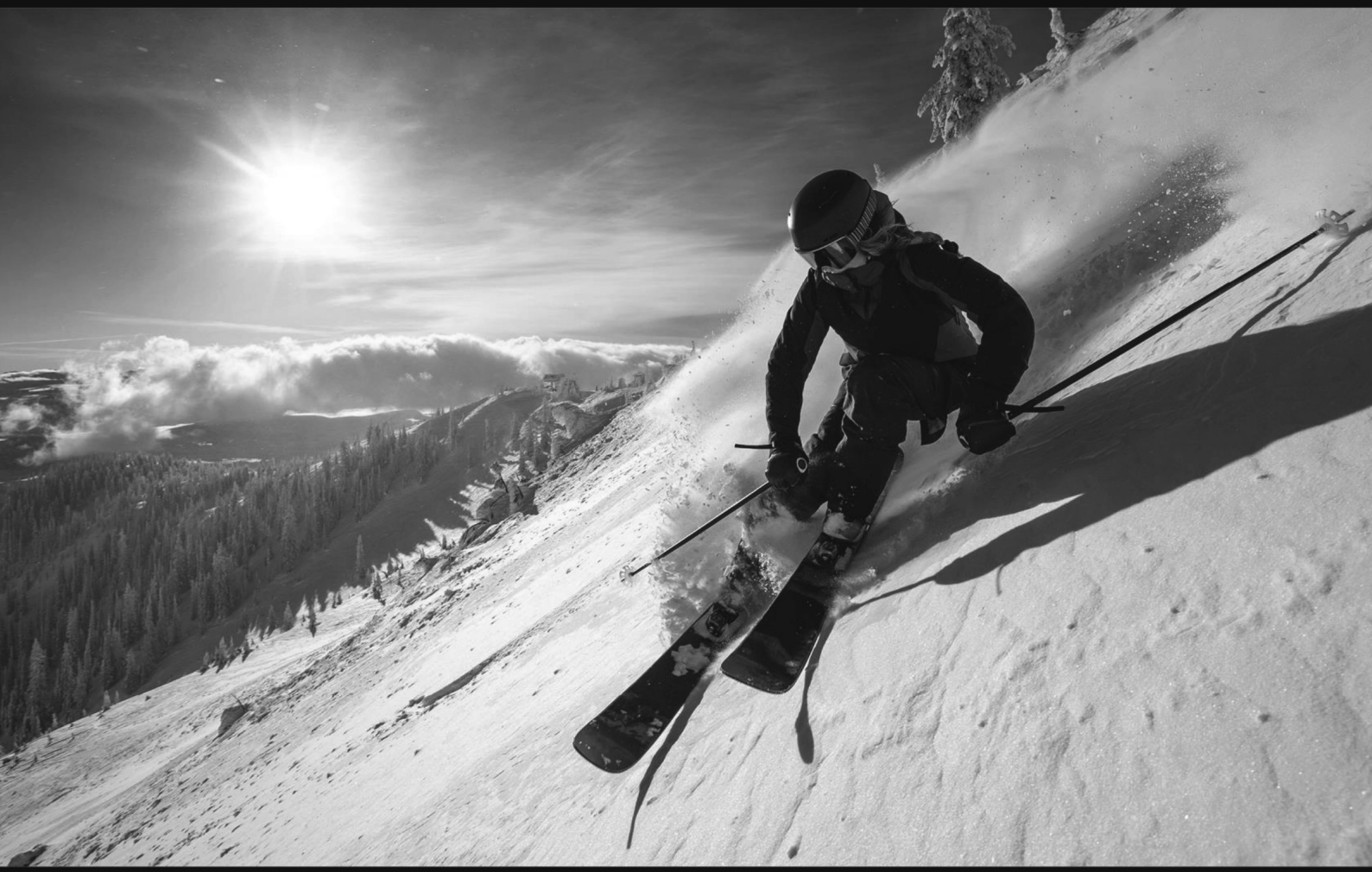
ISSN 2703—240X

The Journal of Sport & Exercise Science



SESNZ
SPORT & EXERCISE SCIENCE
NEW ZEALAND

The Journal of Sport and Exercise Science, Vol. 6, Issue 4, 1-55 (2022)

www.jses.net

Sport and Exercise Science New Zealand

Annual Conference, 23rd – 24th November 2022
Auckland University of Technology, Auckland
Hosted by the School of Sport and Recreation and Sports Performance Research Institute New Zealand

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Contents

Welcome

Welcome to the 2022 Sport and Exercise Science New Zealand Annual Conference at Auckland University of Technology! While we were interrupted by COVID19 last year, we are delighted to be able to meet in person for the 2022 Conference. We very much look forward to catching up with you during the conference over the next two days.

Despite not being able to meet in person, the SESNZ Board have remained busy and there have been some wonderful developments with the organisation over the past two years. We are delighted with the progress that has been made by the International Confederation of Sport and Exercise Science Practitioners (ICSESP) of which we are a founder member. The Organisation, which includes, BASES, ACSM, CSEP and ESSA is making great progress in regard to international collaboration, benchmarking and knowledge sharing. Our journal – The Journal of Sport and Exercise Science - is going from strength to strength and we hope to achieve an impact factor for the journal in 2023. We are delighted to welcome members of CEPNZ to the Conference, and want to say a special thank you to SESNZ Board member Stacey Pine for her leadership in regard to Applied Exercise Physiology accreditation. In June 2022 the Board were able to meet in person in Wellington, hosted by Sport New Zealand – Ihi Aotearoa, for a strategy day at which we were joined by Simon Briscoe and Farhan Tinwala from High Performance Sport New Zealand. Following this excellent meeting we have agreed that moving forwards SESNZ, Ihi Aotearoa and HPSNZ will continue to work more closely with a formal agreement between the partners. As part of this agreement, we are delighted that we will now have a strategic partner from both HPSNZ and Ihi Aotearoa becoming members of the Board of SESNZ

Good luck to all the presenters and don't forget, if you are a student, to register for the student prizes – for the best oral presentation and poster presentation, which will be awarded on Thursday afternoon. A big thank you also goes to our many sponsors: gbc Biomed, VXSport, Cosmed, ImU, Myovolt, Asics, Vald, MR EMG, XLR8, Exerfly and Human Kinetics for partnering to support this year's Conference.

As a note for next year, we are working on an exciting possibility for the 2023 Conference and will have more news about that soon. Thank you very much to the University of Otago and Otago Polytechnic for agreeing to be our joint hosts in 2024, and then to Massey University, Auckland who will host the 2025 Conference. If you and your University would be interested to host the either the 2026 or 2027 Conferences please let one of the Board members know.

It is always a huge team effort to bring everything together for a Conference and we are very grateful and appreciative to everyone involved at AUT University for hosting the event, especially Professor Andy Kilding and the wider team of staff and student helpers from the School of Sport and Recreation and Sports Performance Research Institute NZ. Thank you also to Vanessa Groome for all she does for SESNZ in her role as National Manager and the extra work she undertook behind the scenes to support Andy in getting things ready for our annual get together.

A warm welcome to all and please do not hesitate to contact any of the Board with feedback suggestions or ideas for the future. If you would like to get involved with the direct work of SESNZ and the Board we would be delighted to hear from you as well.

Yours sincerely,

Professor Nick Draper

Chair, SESNZ

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Thank you to all 2022 SESNZ Conference Sponsors. Please take time to visit the sponsor exhibition area in the foyer area throughout the conference to learn more about our sponsors' products and how they could enhance your applied practice and/or research.

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Programme

SESNZ

SESNZ Conference
23rd – 24th November 2022
Auckland University of Technology, Auckland

Day One: Wednesday 23rd November			
07:30	Registration Opens (AF foyer). Tea & Coffee		
08:30	**Mihi Whakatau / Welcome / Opening** *Faculty Dean / Head of School / Chair, SESNZ*		
08:45 – 09:30	**gbc Biomed Keynote Speaker:** **Dr Arne Nieuwenhuys,** University of Auckland *Tired and out of control? Effects of sleep and fatigue on performing under pressure* Chair: Professor Nick Draper		
Parallel Sessions	**Theme: Physiology** **Chair: Dr Ed Maunder**	**Theme: Biomechanics** **Chair: Dr Liz Bradshaw**	**Theme: AEP/CEP/Health** **Chair: Matt Wood**
09:35	Effects of blood flow restriction as a potentiating tool in trained female athletes *Martyn Beaven*	Measurement and reporting of footwear characteristics in running biomechanics: A systematic search and narrative synthesis of contemporary research methods *Codi Ramsey*	The effect of high-intensity interval training and heat therapy on cardiorespiratory fitness in patients with severe lower-limb osteoarthritis *Brendon Roxburgh*
09:50	Team Pursuit: Fitter is Faster *Charles Pugh*	Functional compartmentalisation of motor units during the stretch reflex *Danielle Culberson*	Autonomic dysfunction alters heart rate responses during non-contact boxing in Parkinson's disease *Tone Panassollo*
10:05	The acute effects of lower limb blood flow restriction during aerobic exercise with trained cyclists *Patrick Lander*	Lower-limb asymmetry decreases when fatigued during maximal sprinting in humans *Shayne Vial*	The effect of exercise engagement on low back disability at 12-months is mediated by pain and catastrophizing Paul Marshall
10:20	Effects of shear stress on acute cerebrovascular function *Emma Jones*	How accurate is 3D body scanning technology at estimating body fat percentage? *Samantha Rodrigues*	Promoting mental health: building resilience in teenage children *Edmond Otis*

10:35 – 11:00	**Morning Tea**		
Parallel Sessions	**Theme: Sport and Exercise Psychology** **Chair: Dr Arne Nieuwenhuys**	**Theme: Performance Analysis** **Chair: Associate Professor Kirsten Spencer**	**Theme: AEP/CEP/Health & Fitness** **Chair: Dr Justin Richards**
11:00	Sport psychology: The attitudes of New Zealand athletes *Samuel Richardson*	**Invited speaker** The need to have a robust, objective assessment of performance analysis competencies *Kirsten Spencer, AUT*	**Invited Speaker** Exercise: Friend or Foe *Lynette Hodges, Massey University*
11:15	Influence of an evaluative audience on conscious motor processing and performance during a stop-signal soccer penalty shooting task *Robyn Sullivan*		
11:30	The effect of cognitive fatigue on swimming technique and performance in competitive swimmers *Efe Celik*		
11:45	Effect of exercise intensity and modality on post-exercise executive function *Tina van Duijn*	Combining Sportscode and GPS metrics to monitor locomotion and contact workloads in rugby union *Brett Smith*	Kī o Rahi He Taonga Tuku Iho: Exploring how Kī o Rahi influences hauora *Tasha Burton*
12:00	Elite hockey performance: Examining the relationship between propensity for reinvestment and performance in different game situations *Merel Hoskens*	How New Zealand Rugby transition our people from not using data and technology to using it *Jason Healy*	Moving in the Margins: A qualitative study into the role of physical activity in marginalised communities *Ella Creagh*
12:15	Effect of acute exercise on the state anxiety and autonomic regulation of moderately-anxious, Sedentary Individuals *Orla Scanlon*	Panel discussion - Use of performance analysis in rugby	He hauora te taonga - Exploring Kī o Rahi as a tool to assess components of fitness *Nicholas Parata*
12:30 – 13:45	**Lunch & Poster Presentations**		
13:45 – 14:30	**Keynote Speaker: Dr David Mizrahi,** The Daffodil Centre *Exercise-oncology and chemotherapy-induced peripheral neuropathy* Chair: Dr Paul Marshall		
Parallel Sessions	**Theme: Nutrition** **Chair: Glenn Kearney**	**Theme: S&C** **Chair: Associate Professor Andrew Foskett**	**Theme: Sport and Exercise Psychology** **Chair: Dr Tina van Duijn**
14:35	Full-time nutrition practitioner support may positively influence meal distribution of dietary protein in provincial academy rugby union athletes *Charlie Roberts*	**Invited Speaker** Developing Physically Robust Team Sport Athletes for International Competition *Scott Logan, Auckland Cricket*	Increasing exercise workload degrades the precision of rapid eye movements *Yasmin Kessner*
14:50	The influence of dietary carbohydrate on perceived recovery status differs at the group and individual level – evidence of nonergodicity among endurance athletes *Jeffrey Rothschild*		To pass or not to pass: Investigating the effect of uniform colour on inhibition when passing *So Hyun Park*
15:05	The hydrating effects of hypertonic, isotonic, and hypotonic sports drinks and waters on central hydration during continuous exercise *David Rowlands*		Using the Muller-Lyer illusion as a tool to investigate visual size perception in concussion *Amanpreet Sidhu*

