious and non-injurious impacts. The research will help to establish the link between head accelerations and concussion.

There is an increasing body of evidence that balance and cognitive deficits, and the symptoms of a concussion, will return to normal within 14 days for much of the population. From the Axis Clinic data the number of patients that are asymptomatic within 14 days is 70%, with 30% still symptomatic at that time. The number still symptomatic and requiring on-referral at 6-8 weeks post injury after the Axis Clinic standardized concussion protocol care is currently 6%. People may have clinically recovered from a concussion (i.e. no signs or symptoms), however, some may not have physiologically recovered (e.g. cerebral blood flow, cortical excitability). The period of physiological recovery may outlast clinical recovery time, but the duration of this is unknown. For some people abnormalities that occur as a result of a concussion can remain for up to 45 days post injury despite being clinically cleared to return to their normal activities. The question is: What factors influence time to recovery following sports-related mTBI? Joshua McGeown is aiming to optimise mTBI assessment practices, and exercise/nutrition therapy prescription in order to provide clinicians with more detailed information to manage their patients. Prospective objective assessments integrated within Axis Clinic standards of care is allowing comparisons between objective neurophysiological assessments (e.g. two-digit vibro-tactile stimulation hand held Brain Gauge), and more subjective clinical tools in quantifying mTBI symptomology used to guide return to play decisions. The effect of creatine supplementation in combination with Axis Clinic standard of care is being evaluated by randomizing consenting patients to either creatine supplement, or placebo supplement groups to determine if combined exercise and nutrition therapy is associated with better time to recovery outcomes than exercise treatment alone. Information gained from these studies should assist clinicians by providing more insight into mTBI assessment and treatment methods.

'A Call To Arms'

In delivering this, my 3rd Chairman's report, I quote from the great Winston Churchill "You must look at the facts, because they look at you".

If we look at how we are functioning as an organisation against our key objectives, most of these are being met as below.

1 Our position in the sports medicine arena either to remain in isolation or to tackle reuniting a fragmenting community. We have chosen the latter and have worked hard over the past 12 months to re-establish lost connections, whilst still holding true to our multi-disciplinary representation. The inaugural USL sponsored collaborative Roadshow with Sport and Exercise Physiotherapy NZ (SEPNZ) was testament to this, proving to be a well-attended event working for all sports medicine practitioners across the country. The regional delivery approach and collaboration with SEPNZ is planned on a bi-annual basis, with a similar Roadshow event with Sports Podiatry NZ planned for 2019.

2 Our purpose in sports medicine and its alignment with our charter. We remain aligned to our charter; co-operation with other sporting related national bodies, our scientific conference organisation, dissemination of current information via NZJSM and organisation of lecture tours by prominent sports medicine authorities. We have addressed the need to assist and promote post-graduate educational opportunities with the advent of the Bene Sports Medical Travel Grant for conference travel to the value of $3,000. Despite widespread social media and newsletter promotion, we have had no applications to date. Both BSM and SMNZ are keen to see members benefit from this opportunity and a review of the terms will be undertaken and the grant newly promoted in 2019.

3 Our long-term financial strategy. Reflective in our accounts has been a reduction in revenue primarily from a falling membership, reducing our accumulated fund by $14,000. Whilst not being reflected in this year's accounts, we have sought additional revenue streams with our Roadshow and ACC funded AIMS Games support work for members' initiatives. However, this will only show profit to the organisation should strategies to stabilise and improve membership numbers be effective.

To recap, over the past two years we have seen a decline in membership on a previously static membership rate, with the total numbers dropping to 289. The majority of lost members are physiotherapists as per Table 1, representing a loss of income of approx. $8,300. It is most likely these lost members have joined Sport and Exercise Physio NZ (SEPNZ), a sub-specialty branch of Physio NZ.

Table 1: Membership Movement Feb 2012 – Feb 2018

SMNZ Membership 2012-2018				
	Physios	Doctors	Other	Total
2012	152	104	78	334
2013	150	101	78	329
2014	147	108	68	323
2015	143	106	80	329
2016	147	104	80	331
2017	122	95	76	293
2018	113	94	82	289

The audited financials for the year ending 30th June 2018 show an overall loss of $14,000 which is higher than the budgeted $6,000 loss with the majority attributable to falling membership revenue. A profitable annual conference for 2017 helped offset some of this loss. Following a $12,000 loss in 2017, our accumulated fund is now $24,000.

Over the past two years, the Executive has worked at diversifying revenue streams through our regional collaborative Roadshow and our ACC initiatives.

The inaugural Roadshow ran the length of the country over a busy 10 days in July this year. Whilst the larger cities were included in the schedule, the aim was to deliver to the regions with Tauranga, Napier and Queenstown visited and a total of 280 attendees

recorded. Prof Ann Cools proved to be a fantastic speaker sharing her wealth of experience and delivering clinically relevant workshops. Feedback shared via social media platforms included several reviews supporting this initiative. We need to acknowledge and give a big thanks to USL Medical for their financial support as Roadshow sponsor and to Sharon Kearney, Justin Lopes and Brenda Allum for their roles in delivering a successful and quality event. The Roadshow returned a healthy profit of $13,000 which will be reflected in the next year's financial report.

The 2017 Annual SMNZ Conference 'Keeping Sport and Exercise Healthy' was held in Hamilton with the organising committee putting together a programme of international and national speakers, led by Prof Carolyn Emery (Canada) and Dr Yorck Olaf Schumaker (Aspetar). In keeping with the conference theme, a sport and exercise component was embraced in the form of golf, mountain-biking and walking. Special thanks to Dr Jake Pearson, who is essentially the scientific committee, and to High Performance Sports NZ (HPSNZ) for funding assistance. Despite attendance being down on previous years at only 125 delegates including exhibitors, the return to the organisation was a very healthy $37,000.

Relationships with The Australasian College of Sports and Exercise Physicians (ACSEP) and Sports Medicine Australia (SMA) have grown with a presence at the upcoming ACSEP Conference to be held in Queenstown in February 2019 plus a potential combined conference with Sports Medicine Australia in 2021.

Whilst the Executive will be taking a prudent approach to reducing expenditure, including termination of our office lease and a possible office restructuring, we have much to look forward to over the next three years. Maintaining and developing services and relationships is a priority for the Executive, with the aim being to create a sports medicine community committed to excellence and supporting and learning from each other.

And so, I would call on the entire membership to contribute ideas, initiatives and energy to ensuring we achieve that aim.

In closing, I would like to thank our editorial team of Chris Whatman and Stu Armstrong for their work on the NZ Journal of Sports Medicine producing a quality journal with local relevance. A revamping of the electronic on-line journal is planned in the coming year and a printing format change has assisted with cost reductions. Once again, special thanks to Chris Milne for his continued regular contribution and for the new contribution from Chris McCullough (MSNZ President) in a similarly formatted summary of the Sports Injury Bulletin.

I am grateful to the hard working, dedicated staff of Brenda Allum and Anna Reid, along with the National Executive whose assistance in the governance and operational side of SMNZ has been a great support for myself, and to you all I say thank you. A final special mention must go to Sharon Kearney who has energy beyond comprehension and was a major contributor to the success of this year's Roadshow.

We have a challenging year ahead but feel as a group we can tackle this together.

Dr Stephen Kara
National Chairman
October 2018