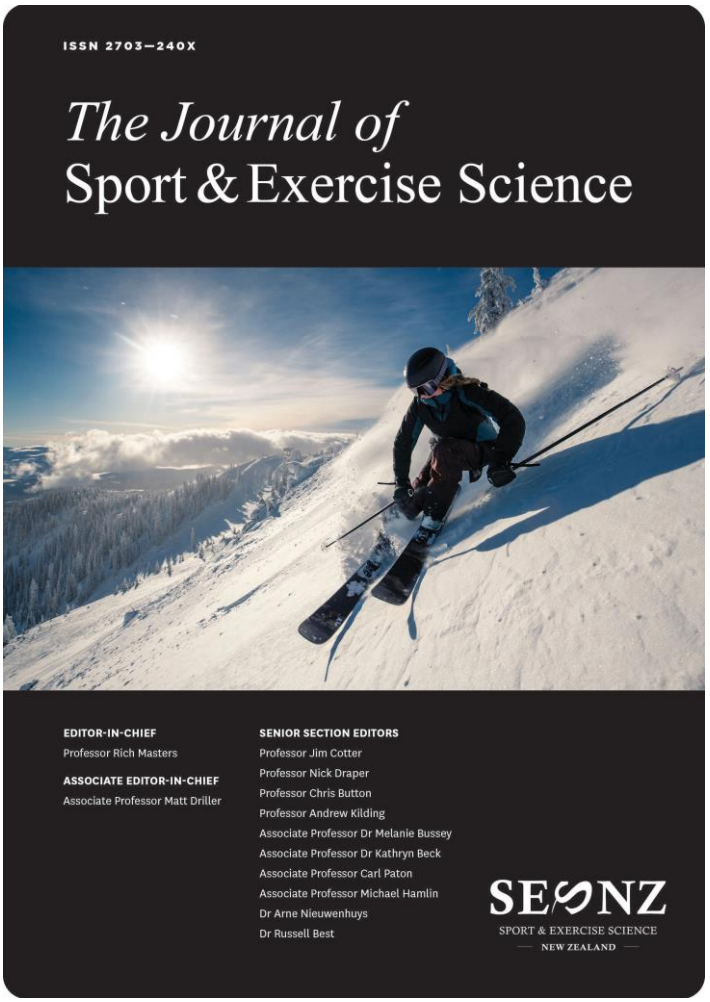
15:20 – 15:45	**Afternoon Tea**		
Parallel Sessions	**Theme: Student & Early Career Researchers** **Chair: Nicole Spriggs**	**Theme: S&C** **Chair: Mark Drury**	**Theme: CEP/AEP** **Chair: Stacey Pine**
15:45	**Invited Speaker** Enhancing Early-Stage Academic Research Career Development *Douglas Seals, University of Colorado* Student led Q&A Session	Gender-specific strength training improves components of military fitness in female soldiers *Jacques Rousseau*	SESNZ's AEP Strategic Group Meeting
16:00		Effects of concurrent plyometric and endurance training sequence on leg power and leg strength in college volleyball players *Eng Hoe Wee*	
16:15		The application of rehabilitation, strength training and sport science in the case study of an x-games gold medallist and 3x Olympian free skier over a 5-year period. *Val Burke*	
16:30		The relationships between physical fitness attributes and match demands in rugby union referees officiating the 2019 Rugby World Cup *Matthew Blair*	
16:45 – 17:30	**VX Sport Keynote Speaker: Professor Karl Friedl,** USARIEM *Current and Future Directions in Human Performance Monitoring* Chair: Professor Jim Cotter		
17:30 – 18:30	**Networking Reception – AF Foyer**		

Day Two: Thursday 24th November			
08:15 – 09:10	**Cosmed Keynote Speaker: Dr Douglas Seals,** University of Colorado *Exercise Training for Promoting Vascular Health During Aging* Chair: Associate Professor James Fisher		
Parallel Sessions	**Theme: Physiology** **Chair: Professor David Rowlands**	**Theme: S&C** **Chair: Matthew Blair**	**Theme: AEP/CEP** **Chair: Matt Wood**
09:15	Handling the heat: Does lower baseline body temperature or opportunity for behaviour improve heat tolerance? *Tiarna Stothers*	**Invited Speaker** Use of movement screenings in S&C *Emily Carter, Tennis New Zealand*	**Invited Speaker** Pain: Considerations for The Clinical Exercise Physiologist *Debbie Bean*
09:30	Does adaptation to cold shock provide cross adaptation to the basic control of breathing? *James Cotter*		
09:45	Altered light exposure during basic training in military barracks on subsequent sleep, wellbeing, and performance of new recruits: a placebo-controlled study *Martyn Beaven*		
10:00	Validity of three core temperature measurement techniques for cool water Swimming *Blake Miller*	Associations between movement competence and sport specialisation in youth football players *Anja Zoellner*	The biomedical and biopsychosocial beliefs of physiotherapists and accredited exercise physiologists in the treatment of people with low back pain *Paul Marshall*
10:15	Cross-adaptation of cold shock to cold-pressor (pain-related) responsiveness. *Kane Cocker*	Do current agility training practices in elite Australian football align with the demands of competition? *Russell Rayner*	Patient education and different exercise modalities for people with chronic low back pain, as scoped for accredited exercise physiologists *Paul Marshall*
10:30 – 11:00	**Morning Tea**		
Parallel Sessions	**Theme: Performance Analysis** **Chair: Associate Professor Kirsten Spencer**	**Theme: S&C** **Chair: Mark Drury**	**Theme: AEP/CEP** **Chair: Stacey Pine**
11:00	Performance analysis and its role at High Performance Sport NZ *Paul McAlpine*	**Invited Speaker** Physical preparation considerations for elite netball athletes *Chloe McKenzie, Robinhood Northern Stars, MIT*	**Invited Speaker** Exercise prehabilitation – preparing cancer patients for surgery and beyond *Matt Wood, Human Potential Centre*
11:15	Behind Closed Doors: a preview into the Silver Ferns implementation of performance analysis *Hayden Croft*		
11:30	Managing data at scale to drive performance. *Evan Wilson*		**Invited Speaker** Exercise and childhood cancer: What is the evidence and the role of exercise? *David Mizrahi, The Daffodil Centre*
11:45	Maximising efficiency and workflow with limited resources *Sam Mulholland-Goad*	The validity and reliability of the Optojump Next system for both flight time and plyometric push up height *Nathan Smith*	
12:00	Panel discussion – Integration of performance analysis at player and management levels	Modelling the relationship between the repetitions left in reserve and movement velocity during resistance training: An accurate method for prescribing intensity and volume and controlling the level of fatigue *Ivan Jukic*	Q&A/Panel: Cancer & Exercise Prescription in NZ
12.15	Mapping sport performance analysis – Integrated landscape of sport *Hayden Croft*	Positive effects of isokinetic eccentric exercise on post-activation potentiation in the lower-body for resistance trained men. *Cam Olsen*	

12:30 – 13:45	**Lunch, Posters, & SESNZ AGM**		
Parallel Sessions	**Theme: Physiology** **Chair: Professor Jim Cotter**	**Theme: S&C** **Chair: Associate Professor Andrew Foskett**	**Theme: Biomechanics** **Chair: Associate Professor Melanie Bussey**
13:45	The effects of blackcurrant and caffeine combinations on performance and physiology during repeated high-intensity cycling. *Carl Paton*	**Invited Speaker** Integrating Strength & Conditioning Practices Within Rowing NZ: Balancing the Off- and On-Water *Ryan Turfrey, HPSNZ*	Automated body segment inertial parameters for the purpose of personalised injury Prevention *Kelly Sheerin*
14:00	Expiratory flow limitation during exercise in athletic adolescents and young adults *Ryan Welch*		Collisions in junior rugby *Nicole Spriggs*
14:15	Polo: What do we know now? *Russ Best*	One velocity loss threshold does not fit all: consideration of sex, training status, history, and personality traits when monitoring and controlling fatigue during resistance training *Ivan Jukic*	Impact of reduced training load on Royal New Zealand Navy recruits' injury and fitness. *Adam Dooley*
14:30	Blue Light— A phone-y concept or a facilitative function? *Martyn Beaven*	Reliability and validity of a portable mid-thigh pull device and inertial cycling ergometer *Fionn Cullinane*	A step-by-step analysis of sprinting acceleration in adolescent boys spanning maturation. *Jako Bekker*
14:45	Mixed-methods heat acclimation in elite male rugby sevens athletes *Stephen Fenemor*	Fatigue and the recovery of neuromuscular function following consecutive days resistance exercise in trained men *Paul Marshall*	Recreating field head impact kinematics using machine learning *Danyon Stitt*
15:05 – 15:45	**IMeasureU Invited Speaker: Dr Elizabeth Bradshaw**, Deakin University *Emerging Sensor Technology Use for Measuring Musculoskeletal Loads in Sport* Chair: Dr Kelly Sheerin		
15:45	**Awards & Closing**		
16:00	**End**		

Our Journal

The Journal of Sport and Exercise Science (JSES) is the official journal of Sport and Exercise Science New Zealand. In its infancy, the journal published primarily the proceedings of the annual conference of SESNZ, but now it publishes up to 4 issues of 6 to 8 peer-reviewed papers each year. Presently, there are 16 Section Editors from around the world, with expertise in the different sport and exercise disciplines. JSES can proudly claim to be truly open-access – articles can be freely viewed by anyone anywhere with an interest in learning about the latest in cutting-edge research in sport and exercise science, and there is no publication fee. Shortly, we will apply for a journal impact factor, which will be the culmination of much hard work behind the scenes.



Sadly, Dr Liis Uiga is stepping down from her role on the journal as Senior Technical Editor. Liis has been a stalwart of JSES and we are immensely grateful for her commitment to the journal. We therefore have a vacancy for a Senior Technical Editor. If you are a member of SESNZ and you have an interest in or experience of copyediting, please contact the Editor-in-Chief (rich.masters@waikato.ac.nz).

Meanwhile, enjoy the conference and keep submitting your great research to JSES.

All the best,

Professor Rich Masters

Editor-in-Chief, *The Journal of Sport & Exercise Science*

Words from our Sponsors

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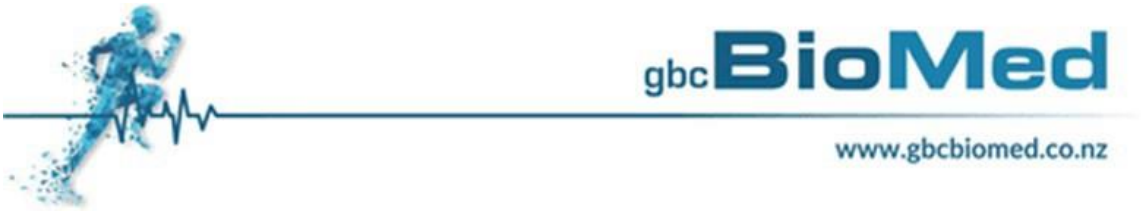

gbcBioMed is very proud to be the platinum sponsor of the 2022 SESNZ conference. At long last we can get together and celebrate with a Conference! Wow, it's been an eventful 2 years since the last SESNZ conference in Christchurch. I don't believe anyone could have imagined the events of the last couple of years. Events that are unprecedented and have created a perfect storm in all our sectors and lives. Some say we are all in the same boat together, but I believe that this is not true. We are all in the same storm! Some of us are in Ocean going Cruise Ships, some in Yachts and some small Boats, some in Life Rafts; some only have their life jackets! The perfect storm has delivered many challenges, to our professional and private lives. However, our business philosophy remains constant; to represent world leading manufacturers producing the best products that are unique and innovative along with our unequal commitment to excellent sales and service. gbcBioMed is the company to turn to for your laboratory or testing equipment. We have an unequal commitment to outstanding sales and service support. We only represent the world's leading brands including Cortex, Lode, h/p/cosmos, Accuniq, Cyclus2, BTS, PulmOne, LymphaTouch and most recently 1080 Motion!

It’s been a long two years however I am very optimistic that this is the start of a new era! Enjoy the conference, catch up with old friends and make new ones; learn and contribute new ideas. And talk to us about your next project!

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Founded in 2013 and based in Auckland, New Zealand, IMeasureU has developed a high-fidelity motion measurement system that enables researchers, sport scientists, coaches and elite athletes to benefit from data-driven insights. IMeasureU was acquired by world-leading motion capture company Vicon in 2017. Fusing wearable technology sensors and proprietary software, IMeasureU and Vicon provide high-fidelity inertial data and motion metrics in any sporting environment through two core products: IMU Step and Capture.U.

IMU Step is an end-to-end hardware, software, and metrics solution used to baseline athletes as well as monitor and manage their recovery following a lower limb injury. IMU Step is used by professional sports organisations and researchers worldwide, including teams in the NBA, MLB, NFL, Euro Soccer, and more.

Capture.U is a software solution enabling anyone with an Apple device and Blue Trident sensors to collect human movement data in any environment, offering new insights into the way movements can be characterised.

IMeasureU is proud to be a Gold Sponsor of SESNZ 2022. Please come by our exhibitors stand to learn more!

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ASICS is at the forefront of the world performance sports market as undisputedly the leading running shoe brand for enthusiasts and professional athletes alike. ASICS is unmatched for technical superiority and rigorous quality. These standards have put the company in good stead and will remain hallmarks of the branch as it innovates and develops well into the 21st Century.

As a performance brand focused on protection and comfort, ASICS is continually testing, reviewing, and upgrading our research and technology. We work with biomechanics, podiatrists, physiotherapists, and other health professionals both internationally and locally here in Aotearoa. These relationships feed into our product development and help professionals stay informed enabling the best care for their clients.

VALD’s innovative range of human measurement technologies are used by more than 1,600 of the world’s most elite sporting teams, high performance academies, strength and conditioning departments, physiotherapists, tactical organisations and first responders.

VALD’s suite of products includes a range of integrated hardware and software systems designed to assess movement, monitor rehabilitation progress and provide unparalleled insight into musculoskeletal performance.

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VALD’s latest innovation is the DynaMo Handheld Strength & ROM handheld dynamometer and inclinometer. It’s an all-in-one dynamometer that allows you to perform more than 300 strength and range of motion tests – including grip strength – from the palm of your hand.

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We make tools to help exercise specialists use EMG to enhance movement and improve exercise outcomes.
Combining our expertise in musculoskeletal analysis and exercise prescription with state-of-the-art wireless EMG recording techniques, we have created an easy-to-use tool to support functional movement screening and exercise prescription, encouraging client accountability and retention.

Only when you measure what is going on with specific muscles can you accurately prescribe an exercise plan tailored to the individual.

MR EMG enables you to screen for dysfunctional muscles and assess variances between individual muscle groups; it can be used in conjunction with dynamometers and force plates to measure individual muscle performance.

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Human Kinetics publish informative instructional books, eBooks, webinars, journals and online courses, which are distributed world-wide. They utilise the breadth of research and science based information to publish in the areas of sport science, fitness, strength and conditioning, sport nutrition, massage, flexibility and every sport that you can imagine! Their aim is to produce and disseminate educational resources that help readers lead healthier and more active lives through their Australian and New Zealand distributor Booktopia.

Exerfly is the ultimate resistance training equipment - using a tether attached to a spinning flywheel, you use your muscles to constantly counteract the momentum of the flywheel. The smooth and constant resistance works your muscles at every angle and the faster you can spin the flywheel using your muscles, the more force you'll need to generate to overcome the momentum of the flywheel. Add more flywheels, and you'll really feel the overload.

One feature which makes Exerfly unique is its motorised technology allowing users to select the desired eccentric overload, taking the athlete to new heights otherwise unachievable with traditional weights, and the in-built sensor that sends the user's rep-by-rep data straight to the Exerfly app, providing high-level workout metrics for effortless accountability. Exerfly supports a huge range of exercises that includes horizontal, vertical and rotational movements in many different combinations. Exerfly operates from New Zealand and supplies to a global stage, working with countless professional sports teams in the Premier League, NBA, MLB, CHL, NFL and Olympic organisations.

"I believe the Exerfly products provide a type of stressor at an intensity that will allow us to make serious improvements in our KPIs. We are lucky that the Exerfly company has been responsive, open minded, and eager to innovate using the feedback of coaches in the field. They are already ahead of most other companies in this particular space, and we are excited for the continued evolution"!

Chris Chase, Director of Performance
- Memphis Grizzlies

Our XLR8 staff are passionate about fitness and sport. Proudly 25 years old and still 100% New Zealand family owned & operated Canterbury business. The range is stacked full of quality products designed to meet the needs of elite sport, professional trainers, teachers, rehabilitation and medical specialists, coaches and athletes.

XLR8 products have received ringing endorsements from New Zealand's leading coaches, fitness professionals and sports people. When quality and performance counts, the professionals turn to XLR8.

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SESNZ are able to offer discounted indemnity and liability insurance to our members through GSI Direct. Members can access this through the following link (n.b. not available through GSI Direct's website)
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SESNZ members can purchase insurance cover directly through the members page on the SESNZ website.

GSI Direct specialise in providing small businesses, consultants and contractors with affordable liability insurance online in New Zealand. We encourage SESNZ members to investigate whether they can save on their premiums through this offering, or if they currently don't purchase any insurance, investigate whether it's something they should consider.

If you aren't already a SESNZ member follow this link to join us and grow your network. Annual membership is only $120 for Full Members and $30 for Students: https://sesnz.org.nz/membership/

Keynote Speakers

Dr Arne Nieuwenhuys, *University of Auckland*

Arne Nieuwenhuys is Senior Lecturer in Sport, Exercise and Performance Psychology in the Department of Exercise Sciences at the University of Auckland. Arne obtained his PhD from VU University Amsterdam and, prior to coming to New Zealand, has worked as an Assistant Professor at Radboud University Nijmegen in The Netherlands. He is a former international level sailor and, in more recent years, has developed an interest in long-distance running. At the University of Auckland, Arne teaches undergraduate papers in 'Sport Psychology' and the 'Psychology of Physical Activity' as well as an advanced postgraduate paper in 'Exercise and Performance Psychology'. He is Associate Editor for the Journal of Sport and Exercise Science and the European Journal of Sports Science.

Professor Douglas Seals, *University of Colorado Boulder*

Dr Seals is a Distinguished Professor of Integrative Physiology at the University of Colorado Boulder. He is internationally recognized for his research regarding the effects of aerobic exercise training on cardiovascular health with aging, particularly vascular function and the physiological mechanisms by which the benefits of exercise are mediated. Dr Seals has published more than 320 articles and has an h-index of 120+, with over 44,000 citations of his work. His research has been continuously supported by the National Institutes of Health for the last 35 years, including a prestigious 10-year MERIT award by the National Institute on Aging from 2004-2014. In 2013, Dr Seals was honoured by the American Physiological Society's (APS) Environmental & Exercise Physiology Section as the Edward F. Adolph Distinguished Lecturer for his work in exercise and vascular aging. In 2022, Dr Seals was given The Honor Award which is the highest distinction awarded by the APS Environmental & Exercise Physiology Section.

Professor Karl Friedl, *U.S. Army Research Institute of Environmental Medicine (USARIEM)*

Dr Friedl's research focusses on extending limits of human physiological performance. Dr Friedl received B.A. (1976) and M.A. (1979) degrees in zoology from the University of California, Santa Barbara and the Ph.D. degree in biology (1984) through the Institute of Environmental Stress in the University of California, Santa Barbara. Dr Friedl retired from thirty years of active duty service in the Army in 2013, where he had last served as Director of the Telemedicine and Advanced Technology Research Center (TATRC) at the US Army Medical Research and Materiel Command. Previously, he served as Commander, U.S. Army Research Institute of Environmental Medicine (USARIEM); Director, Army Operational Medicine Research Program; Principal Investigator, USARIEM; and Chief of Physiology and Biostatistics Service, Madigan Army Medical Center. Dr Friedl has made specific contributions in the areas of endocrine regulation in semi starvation, physiological effects of anabolic steroids, body composition methods and standards, physiological monitoring, and metrics of research return on investment. He has published nearly 200 original articles, book chapters, technical reports, and commentaries, and made over 250 scientific presentations at national and international meetings. He is a co-inventor on an Army patent for a system for remote neuropsychological assessment and organized major initiatives such as the Defense Women's Health Research Program (DWHRP), Technologies for Metabolic Monitoring (TMM), Bone Health and Military Medical Readiness (BHMMR), Gulf War Illnesses research program (GWIRP), and the Army's Parkinson's research program (NETRP).

Dr David Mizrahi, *University of Sydney*

Dr Mizrahi is a Research Fellow at The Daffodil Centre. He is an Accredited Exercise Physiologist, with his research focusing on exercise during and after cancer treatment for child and adult cancer survivors. He investigates the impact of exercise interventions on patient-reported and clinical outcomes, as well as the considerations around implementing exercise into routine clinical practice. David is an Australian-American Fulbright Postdoctoral Scholar, spent 4-months in the USA (St Jude's Children's Research Hospital, Tennessee) in 2022 to investigate exercise for childhood cancer patients undergoing treatment and formalising partnerships. He has ongoing collaborations with researchers around Australia, USA, Canada and Sweden to advance the understanding of the role of exercise for cancer survivors. David is the Chair of the executive committees for Clinical Oncology Society of Australia (Exercise and Cancer), deputy chair of Little Big Steps (registered childhood cancer charity), and was a member of Exercise and Sports Science Australia (Research). His is the lead guest editor for the Frontiers in Pediatrics special edition on "Childhood cancer and physical activity". He is the co-host of the Little Big Forum, an annual webinar on exercise and childhood cancer.

Invited Speakers

Dr Debbie Bean, *AUT University*

Debbie Bean is a Senior Research Fellow in the Health & Rehabilitation Research Institute at AUT. She is also a Health Psychologist and has experience in the field of chronic pain management. Debbie's main research interests include the assessment and management of chronic pain, and complex regional pain syndrome. Dr Bean will consider the prevalence/problem of chronic pain and psychological barriers/facilitators of exercise e.g., motivation, pain beliefs, fear avoidance, pain catastrophizing, and tools to overcome some of these.

Dr Elizabeth Bradshaw, *Deakin University*

Dr Elizabeth (Liz) Bradshaw is a Sports Biomechanist in the Centre for Sport Research at Deakin University in Melbourne. She has worked extensively in elite sport through consultancy and/or employment at the Victorian Institute of Sport, Australian Institute of Sport, the New Zealand Academy of Sport, and Gymnastics Australia. She is a Life Member of the International Society of Biomechanics in Sport (ISBS) and an Associate Editor of their journal, Sports Biomechanics.

Dr Emily Carter, *Tennis New Zealand*

Emily has a PhD from AUT focusing on the athletic development of junior tennis players. Her research centred on evaluating the relationship between movement competency and tennis performance, and how this can be influenced through S&C intervention both acutely and longitudinally. Emily is a qualified physiotherapist with a MSc in S&C and has spent the last 8 years as the S&C lead for Tennis NZ working both junior and professional players, recently moving into the role of High Performance Manager.

Dr Lynette Hodges, *Massey University*

Lynette Hodges is a Senior Lecturer in Sport and Exercise at Massey University. Dr Hodges teaches courses in Clinical Exercise Physiology, exploring the assessment, prescription, and monitoring of exercise programmes designed to achieve specific health outcomes for individuals with non-communicable diseases. She is current board member of Clinical Exercise Physiology New Zealand (CEPNZ) and chair of the organization's research, education, and professional affairs committee. Within this group, she is responsible for coordinating and developing webinars, overseeing the design and development of educational information, and organizing and managing the yearly CEPNZ conference. Dr Hodges' research focuses mainly on Myalgic Encephalomyelitis/Chronic Fatigue Syndrome (ME/CFS).

Scott Logan, *Auckland Cricket*

Scott is the Strength and Conditioning Coach for Auckland Cricket. Over the past decade Scott has been the Black Sticks Men's Hockey Team lead S&C and has prepared the team for over 250 international matches including 2 Olympic, 2 Commonwealth and 2 World Cup campaigns and multiple other pinnacle tournaments. Scott's key roles have been GPS / load monitoring, sports science, diagnostics, strength training, conditioning training and injury rehabilitation and prevention. Collectively, these roles over many years have allowed Scott to refine his approaches to ensure he is developing a robust squad of players, able to cope with the intensity of match play at the elite level as well as endure the highly demanding tournament schedules at pinnacle events.

Dr Chloe McKenzie, *Te Pūkenga MIT*

Chloe has a PhD from AUT in the area of Sports Kinesiology and Injury Prevention. Her research evaluated the NetballSmart Dynamic Warm-up, focusing on the development of physical capabilities and reducing injury risk in youth netball players. She has spent the last 5 years as the Strength and Conditioning Coach of the Robinhood Stars netball team, as well as running Next Level Netball, a small business involved in running strength and conditioning programmes for several schools in Auckland. Chloe is also a lecturer at Te Pūkenga MIT. Her research interests include injury prevention and performance in female athletes.

Ryan Turfrey, *High Performance Sport New Zealand*

Ryan currently works as a Senior Strength & Conditioning Practitioner for High Performance Sport New Zealand and is the National Lead for RowingNZ. He has spent the last 13 years working in elite sport and has led the strength and conditioning programme for multiple Olympic and World Championship medal winning campaigns across the last

three cycles (London 2012, Rio 2016 and Tokyo 2020) in cycling (BMX), canoe slalom and rowing. Ryan is currently undertaking a PhD at the University of Auckland in the field of Exercise Science and additionally holds a Masters of Sport and Exercise with 1st class Honours from the Auckland University of Technology.

Associate Professor Kirsten Spencer, *AUT University*

Dr Kirsten Spencer is currently Head of Department, Coaching and Youth Sport Development and a member of the Sports Performance Research Institute NZ where she is leader for the Youth Sport Development Research Group and with the Sport Technology Research Group. She is also Director of the International Society of Performance Analysis in Sport. The current focus of her research is the development of junior coaching programmes in youth with a focus on modification of games, athlete life skill development, the use of technology in coaching and Scanning in elite sport. She has current research collaborations with South Africa Hockey, High Performance Sport New Zealand (HPSNZ), NZ Rugby, Netball NZ, NZ Football, Hockey NZ, The Blues and Surf Life-Saving NZ. Kirsten is the Associate Editor of Frontiers: Elite Sports and Performance Enhancement, the Review Editor of Frontiers in Movement Science and Sport Psychology.

Matt Wood, *Human Potential Clinic, AUT University*

Matt is a Clinical Exercise Physiologist and Manager of the Human Potential Clinic where he provides exercise assessment and training services for healthy individuals and those living with chronic health conditions. In addition, Matt is also a senior lecturer at AUT's School of Sport and Recreation, specialising in exercise physiology and exercise prescription. Matt also has a special interest in improving exercise-related processes for managing clinical clients in the NZ fitness and medical industries, working with large organisations to improve client/patient care. His research interests include a variety of clinical, occupational and sports physiology projects; with a current focus on ways of optimising exercise prescription for cardiac and cancer patients.

Keynote Presentations

Sleep and motor control in high-pressure performance situations

Arne Nieuwenhuys[1]

[1]*Department of Exercise Sciences, University of Auckland, Auckland, New Zealand*

Sleep is often considered essential for athletes' health, recovery, and performance. However, despite its perceived importance, elite athletes tend to sleep less well than gender and age-matched controls – exhibiting shorter sleep duration, elevated wake after sleep onset, and lower sleep efficiency. Recent neurophysiological evidence suggests that a lack of sleep can increase emotional brain responding and decrease cognitive control, especially at those moments when it counts the most. Knowing this, are elite athletes and other professionals operating under high levels of pressure (e.g., police officers, soldiers, medical personnel) at an increased risk of experiencing negative effects of insufficient sleep on their performances? Drawing upon several years of research, I will review literature on sleep behaviour in elite athletes and present available evidence for the effects of sleep deprivation on athletic performance. After that, I will consider implications of sleep deprivation on performance under pressure, considering both complex perceptual-motor tasks as well as executive functions underlying the control of movement. Special attention will be given to recent and ongoing work on response inhibition, aiming to determine the extent of sleep deprivation required for individuals to start losing control over their actions in more and less stressful situations.

Exercise training for promoting vascular health with aging

Douglas Seals[1]

[1]*University of Colorado*

Aging is the primary risk factor for cardiovascular diseases (CVD), cognitive dysfunction and chronic kidney disease. Arterial dysfunction is the main mechanism by which aging causes these and many other chronic disorders. Two major expressions of "arterial aging" are large elastic artery stiffening and vascular endothelial dysfunction. Aerobic exercise is associated with reduced risk of CVD and other chronic age-related disorders. This presentation will consider effective exercise approaches for promoting vascular health with aging and will discuss current research gaps/future directions with regards to public health implications including insight into the efficacy of "time-efficient" forms of exercise training, the effects of regular exercise on cerebrovascular function, and potential sex-differences in the vascular adaptations to exercise training.

Current and future directions in human performance monitoring

Karl E. Friedl[1]

[1]*US Army Research Institute of Environmental Medicine*

Performance and health state awareness is increasingly informed by physiological monitoring technologies and real-time predictive modeling that feed data-hungry artificial intelligence (AI) pattern recognition at the edge. We have come a long way from earlier days of "strong pills" and "smart pills" and, instead seek to improve human biology through mental preparation and optimized rest, nutrition, and training. If we can measure and monitor health & performance states, we can improve safety, reduce risk of injury, and sustain and enhance mental and physical performance. Monitoring technologies range from instrumented training equipment, to wearable sensors, and to area/team performance monitoring. Increasingly transparent and unobtrusive technologies data feed new algorithms and models to optimize training, pacing, and guide the use and development of other assistive technologies. Performance enhancing strategies will likely be changed with continuous monitoring of analytes such as lactate, ketones, and glucose and by advances in neurostimulation devices. Personally customized physiologically aware virtual agents (PAVA) will provide biofeedback and coaching to enhance mental self-regulation. Functional fiber technologies will soon replace outmoded wrist- and chest-worn devices with monitoring and computation occurring within wear-and-forget smart clothing, shoes, and other equipment that respond to the needs of individuals and provide supersensory awareness of their ambient environmental conditions. At some point in the continuum of technology use, optimization of individual performance may provide an unfair asymmetrical advantage to those with the most effective technologies. While it would be unethical not to provide every safe and effective advantage to our soldiers, some aspects of "technological doping" may need to be regulated in competitive athletics. Disclaimer: the opinions and assertions in this presentation are those of the author and do not necessarily constitute any official policy or views of the United States Army.

Exercise-oncology and chemotherapy-induced peripheral neuropathy

David Mizrahi[1]

[1]*The Daffodil Centre, University of Sydney, Australia*

Exercise in cancer care (termed 'exercise-oncology' is a rapidly emerging field, with more institutions endorsing exercise during and after cancer treatment. With established benefits in improving fitness, strength, psychological wellbeing and quality of life, more cancer-symptoms are being explored for whether there are benefits from exercise. Chemotherapy-induced peripheral neuropathy (CIPN) is a debilitating neurological side-effect from numerous chemotherapy agents. This talk will give an overview into CIPN, as well as the potential role for exercise in managing CIPN symptoms.

Invited Presentations

Pain insights: Considerations for the clinical exercise physiologist

Debbie Bean[1,2]

[1]*Health & Rehabilitation Research Institute, Auckland University of Technology*
[2]*Department of Anaesthesiology & Perioperative Medicine, Waitematā District Health Board*

Persistent pain affects around one in five people, and is the leading cause of disability in Aotearoa New Zealand. Not surprisingly, exercise physiologists will frequently work with people with persistent pain across a variety of settings. Although exercise is beneficial for pain, using exercise in clinical practice for persistent pain can be challenging. This talk will describe models for making sense of persistent pain, which is often unrelated to tissue damage but is also not purely psychological. Instead, science suggests that pain represents a threat response incorporating the activity of the central nervous system, immune system, and autonomic aspects. I will then consider how beliefs, thoughts, emotions, and behavioural patterns can influence pain, both positively and negatively. These psychological factors also influence individual's reactions to exercise and engagement in active rehabilitation. Finally, I will explore strategies for incorporating pain science and psychology into exercise rehabilitation to engage clients positively, build relationships, provide education, reduce disability, and optimise outcomes.

Emerging sensor technology use for measuring musculoskeletal loads in sport

Elizabeth J. Bradshaw[1,2,3]

[1]*Centre for Sport Research, Deakin University, Australia*
[2]*Sport Performance Research Institute New Zealand,*
[3]*Auckland University of Technology, New Zealand*

Inertial and magneto-inertial sensors (also known as inertial measurement units) are increasingly prevalent wearable measurement technologies being used in sports biomechanics to provide technical insight on performance (optimal technique, injury minimisation) and assist in athlete training load management (e.g., return to training, readiness, tapering before competition)1. Recent editorial statements and reviews have provided some words of caution and guidelines for best practice for this technology.[1,2,3] Existing predominantly lab-based methods that this technology is being used to try and replicate in the field include mainly three-dimensional kinematics, force plates, high-load accelerometers, and strain gauges. Standard laboratory methods have often limited our understanding of musculoskeletal (MSS) loads in exercise and sport due to cost barriers, time barriers, athlete recruitment challenges, safety, and reduced ecological validity. However, knowledge gained from these methods and studies should be used as a guide when moving towards using sensor technology to measure MSS loads in the field, adjusting for known methodological differences. Sensors are already changing our knowledge of MSS loads. For example, wrist loads on the pommel horse in men's artistic gymnastics was previously estimated to be 1-2 Body Weights (BW) via instrumentation with a load cell[4] or force plates[5]. When these loads were measured with inertial sensors mounted on the wrists, they were on average 10 times gravitational acceleration (g) (where: 1 Body Weight (BW) = body mass (m) in kilograms × gravity (g) of -9.81 m/s^2; when body mass is fixed, 1BW = 1 g), and as high as ~19 g, during counter-clockwise circles.[6] Similarly, forearm loads in foundation gymnastics skills have been shown to be movement direction and apparatus specific; ~10 g for the forward handspring but ~14 – 15 g for the backward handspring on the floor apparatus,[6] increasing to over 20 g for the forward handspring on vault.[7] Similarly, in cricket bowling, tibial acceleration loads were recently assessed for the full delivery stride and, for the first time, the follow-through. It revealed that the highest tibial load is during back foot contact during the follow-through phase.[9] Sensors are therefore changing our knowledge of MSS loads in sport and provide the potential for more sport-relevant measures and greater scientific insight/feedback. The current limitations to the wider use of sensors include cost, end-user and application specific software, and limited normative data sets to guide interpretation. Overcoming these limitations may be a more fruitful focus for Sports Biomechanics than replicating previous methods (e.g., estimating a ground reaction force using sensors).

[1]Hughes, G.T.G. et al. (2021). Novel technology in sports biomechanics: Some words of caution. *Sports Biomechanics*. https://doi.org/10.1080/14763141.2020.1869453
[2]Dadashi, F. et al. (2013). Inertial measurement unit and biomechanical analysis of swimming: An update. *Swiss Society of Sports Medicine, 61*, 21-26. https://infoscience.epfl.ch/record/189819
[3]Ghattas, J. & Jarvis, D.N. (2021). Validity of inertial measurement units for tracking human motion: A systematic review. *Sports Biomechanics*. https://doi.org/10.1080/14763141.2021.1990383
[4]Markolf, K.L. et al. (1990). Wrist loading patterns during pommel horse exercises. *Journal of Biomechanics, 23*(10), 1001-1011.
[5]Fujihara, T. et al. (2009). Biomechanical analysis of circles on pommel horse. *Sports Biomechanics, 8*(1), 22-38. https://doi.org/10.1080/14763140802629974
[6]Bradshaw, E.J. (2016). Pilot tests of inertial measurement units during artistic gymnastics training on pommel horse and vault. *Research to Practice*, Melbourne, 276.
[7]Campbell, R. A. et al. (2021). Inertial measurement units are 'all g': Inter-trial reliability when assessing upper and lower body impact loading in artistic gymnastics. *International Journal of Sports Science & Coaching, 16*(2), 380–390. https://doi.org/10.1177/1747954120970310
[8]Campbell, R.A. et al. (2022) The use of inertial measurement units to quantify forearm loading and symmetry during gymnastics vault training sessions. *Sports Biomechanics*. https://doi.org/10.1080/14763141.2022.2117642
[9]Epifano, D.J. et al. (2022). Comparing tibial accelerations between delivery and follow-through foot strikes in cricket pace bowling. *Sports Biomechanics*. https://doi.org/10.1080/14763141.2022.2136582

Use of movement screenings in strength and conditioning

Emily Carter[1]

[1]*Tennis New Zealand*

This presentation will consider the use of movement screening in strength and conditioning practice. Specifically, considering why and when to use them and how to select appropriate movements for your sport and how to interpret and use the data they provide.

Exercise: Friend or foe?

Lynette Hodges[1]

[1]*School of Sport, Exercise and Nutrition, Massey University*

Once dismissed as 'all in the mind,' Myalgic Encephalomyelitis/Chronic Fatigue Syndrome (ME/CFS) is now recognized as a serious debilitating condition; however, there is currently no cure or approved treatment. Notably, and contrary to many other non-communicable

diseases, exercise has been found to worsen symptoms of ME/CFS and may cause post exertional malaise (PEM). In this presentation, Dr Hodges discusses the effect of exercise on ME/CFS and provides valuable insight into this complex, poorly understood condition.

Developing physically robust players for international competition

Scott Logan[1]

[1]*Auckland Cricket*

This talk will provide insights into how team sport players prepare physically for the demands that major tournaments like the Olympics, Commonwealth Games and World Cup place on the body where athletes are required to play multiple games within a tournament. We will look at strength training, conditioning, game load, recovery, injuries, and diagnostic monitoring that helps these athletes handle 40 – 60km training weeks in the build up to 40 – 60km back-to-back competition weeks.

Physical preparation considerations for elite netball athletes

Chloe McKenzie[1]

[1]*Te Pūkenga MIT and Next Level Netball*

Netball is a physically demanding sport with a high risk of injury to athletes. This talk will cover some of the key programming considerations and approaches used to optimally prepare players for the ANZ Premiership.

Exercise and childhood cancer: What is the evidence and the role of exercise?

David Mizrahi[1]

[1]*The Daffodil Centre, University of Sydney, Australia*

The exercise-oncology literature is rapidly growing, however this literature is predominately among adults. Cancer represents around 1% of all cancers, yet the impact to the community and survivors are dealt with living for decades with high risk of developing co-morbidities. The role of exercise is less clear in childhood cancer patients and survivors. This talk will discuss the latest evidence around exercise and children's cancers, as well as strategies to promote positive behaviour change in this population.

The need to have a robust, objective assessment of performance analysis competencies

Kirsten Spencer[1]

[1]*School of Sport and Recreation, Sport Performance Research Institute NZ, AUT University*

Sport performance and data analysts are integral to the understanding of player development and player performance in sports across the world. These individuals provide detailed training and competition information that is acted upon by coaches and managers, in conjunction with data from other practitioners. The aim of this talk is fourfold: To present a robust and trustworthy international accreditation process that accurately reflects the analysts competencies which can be implemented by the organisation, the club or coaches and managers across sports to provide the level of knowledge and give confidence in the skills of the analyst they have employed, or are considering employing; secondly to identify career development opportunities and support analysts to become world-class; thirdly to share the development of a world-class accreditation framework that supports analysts at all stages of their career from both the individual and department to whole organisation level, and fourthly to provide a 'home' for all analysts to support each other no matter what stage of their career or lifecycle. This talk will provide a foundation for other Performance Analysis themed sessions within the 2022 conference programme.

Integrating strength and conditioning practices within RowingNZ: Balancing the off- and on-water

Ryan Turfrey[1]

[1]*High Performance Sport New Zealand*

This talk will provide insight into both the theoretical underpinnings and practical implementation of strength and conditioning practices within the RowingNZ programme. Specifically, how the broader physiological determinants of performance are addressed across the span of a campaign and how these objectives are achieved within the context of their land-based training. Focused across the three primary pillars of strength and conditioning programming within the emphasis of RowingNZ programme (physiological, biomechanical, and prehabilitation), specific examples of programme-design matched to objectives and the collaborative means of achieving them will be discussed.

Exercise prehabilitation: Preparing cancer patients for surgery and beyond

Matt Wood[1]

[1]*Human Potential Centre, AUT University*

Poor physical fitness is associated with comparatively worse outcomes following major surgery in cancer patients. Patients with poor physical fitness are at greater risk of complications, longer length of hospital stay (LOS), and mortality. Moreover, many patients fail to regain their preoperative functional status which is often subject to further insult from subsequent treatments. Previously, researchers have used a variety of preoperative exercise interventions in an attempt to improve physical fitness and its associated outcomes. A recent meta-analysis of exercise interventions in gastro-intestinal cancer surgery patients, reported improvements in a surrogate measure of exercise capacity, but found no significant difference in LOS, rates of postoperative complications, 30-day readmission, and mortality. The observed differences may in part be due to significant heterogeneity in the structure and delivery of exercise programmes, the short time-frame between diagnosis and surgery, and the outcome measures used to evaluate the efficacy of interventions. More recent studies have focused on well-structured time-efficient exercise interventions for improving physical fitness. Researchers have incorporated high-intensity interval training protocols in isolation or in combination with resistance training. While the initial research findings appear promising, there are nonetheless, a number of additional considerations for exercise interventions to be practically viable in the NZ context.

Oral Presentations

Physiology

Effects of blood flow restriction as a potentiating tool in trained female athletes

Beaven, C.M.[1]; Wharemate, J. [1]

Te Huataki Waiora School of Health, University of Waikato, New Zealand

Introduction: Post activation potentiation is an acute improvement in performance following a conditioning stimulus. Blood flow restriction (BFR) is a training method that restricts blood flow that increases the metabolic stress and muscle activation. Research has shown some success using BFR as a potentiation tool in males; however, there is no research involving females. **Methods**: Fifteen resistance-trained females completed a randomised crossover study. Participants completed loaded squat jumps and 20-m sprint at baseline, 4-, and 8-min post a squat protocol (four sets of bodyweight squats of 30, 15, 15, 15 repetitions) either with or without occlusion cuffs at a pressure of 180 mmHg. Theoretical maximal power (Pmax), force (F0), and velocity (V0) were calculated in vertical and horizontal directions. **Results:** A negative effect of time on jumps was observed ($p < 0.001$). There was an interaction effect observed in the bodyweight jump results showing that the decrease in jump height was more extensive in CON ($p = 0.0436$). Sprint potentiation results were unclear (Post 4: d = 0.22 ± 0.42) or trivial (Post 8: d =- 0.16 ± 0.24). Correlational analyses indicated that $Pmax_{VERT}$ was very strongly correlated with jump performance ($r = 0.97$), but $F0_{VERT}$ was weak (r =0.22). In contrast, both $Pmax_{HORIZ}$ ($r = 0.71$) and $F0_{HORIZ}$ ($r = 0.65$), were strongly related to sprint speed. There was no indication that high levels of theoretical maximal force ($F0_{HORIZ}$ or $F0_{VERT}$) were related to the potentiation response. **Discussion:** There was no evidence of potentiation on sprint or jump performance at any time point after the conditioning stimulus; however, the decrease was following BFR was significantly less than that observed in the CON condition for the bodyweight jumps at the four-minute time point. **Take home message:** The BFR protocol utilised appeared to be too fatiguing and failed to elicit PAP in this trained female cohort.

Effects of shear stress on acute cerebrovascular flow-mediated dilation

Jones, E.M.W.[1,2]; Gibbons, T.D.[1,2]; Campbell, H.A.[2]; Stothers, T.A.M.[1]; Cotter, J.D.[1]; Thomas, K.N.[2]

[1]School of Physical Education, Sport and Exercise Sciences, University of Otago, New Zealand
[2]Department of Surgical Sciences, Dunedin School of Medicine, University of Otago, New Zealand

Introduction: Greater magnitudes of increase in antegrade shear stress are associated with greater vessel dilation and are considered atheroprotective in peripheral vasculature. However, it remains unclear as to whether this is the same in cerebral vessels. Cerebrovascular shear stress *increases* during hypercapnia and hypoxia, and *decreases* during hypocapnia. The aim of this investigation was to use two dissimilar stimuli to increase cerebrovascular shear stress, and one to decrease it, to isolate the role of shear stress on acute cerebrovascular function. **Methods:** Cerebrovascular shear stress was manipulated in fourteen healthy adults using three interventions. Hypercapnia (+10 mm Hg $P_{ET}CO_2$) and hypoxia (75% – 80% SpO_2) were used to increase cerebrovascular shear stress; and hypocapnia (-10 mm Hg $P_{ET}CO_2$) was used to decrease it. Stimulus exposure was 6-min intervals, with 4-min breaks, for 60 min. Change in cerebrovascular endothelial function was measured before and after each intervention using Duplex ultrasound following a transient increase in $P_{ET}CO_2$ (+10 mm Hg) via an end-tidal clamping system (i.e., cerebral flow-mediated dilation; cFMD). Respired gases, heart rate, blood pressure, haematocrit and cerebral blood flow were measured during each intervention. **Results:** Cerebrovascular shear stress was increased in hypercapnia (43% ± 24%, $p < 0.0001$) and hypoxia (12% ± 10%, $p < 0.0001$), and decreased following hypocapnia 29% (29% ± 11%, $p < 0.0001$). Hypocapnia decreased acute cFMD ($p = 0.02$) but no improvements in acute cFMD followed hypercapnia ($p = 0.34$) or hypoxia ($p = 0.73$). **Discussion:** The present findings highlight that shear stress may not be as key of a contributor to improvements in endothelial function of cerebrovasculature as previously suggested. **Take home message:** Impairments in cerebrovascular function may increase the risk of developing neurological diseases. Identifying ways to improve cerebrovascular function acutely may help guide the development of novel interventions that work specifically to prevent or delay cerebrovascular dysfunction.

The acute effects of lower limb blood flow restriction during aerobic exercise with trained cyclists

Lander, P.[1]; Paton, C.[1]

[1]Eastern Institute of Technology, New Zealand

Introduction: Completing training with the addition of limb blood flow restriction (BFR) may benefit endurance exercise adaptations. However, little is known about the acute physiological responses to BFR during aerobic-based exercise and its effect on the ability to sustain exercise intensity. This study examines the physiological responses to BFR applied during incremental exercise and 3-km time trials with trained cyclists. **Methods:** Nine males (39 ± 8 years, 179 ± 5 cm, 75 ± 5 kg, and 58 ± 4 $ml.kg^{-1}.min^{-1}$) completed two sessions with either 0-mmHg (CON) or 80-mmHg (BFR_{80}) pressure applied to the upper-thighs via pneumatic cuffs. Subjects performed an incremental test (100W with 40W increments) to volitional exhaustion and a maximal effort self-paced 3-km time trial. Power output (PO), respiratory parameters (VO_2, VCO_2 VE), heart rate, muscle O_2 saturation (SmO_2), and blood lactates were measured during tests for

comparison. **Results:** Peak power achieved in the incremental exercise test was significantly ($p < 0.01$) reduced in BFR_{80} (309 ± 62 W) compared to CON (409 ± 43 W) and led to a concurrent reduction in maximal VO_2. Submaximal power at fixed blood lactate concentrations of 2-mMol and 4-mMol was also significantly lower in BFR_{80} than CON. Correspondingly, the mean power output in the 3-km trial was significantly lower in BFR_{80} (277 ± 59 W) than in CON (366 ± 62 W). **Discussion:** BFR applied during cycling leads to substantial reductions (~25%) in incremental peak power, submaximal power at fixed blood lactate concentrations and mean power during a 3-km time trial. The reductions in performance were associated with elevated blood lactate concentrations and heart rates during BFR_{80}. However, there appears little effect of BFR on respiratory measures or SmO_2 at equivalent exercise intensities. **Take home message:** BFR applied during aerobic exercise decreases the ability to sustain and achieve maximal exercise intensity. The primary mechanism responsible for the reduced power is elevated lactate concentrations at equivalent exercise intensities.

Team Pursuit: Fitter is faster

Pugh, C.F.[1,2]; Beaven, C.M.[1]; Ferguson, R.A.[3]; Driller, M.W.[4]; Palmer, C.[2]; Paton, C.D.[5]

[1]*Te Huataki Waiora School of Health, University of Waikato, New Zealand*
[2]*Cycling New Zealand*
[3]*School of Sport, Exercise and Health Sciences, Loughborough University, United Kingdom*
[4]*Sport and Exercise Science, School of Allied Health, Human Services and Sport, La Trobe University, Australia*
[5]*School of Health and Sport Science, Eastern Institute of Technology, New Zealand*

Introduction: Leading a 4-km team pursuit (TP) requires high-intensity efforts above critical power (CP) that depletes rider's finite work capacity (W′), whereas riders following in the aerodynamic draft may experience some recovery due to reduced power demands. This study aimed to determine how rider ability and CP and W′ measures impact TP performance and the extent to which W′ can reconstitute during recovery positions in a TP race. **Method:** Three TP teams, each consisting of 4 males, completed individual performance tests to determine their CP and W′. Teams were classified based on their performance level as International (INT), National (NAT), or Regional (REG). Each team performed a TP on an indoor velodrome (INT: 3:49.9; NAT: 3:56.7; REG: 4:05.4; min:sec). Ergometer-based TP simulations with an open-ended interval to exhaustion were performed to measure individual ability to reconstitute W′ at 25 – 100 W below CP. **Results:** The INT team possessed higher CP (407 ± 4 W) than both NAT (381 ± 13 W) and REG (376 ± 15 W) ($p < .05$), whereas W′ was similar between teams (INT: 27.2 ± 2.8 kJ; NAT: 29.3 ± 2.4 kJ; REG: 28.8 ± 1.6 kJ; $p > .05$). The INT team expended 104 ± 5% of their initial W′ during the TP and possessed faster rates of recovery than NAT and REG at 25 and 50 W below CP ($p < .05$). **Discussion:** Because of a greater CP and faster W′ reconstitution, the INT team were able to produce a higher lead rider power output than the NAT and REG teams, which likely contributed to the INT team finishing 7- and 15-seconds faster, respectively. **Take home message:** While improvements in CP and/or W′ may lead to enhanced TP performance, our data indicate that overall endurance capacity is the most important physiological factor of TP performance.

Blue light: A phone-y concept or a facilitative function?

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Introduction: Blue light, an integral part of sunlight and LED devices such as mobile phones and laptops, has been shown to improve cognitive functions, including sustained attention and speed of information processing. Electroencephalography (EEG) can be used to gauge cognitive functioning and high alpha-band (α) signals are inversely related to brain activity and have been shown to reflect focused attention. **Methods**: Twenty participants completed 4-min of quiet sitting followed by 40 trials of a selective attention and cognitive processing speed test (Stroop Test) after 15 minutes of exposure to either a blue (intervention) or red (placebo) light. EEG was used to measure α-power signals for the duration of the intervention. **Results:** High alpha power was significant lower (i.e., more activity) at post-test, compared to pre-test for the blue light group; whereas, no significant changes for the red light group were found. In the Stroop test, a clear moderate difference (d = 0.99, $p = 0.0558$) was seen between the groups with the interference time decreasing by 68 ms in the blue condition compared to a 35 ms increase in the red condition. **Discussion:** Trends showed less frontal α-power (greater activity) in the blue light group during quiet sitting and Stroop performance was superior in the blue light group indicating that blue light may have a facilitative effect on cognitive functions. These cognitive effects could have benefits in a variety of occupational contexts including competitive sporting environs. **Take home message:** 15 minutes of exposure to blue light altered activity in brain regions associated with attention and improved cognitive performance.

Does adaptation to cold shock provide cross adaptation to the basic control of breathing?

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Introduction: Cold water immersion (CWI) elicits strong cardiorespiratory responses termed the cold shock response (CSR). This entails an inspiratory gasp followed by hyperventilation and increased heart rate and blood pressure. Adaptation to CSR is both powerful and rapid, occurring within eight exposures, thereby comprising a potentially rapid way to blunt stress responsiveness. However, limited research exists around whether adaptation to CSR provides cross-adaptation to other

stressors, such as hypoxia and hypercapnia. Hypoxia and hypercapnia induce hypoxic (HVR) and hypercapnic (HCVR) ventilatory responses, mediated by peripheral and central chemoreceptors, respectively. One study demonstrated that CSR adaptation provides cross adaptation to acute hypoxia while exercising. However, carbon dioxide was uncontrolled in that study and would thereby have constrained HVR, so neither HVR nor HCVR adaptations have been examined directly. The purpose of this study was therefore to explore whether CSR adaptation provides cross adaptation to hypoxia or hypercapnia as primary stressors. **Methods:** Twelve cold-naïve volunteers undertook 8, 3-min head-out CWI's in 13°C water, with HVR and HVCR evaluated before and after adaptation. Eight control participants completed these evaluations before and after a control period. **Results:** Cold-induced increases in ventilation and tidal volume were attenuated ($p \leq 0.004$) after repeated bouts of CSR, but not to greater extent than for the Control group (interactions: $p \geq 0.232$). Nor were cold-related perceptions reliably blunted during CSR (interactions: all p's > 0.102). Ventilatory sensitivities were not blunted across the adaptation period for the CSR group, for hypoxia (interaction 95% CI: 0.1 to -1.2 L/min/%SaO2) or hypercapnia (95% CI: 0.4 to -0.6 L/min/mm Hg CO2). **Take home message:** This study did not show evidence of CSR adaptation, which may at least partly explain the lack of evidence for CSR cross-adaptation to hypoxia or hypercapnia. The null findings may reflect a low sample size and the nature of participants and control exposures.

Handling the heat: Does lower baseline body temperature or opportunity for behaviour improve heat tolerance?

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Introduction: Body temperature, breathing and brain blood flow are closely interlinked. High body (core) temperature causes hyperventilation, reducing blood flow to the brain, increasing its temperature, and potentially limiting heat tolerance. Core temperature fluctuates across the day and the menstrual cycle, but whether these natural variations affect breathing, brain blood flow control or tolerance during exercise heat stress remains unknown. Additionally, behaviour is the most effective means of controlling body temperature and is driven by thermal discomfort; this may also drive hyperventilation and thereby limit heat tolerance, but previous research had not examined this possibility. We assessed how differences in baseline core temperature (i.e., diurnal and luteal menstrual phase) and behaviour affected heat tolerance, cerebrovascular and respiratory control. **Methods:** Thirteen participants cycled in a heated suit until volitional exhaustion in three settings (randomised order): morning, afternoon, and afternoon with access to face cooling as desired. **Results/Discussion:** Heat tolerance was limited by maximal core temperature (~39.0 °C), not the rise in temperature, so heat tolerance (capacity to increase) was ~0.4 °C lower in the afternoon. Individual tolerance varied markedly (range: 37.5 to 40.0 °C) but was not different between females and males. Face cooling did not lessen discomfort or improve tolerance, and for most participants (8/13) it failed to blunt the heat-induced hyperventilation and reduced brain blood flow. Hyperventilation developed linearly from the onset of heating and was attributed to physical heating effects rather than psychological effects for most people. **Take home message:** Core temperature is the principal and linear driver of both physiological responses and thermal perceptions during low-intensity exercising heat stress. Heat tolerance is limited by an upper limit of core temperature, which is highly individual and for most individuals is driven by accumulating physiological factors rather than perceptual discomfort.

Cross-adaptation of cold shock to cold-pressor (pain-related) responsiveness

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Introduction: Cold water immersion (CWI) is a readily available stressor of increasing popularity. CWI induces the cold shock response (CSR); a strong sympathetic stimulus involving initial gasp followed by elevated ventilation, heart rate, and blood pressure. Humans adapt rapidly and strongly to repeated brief CWI, thought to be modulated through rapid adaptation within the CNS. The aim of this study was to identify whether CSR adaptation provides protection against another sympathetic stressor, the cold pressor test (CPT), and vice-versa. **Method:** Nineteen participants (10 males, 9 females) undertook one of two interventions: (i) eleven undertook CSR adaptation (8 daily 3-min whole-body CWI in 13°C), (ii) eight undertook CPT adaptation (8 daily 3-min hand immersion in ice water). All participants were exposed to each stressor on separate days before and after adaptation. **Results:** Repeated CSR did not appear to attenuate mean arterial pressure (pre = 99 ± 8 mmHg, post = 99 ± 11 mmHg) or systolic pressure (134 ± 13 vs. 140 ± 15 mmHg) responses to CPT. Repeated CPT did not appear to attenuate the ventilation (38.4 ± 15.8 vs. 33.5 ± 12.3 L/min), breathing frequency (27 ± 10 vs. 25 ± 9 breaths/min) or tidal volume (1.4 ± 0.6 vs. 1.4 ± 0.5 L) responses to CSR. **Discussion:** Initial indications are that whole-body cold shock adaptation does not transfer (cross adapt) to cold pressor responsiveness. Insufficiency in the adaptation protocol is yet to be investigated and may have contributed to this finding, as initial indications are that the adaptation protocol may not have been a sufficient stimulus for a number of participants. **Take home message:** Early data suggests no cross-adaptation though analysis of the initial adaptation protocols is yet to be undertaken.

Validity of three core temperature measurement techniques in cool water swimming

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Introduction: As the popularity of open-water swimming increases, it is critical to know the associated risks. Open-water swimming water temperature regulations are based on core temperature responses measured rectally. Rectal temperature is a sluggish index of core temperature. The heart is the organ most at risk during hypothermia, and its temperature is closely represented from oesophageal temperature, whereas gastrointestinal pill temperature is most practical in swimming. The purposes of this research were to determine the (a) validity of rectal temperature to guide open water swimming legislation of water temperatures (relative to oesophageal temperature), and (b) the validity of gastrointestinal (pill) temperature, as a fieldable index of core temperature during swimming. We hypothesised that oesophageal temperature would decouple from rectal temperature, more so in swimming and leaner individuals. **Methods:** Six participants have undergone three immersions in 20.1°C water (i.e., wetsuits prohibited), in randomised order: (a) standing, (b) treading water, and (c) swimming, using a stroke of choice. Immersion continued until core temperature reached 35.5°C, 60 minutes, or intolerance. **Results:** The response of different core temperature indices depended on the activity (interaction: $p = 0.035$). Specifically, oesophageal temperature fell $0.72°C \cdot h^{-1}$ faster than rectal temperature did when swimming ($p = 0.001$, 95% CI [-0.36, -1.09]) but did not show any reliable difference when standing (95% CI [0.01, -0.73]) or treading (95% CI [0.07, -0.66]). Gastrointestinal temperature responses were intermediary between those of rectal and oesophageal when swimming. In this small sample size, the oesophageal-specific cooling (i.e., uncoupling from rectal) was not observably related to any anthropometric measure when swimming or treading ($R^2 < 0.25$) but was moderately predicted by body density and fat mass when standing (both $R^2 = 0.78$). **Take home message:** Rectal temperature is not fully indicative of the most safety-relevant core temperature when swimming.

Polo: What do we know now?

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Introduction: Academic interest in the equestrian sport of Polo is growing, with interest in areas such as performance analysis, load management, exercise physiology and biomechanics. Polo presents a strong data collection opportunity for a range of sports science specialists, due to Polo being a team sport, and players required to play multiple horses per game. This is despite players considering horses to contribute proportionally more to their performance than human factors. A brief review of the work conducted to date and emerging questions is presented. **Method:** A narrative review of research to date was conducted, with an emphasis on evidence related to performance and human but not veterinary factors. This will include performance analysis of successful Polo performance, spatiotemporal characteristics of the game as assessed by global positioning systems and player heart rate responses to play and performance profiling battery results as they relate to player ability. **Results:** Stereotypical team sports performance analysis parameters apply to Polo (e.g., conversion of penalties and goal scoring, with lower penalty concession). Spatiotemporal parameters can be reliably assessed, with increased distance and average and maximum speeds attained at higher levels of the game. Open and Women's Polo display distinct spatiotemporal characteristics. Cardiovascular demand is high with player sustaining high average heart rates throughout games, and attaining (near) maximal values. Player strength characteristics have also demonstrated moderate to large correlations with playing ability. **Discussion:** Polo presents a novel opportunity to the sports scientist, in that it combines elements of traditional team sports with the challenges of data collection in an equestrian environment. There is scope to increase both the depth and breadth of investigations across all sports science disciplines within Polo, especially as technology continues to permeate equestrian sport. **Take home message:** Polo presents an idiosyncratic data collection environment for most sports science disciplines.

The effects of blackcurrant and caffeine combinations on performance and physiology during repeated high-intensity cycling

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Introduction: Blackcurrant juices and extracts containing anthocyanin may provide ergogenic benefits to sports performance. However, there are no studies examining the co-ingestion of blackcurrant with caffeine. This investigation examined the effects of acute supplementation with a proprietary blackcurrant beverage administered in isolation or in combination with caffeine on repeated high-intensity cycling. **Methods:** Twelve well-trained male cyclists (age = 39.5 ± 11.4 years; height = 177.9 ± 5.7 cm; weight = 78.2 ± 8.9 kg; peak oxygen consumption = 4.71 ± 0.61 $L \cdot min^{-1}$) completed experimental sessions consisting of repeated (8 × 5-minute) maximal-intensity efforts. Four experimental treatments were administered in a double-blind, balanced Latin-squares design; Blackcurrant + Caffeine (BC), Blackcurrant + Placebo (BP), Caffeine + Placebo (CP), and Placebo + Placebo (PP). Differences in power output (PO), heart rate (HR), Oxygen consumption ($\dot{V}O_2$), muscle Oxygen saturation (SmO_2), rate of perceived exertion (RPE), and cognitive function (Stroop) were compared between treatments using two-way repeated-measures ANOVA and effect size analysis. **Results:** There were no significant differences (all p's > 0.05) in physiological or cognitive variables with any supplement treatment (BC, BP, CP) relative to PP. However, PO was significantly lower ($p < 0.05$) in BP (301 ± 5 W) compared with both BC (311 ± 4 W) and CP (308 ± 4 W), with small effect sizes (d) of 0.28 and 0.21 respectively. $\dot{V}O_2$ was also greater ($p < 0.01$) in BC (3.81 ± 0.47 $L.min^{-1}$) compared to BP (3.68 ± 0.37 $L.min^{-1}$), however the effect size was trivial ($d = 0.19$). Differences in HR, SmO_2, RPE and Stroop between treatments were non-significant ($p > 0.05$) and trivial ($d < 0.2$). **Discussion:**

Blackcurrant administered in isolation had little effect on performance or physiological measures during repeated high-intensity cycling. However, a caffeine and blackcurrant combination may provide some benefit when compared to blackcurrant administered alone. **Take home message:** Blackcurrant extract administered in isolation provides no beneficial effect on cycling performance.

Expiratory flow limitation during exercise in athletic adolescents and young adults

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Introduction: Traditionally, the ventilatory system is considered 'overbuilt' for the demands of exercise in healthy subjects; rather, cardiac factors are thought to limit peak exercise. Recent evidence suggests that ventilatory limitations during peak exercise are common in children and adolescents; however, the prevalence has not been established in a large cross-sectional study. Tidal expiratory flow limitation (EFL_T) is an important marker of ventilatory limitation during exercise and occurs when the tidal breath reaches its maximal capacity to generate expired flow despite increased expiratory effort. The purpose of this study was to determine the prevalence of EFL_T in healthy athletes aged 10 to 24 years. **Method:** Healthy, athletic subjects (n = 122, 69 males, 53 females), completed spirometry, a cardiopulmonary exercise test and the modified Borg dyspnoea score. The prevalence and severity of EFL_T during peak exercise was determined by the vector-based analysis technique. Exercise induced arterial hypoxemia (EIAH) was defined as a ≥ 4% decrease in SpO_2 compared to baseline. Alpha was set at 0.05. **Results:** ELF_T was present in 70% of subjects. There was no difference in the prevalence of EFL_T between males (74%) and females (66%), but males had greater severity of EFL_T (29% vs. 20% of tidal volume expiratory flow limited, p < 0.05). The presence of EFL_T was associated with greater Borg score in males (6.2 vs. 4.9, p < 0.05) but not females. EIAH was present in n = 13 subjects that demonstrated EFL_T and n = 2 non-EFL_T subjects. **Discussion:** We found a relatively high prevalence of EFL_T in healthy, athletic subjects, with no gender difference in prevalence. EFL_T is associated with greater dyspnoea and EIAH, although further studies should focus on the consequences and predictors of EFL_T during peak exercise in healthy subjects. **Take home message:** The presence of EFL_T should be considered a normal physiological feature during peak exercise in healthy adolescents/young adults.

Altered light exposure during basic training in military barracks on subsequent sleep, wellbeing, and performance of new recruits: A placebo-controlled study

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Background: The manipulation of light-exposure in the evening has been shown to improve sleep, and may be beneficial in the military setting where sleep is reported as being problematic. This study investigated the efficacy of reduced temperature-light and luminous-flux in living quarters on sleep, performance, and wellbeing of military-trainees. **Methods:** Sixty-four officer-trainees (52 males, 12 females, *M*age = 25 years, SD = 5 years), wore wrist-actigraphy devices for 6-weeks during initial military training to assess sleep. Participants were randomly allocated to either: low-temperature light (LOW, n = 19), standard-temperature lighting + placebo 'sleep-enhancing device' (PLA, n = 17), or standard-temperature lighting (CON, n = 28) in barracks, where they resided. Trainees were tested using a 2.4 km run and measures of upper-body muscular-endurance pre and post a 6-week training course and completed weekly subjective wellbeing questionnaires. **Results:** Run time improved by 91 s pre to post training in LOW, which was significantly greater than PLA (68 s) and CON (35 s), respectively (p < 0.05). Similarly, curl-up improvement favoured LOW (Δ14 reps), compared to PLA and CON (Δ6 and Δ8 reps, respectively, p < 0.05). Repeated measures MANOVA revealed a significant Group × Time interaction for time in bed, total sleep time, soreness, fatigue, and mood (p < 0.05), with significant and *small* to *large* effect sizes in favour of LOW for total sleep time and mood compared to both PLA and CON. S*mall* to *large* effects were also seen in favour of PLA for soreness and fatigue compared to LOW and CON. **Discussion**: The current study showed that altering the light-exposure in military barracks in the evening, may lead to improvements in sleep, mood, and aspects of physical performance over a duration of 6-weeks in military recruits. **Take home message:** Altering lighting conditions over a 6-week military training period significantly improved physical performance, sleep, and mood.

Mixed-methods heat acclimation in elite male rugby sevens athletes

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Introduction: Multiple factors influence heat acclimation (HA) induction and retention, while practical considerations impact the design and integration of HA protocols within an elite training schedule. **Method:** Twelve elite male rugby sevens athletes undertook a 10-day mixed active/passive HA protocol across two-weeks of normal rugby sevens training. Core temperature (T_c), sweat loss, heart rate (HR), and performance (mean and peak power during 6-s repeated-sprints) were assessed using a sport-specific heat response test (HRT) before (Pre-HA); after five days (Mid-HA); after 10 days (Post-

HA); and 16 days Post-HA (Decay). All HRTs and active HA sessions were performed in an environmental chamber set at 35°C, 80% rH. **Results:** Resting, submaximal, and end-exercise core temperature were lower at Mid-HA (≤ -0.26 °C; d ≥ -0.47), Post-HA (≤ -0.30 °C; d ≥ -0.72), and Decay (≤ -0.29 °C; d ≥ -0.56), compared to Pre-HA. Sweat rate was greater Post-HA compared to Pre-HA (0.3 ± 0.3 $L \cdot hr^{-1}$; d = 0.63). Submaximal HR was lower at Mid (-9 ± 4 bpm; d = -0.68) and Post-HA (-11 ± 4 bpm; d = -0.90) compared to Pre-HA. Mean and peak 6-s power output improved Mid-HA (83 ± 52 W; 112 ± 67 W; d ≥ 0.47) and Post-HA (125 ± 62 W; 172 ± 85 W; d ≥ 0.72) compared to Pre-HA. Improvements in HR and performance persisted at Decay (d ≥ 0.66). **Discussion:** Five days of mixed-methods HA integrated into an elite teams training program elicited many typical physiological, and performance adaptations, with an additional five days eliciting further improvements in resting T_c, sweat loss, and performance. Adaptations were well retained after 16-days with no heat exposure, providing evidence for the efficacy of a practical, and ecologically-valid HA protocol. **Take home message:** Ten days of mixed-methods HA can elicit persistent physiological and performance adaptations when integrated into an elite rugby sevens training program.

Strength and Conditioning

The relationships between physical fitness attributes and match demands in Rugby Union referees officiating the 2019 Rugby World Cup

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Introduction: This study examined the relationships between physical fitness attributes and match demands in lead rugby union referees. **Methods:** Eleven referees underwent anthropometric and fitness assessments (40-m sprint, Yo-Yo Intermittent Recovery Test, 1.2-km shuttle run) prior to the 2019 Rugby World Cup. Match activities were assessed via global positioning system devices (total distance, high-speed running distance [> 5 $m \cdot s^{-1}$], average speed, and peak intensities over 1-min, 5-min, and 10-min epochs) and heart rate variables were measured using chest-worn monitors (mean HR, summated heart-rate-zones, time above 90% HRmax). **Results:** Forty-metre sprint time was significantly related to maximum speed (r = -0.79, p = 0.004) and high-speed running distance (r = -0.63, p = 0.037) during matches. Likewise, ∑7 skinfold thickness was significantly correlated with high-speed running distance (r = -0.72, p = 0.01). Yo-Yo Intermittent Recovery Test, 1.2-km Shuttle Run Test, age, and body mass index exhibited non-significant correlations (r = -0.58 to 0.53, p's > 0.05,) with match demand variables. **Discussion:** Results suggest it may be pertinent for referees to optimise sprint capacity and body fat composition to execute greater high-speed running volumes and reach higher peak speeds during matches. **Take home message:** Yo-Yo Intermittent Recovery Test and 1.2-km shuttle run tests are not correlated to specific match activity variables and thus may not be relevant for monitoring of rugby union referees.

The application of strength training and sport science in an Olympic free skier

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Introduction: From 2017 – 2022 we used conservative management for a free skier with hip, back, knee, and pelvic injuries. We collected the following data: Anthropometry (ISAAK, O-Scale), leg strength (Str), and power (Pow). **Methods:** His 2017 diagnoses: bilateral labral tears & cam lesions; FAI; hypermobile SI Joint; and back pain. We used anti-inflammatory and pain-free Str and Pro exercises; then progressed his Str, Pro and Pow; and "Return to Snow" (RTS) exercises. He departed and competed successfully in the 2017/2108 competitive season. In 2019 he suffered a Rt knee MCL avulsion. He used a hinged brace and muscle stim; did Str/Pro of the Lt leg, then progressed into hypertrophy and progressive Str, Pro & Pow training. After he completed his RTS exercises he departed and competed successfully in the 2020 – 2022 competitive seasons (being "locked out" of NZ due to Covid-19 Restrictions). **Results:** In 2107 he departed pain-free in 100% health for his Northern Hemisphere Season in which his biggest achievements were an X Games Big Air Bronze medal and 4th Place at the 2018 Winter Olympics in Slopestyle. In 2020 he departed to the Northern Hemisphere after his right knee was 100% healthy and he passed all the RTS guidelines set out for him. By the end of this block (which included Covid lockdown in NZ with access to the strength studio) his double and single 1 RM Leg press was 390 and 140 kg, respectively; He competed in another two X-Games in the 2022 Winter Olympics. **Discussion/Take home message:** Conservative management can be a successful option to surgical intervention. This athlete's injuries were remedied by a progressive Str, Pro, & Pow overload.

Gender-specific strength training improves components of military fitness in female soldiers

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Introduction: In military populations, fewer women than men meet the standards of physically demanding military roles. The purpose of this study was to determine whether female soldiers are able to improve their physical fitness and operational readiness through a gender-specific physical conditioning programme emphasising strength training. **Methods**: Twenty-eight female soldiers (age 31.5 ± 8.2 years, weight 72.3 ± 11.3 kg, height 167 ± 5 cm) were assigned to a 10-week physical training programme emphasising strength training (TG: n = 15), or to a control group (CG; n = 13) that maintained normal practice. Both groups participated in a series of pre- and post-tests including the New Zealand (NZ) Army's Required Fitness Level test (RFL) and Land Combat Fitness Test (LCFT), and a body composition assessment. **Results:** The TG showed improvements on the RFL test; push-ups (↑25%), curl-ups (↑12%), and 2.4-km run time (↓9%) and on the LCFT; lift-and-place (↑28%), battle manoeuvre (↑6%), lift-and-carry (↑25%), and 4-km endurance march (↓5%). In contrast, the CG showed little or no improvement. A 5% decrease in fat mass (FM) and a 5% increase in skeletal muscle mass (SMM) was observed for the TG, compared to a 1% increase in FM and no change in SMM for the CG. **Discussion:** The 10-week training programme improved physical performances of female soldiers. The adaptations can be attributed to the emphasised resistance training programme compared to normal practice for this population. Emphasising resistance training resulted in improvements in fitness outcomes specific to the NZ Army. This could likely lead to improvements in occupational task performances. **Take home message:** It is possible that gender differences in physical performance measures can be reduced following tailored resistance training for women, which highlights the importance of such training for physically demanding occupations.

Effects of concurrent plyometric and endurance training sequence on leg power and leg strength in college volleyball players

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Introduction: This study examined the effects of concurrent plyometric and endurance training (CPET) sequence on leg power and leg strength of volleyball players. **Method:** Thirty- five players (M_{age} = 20.34 years, SD = 1.8 years) were pre-tested on leg power (vertical jump) and leg strength (1RM back squat) parameters. Subsequently, they were randomly assigned to Control Group (CG, n = 12), Plyometric-Endurance Group (PEG, n = 12) and Endurance- Plyometric Group (EPG, n = 11). All groups had similar volleyball training while additional plyometric and endurance training were given to PEG and EPG for 6 weeks (3 sessions/week). Post-tests on leg power and leg strength were conducted after the 6-week period. **Results:** There was significant difference in the post-test leg power (p = 0.021, η_p^2= 0.21) among groups, however Tukey-HSD showed insignificant difference between PEG and EPG, but both groups were significantly different from CG. There was insignificant difference in the post-test leg strength (p = 0.208). Moreover, both PEG and EPG improved in pre-post mean leg power (9.2%, d = 6.4 vs. 6.6%, d = 2.7) and leg strength (12.5%, d = 1.1 vs.16.3%, d = 1.4). CG had a decreased performance in leg power (-1.8%) but improved leg strength (2.6%, d = 0.2). **Discussion:** The findings suggest that performing 6 weeks of plyometric training, with 3 sessions and 85 – 120 jumps per week, before endurance training could improve leg power. While some past research reported CPET resulted in increased muscular strength, others revealed that the degree of the interference response on strength was significantly increased with increasing endurance training frequency. However, large effects size in PEG and EPG pre-post leg strength echoed the benefit of CPET. **Take home message:** CPET enhanced leg power in team athletes. To improve strength using CPET, practitioners should consider reducing frequency of endurance training when conducting CPET.

Do current agility training practices in elite Australian football align with the demands of competition?

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Introduction: While one-versus-one (1v1) agility is vital to success in invasion sports, including Australian football (AF), the nature of agility in AF is poorly understood. Subsequently, it is unknown if training and testing used by elite athletes reflect game demands. Therefore, this study aimed to determine if training and testing used in elite AF align with game demands. **Methods:** To determine the 1v1 agility demands of AF, a notational analysis was performed that analysed two rounds of the 2016 Australian Football League (AFL) season. In addition, high-performance managers in the AFL were surveyed to determine agility training and testing practices. Ten of the 18 high-performance managers responded to the survey. **Results:** The study revealed substantial variation of demands in 1v1 agility scenarios in AF. In particular, movement technique and angle varied between events. Analysis of agility technique indicated a preference for sidestepping, with differences observed between attacking and defending athletes. Analysis of movement speeds indicated a preference for submaximal approaches. Finally, deceptive manoeuvres were found to be particularly effective for attacking athletes. The survey revealed that open and closed agility training methods are used in elite AF. However, subjective agility assessment was generally preferred to formal agility testing. **Discussion:** 1v1 agility in AF is varied and occurs in context to a range of playing scenarios. Agility events in AF frequently occur at submaximal speeds and are often not approached front-on. Further, differences between attacking and defending agility indicate independence of these roles. These aspects contrast common agility training and testing methods. **Take home message:** Agility training should reflect the demands of AF. Training that accurately simulates agility scenarios and allows athletes to perform attacking and defending roles may be particularly effective. Further, training methods that permit deceptive manoeuvres should be incorporated. Suitable training methods may include 1v1 training and small-sided games.

Associations between movement competence and sport specialisation in youth football players

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Introduction: Sport specialisation involves focused, year-round participation in a single sport. Due to the narrow focus on sport-specific movement patterns, it has been suggested that specialising at a young age can limit the development of broad movement competence. Thus, the aim of this study was to investigate the association between sport specialisation and movement competence in youth football players. **Method:** Male football players (n = 55) aged 13 to 18 years, who were at least 6 months post-peak height velocity were included and grouped based on their football development pathway as either specialised (n = 19) or not specialised (n = 34). Movement competence was assessed in bilateral drop jumps (DJ) and unilateral countermovement jumps (CMJ) using kinetic data collected on a force plate. Kinetic data were used to calculate jump height, reactive strength index (RSI), and peak landing force. Linear mixed models in R statistical software were used to analyse differences based on groups and time since becoming specialised. **Results:** Greater asymmetries were seen in the specialised group for RSI (30% vs. 22%; p = 0.01) and peak landing force (30% vs. 14%; p = 0.05) during unilateral CMJ. Time since becoming specialised had significant positive interactions (p < 0.05) with jump height (DJ, CMJ), RSI (DJ, CMJ), and eccentric impulse (CMJ). **Discussion:** These findings suggest that players who have followed a specialised football pathway may be more likely to develop asymmetries in unilateral jump landing technique. This may be due to a high volume of training-specific skills, which could place more focus on their dominant side, and thus increasing asymmetries between dominant and non-dominant legs. Asymmetries, particularly in peak landing force, have previously been linked with increased injury risk in youth football players. **Take home message:** A specialised youth football pathway may limit the development of broad, balanced movement patterns which may lead to an increase in asymmetries and associated injury risk.

Modelling the relationship between the repetitions left in reserve and movement velocity during resistance training: an accurate method for prescribing intensity and volume and controlling the level of fatigue

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Introduction: This aimed to examine the goodness of fit and prediction accuracy of general and individual relationships between the repetitions left in reserve and the mean absolute velocity (RIR-velocity relationship) in the free-weight back squat exercise. The effects of sex, training status, and history, as well as personality traits, on goodness of fit, and the accuracy of these relationships were also investigated. **Methods:** Fifty-one resistance-trained people (15 females, 36 males) with a wide range of strength levels, training experience, and different training practices were recruited and performed a one-repetition maximum (1RM) test, and two repetitions to failure (RTF) tests 72 hours apart. RTF tests were performed with 70, 80, and 90% of 1RM with 10 minutes of rest between sets. **Results:** Regardless of the load and modelling strategy used, individualized RIR-velocity relationships provided twice as high goodness of fit and were always able to predict RIR in a subsequent testing session with acceptable accuracy compared to general RIR-velocity relationships. Similar results were obtained when both general and individual RIR-velocity relationships were averaged across the loads. **Discussion:** Using RIR-velocity relationships in practice could further be simplified by establishing a single relationship which covers a range of loads (i.e., 70 to 90% of 1RM), rather than having a profile for each load separately. This allows selection of the loads based on the "starting velocity" (i.e., the velocity associated with an indented load that can be lifted a given number of times) and termination of the sets when the "stopping velocity" (i.e., velocity associated with an intended RIR) is reached. **Take home message:** The individual RIR-velocity relationship can be used in lieu of traditional RT methods to monitor, prescribe and adjust both the training load and set-volume more accurately, potentially allowing for more efficient adaptation and better fatigue management.

Positive effects of isokinetic eccentric exercise on post-activation potentiation in the lower-body for resistance trained men

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Introduction: Eccentric resistance training has been demonstrated to elicit superior improvements resistance training outcomes via exposure to higher stimulus intensities. Literature suggests that high intensity concentric and isometric exercises can be used effectively as a means of potentiating subsequent muscle actions. Therefore, we sought to investigate the effects of isokinetic eccentric exercise as a means of potentiating subsequent expressions of power. **Methods:** 19 resistance trained men (age = 22.2 ± 3.2 years, resistance training experience = 3.9 ± 2.4 years) completed three sessions randomly assigned with pre- and post-tests completed in the drop jump (DJ), loaded counter-movement jumps (CMJ), and 6-second cycling peak power. An isokinetic eccentric cycling ergometer intervention was completed with 2 sets of 15 seconds at either 35 RPM (SLOW), 70 RPM (FAST), or concentric cycling at 70 RPM (CONTROL). Performance data was collected using an OptoJump™, linear-position transducer, and Wattbike™. **Results:** The eccentric interventions did significantly improve relative power in the 45 kg loaded counter-movement jump (p = 0.028) and substantial improvements where observed in CMJ jump height after FAST (d = 0.40 ± 0.48), and SLOW (d = 0.31 ± 0.42). Clear effects were also found after the FAST intervention in peak power (d = 0.23 ± 0.32), relative power (d = 0.25 ± 0.34), peak cadence

(d = 0.26 ± 0.42), time-to-peak power (d = 0.81 ± 0.96), and cadence at peak power for the six-second peak power test (d = 0.92 ± 0.57). Eccentric cycling did not affect DJ measures. **Discussion:** Isokinetic eccentric resistance exercise did not appear to have a substantive effect on fast stretch-shortening cycle (SSC) efforts this cohort; however, slower SCC results appear promising, particularly with eccentric cycling at 70 RPM transferring to a biomechanically similar movement. Improvement in the loaded CMJ for relative power may be indicative of an acute improvement in force-velocity profile. **Take home message:** Fast isokinetic eccentric cycling can potentiate jump and cycling performance.

Validity and reliability of the Optojump for estimating plyometric push up height and flight time

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Introduction: Measuring neuromuscular fatigue and performance is important in several sporting settings. It is important that the apparatus used to measure such performance is both valid and reliable. The primary aim of this study was to assess the validity and reliability of the OptoJump Next system against a force plate, for both flight time (FT) and plyometric push up (PPU) height. A secondary aim was to assess the relative body mass at the top and bottom positions of a push up in this cohort, comparing it to the current body of literature. **Methods**: Forty-nine participants (age = 24.9 ± 8.7 years) performed three maximal effort PPU trials, with a minimum of 30 seconds of rest in between efforts. Each trial was measured simultaneously by both the OptoJump and force plate devices. **Results**: Although near perfect correlations existed between the OptoJump and force plate for FT (r = 0.99) and PPU height (r = 0.99), systematic differences between the two systems were observed. The OptoJump underestimated FT and PPU height by 0.016 sec and 0.743 cm, respectively. Interrater reliability was excellent, with ICCs ranging from 0.98 to 0.99 for FT, and less than 0.99 for PPU height. It is proposed that the following equations are used to allow OptoJump and force plate data to be used interchangeably for FT and PPU height. Force plate PPU height (cm) = 0.864 × 0.985 + OptoJump PPU height. Force plate FT (s) = 0.0321 + 0.985 × OptoJump FT. **Discussion**: The OptoJump is a valid and reliable tool for the assessment of PPU height in field-based settings. Observations in this study confer with current literature regarding distribution of mass at the top and bottom of the push up. **Take home message:** The Optojump is suitable for performance and fatigue testing of the upper body via the plyometric push up.

Reliability and validity of a portable mid-thigh pull device and inertial cycling ergometer

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Introduction: The aim of this study was to assess the reliability and validity of a portable Isometric Mid-Thigh Pull ($IMTP_{SG}$) device using a single axis load cell strain gauge with a force plate ($IMTP_{FP}$) as the criterion measure. Additionally, the reliability of an inertial load cycling ergometer (IE) was assessed. Both devices were developed by High Performance Sport New Zealand (HPSNZ) for strength and power testing. **Methods:** Eight trained sprint cyclists (age = 20.63 ± 1.92 years; height = 1.76 ± .05 m, weight = 77.73 ± 6.13 kg) with greater than 1 year resistance training experience participated across two sessions, which were 48 hours apart. A counterbalanced measure design was used. After a standardised 10-min warm up, participants performed one familiarisation effort followed by three 4 to 6 sec (3-minute rest) maximal seated sprints on the IE. Participants then performed two familiarisation IMTP efforts, and then undertook three maximal 4 to 5 sec efforts (3-minute rest) on either the $IMTP_{FP}$ or $IMTP_{SG}$ device. Thirty-minute rests were used between devices and exercises. **Results:** Inertial ergometer test-retest reliability: Peak power ICC = 0.991, 95% CI [0.961, 0.998; CV = 1.54, Optimal Cadence ICC = 0.964, 95% CI [0.815, 0.993]; CV = 1.22. The test-retest reliability: $IMTP_{SG}$ ICC = 0.993, 95% CI [0.960, 0.999]; CV = 2.19, $IMTP_{FP}$ ICC = 0.979, 95% CI [0.900, 0.996]; CV = 2.90. The $IMTP_{SG}$ criterion validity $r(8) = 0.962$, $p < 0.001$, 95% CI [0.797, 0.993] with a mean bias of -52 ± 130.06 N. **Discussion:** The IE was found to be highly reliable between sessions across peak power and optimal cadence for peak power. The $IMTP_{SG}$ demonstrated greater reliability between sessions than the $IMTP_{FP}$. The $IMTP_{SG}$ exhibited acceptable validity against the criterion measure ($IMTP_{FP}$). **Take home message:** The IE is a reliable tool to measure peak power and optimal cadence during maximal seated cycling, whilst the $IMTP_{SG}$ was found to be a reliable and valid tool for the assessment of leg extensor strength.

One velocity loss threshold does not fit all: Consideration of sex, training status, history, and personality traits when monitoring and controlling fatigue during resistance training

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Introduction: This study aimed to quantify the potential variability in the volume of work completed after reaching different velocity loss thresholds and determine the effects of sex, training status and history, as well as psychological traits on the reliability and magnitude of the amount of work completed after reaching different velocity loss thresholds using different loads in the back squat exercise. **Methods:** Fifty-one resistance-trained people (15 females, 36 males; 18 to 40 years of age) with a wide range of strength levels, training experience, and different training practices were recruited and performed a one-repetition maximum (1RM) test, and two repetitions to failure (RTF) tests 72 hours apart. RTF tests were performed with 70%, 80%, and 90% of 1RM with 10 minutes of rest between sets. **Results:** The findings of the present study question the utility of using velocity loss thresholds to prescribe RT volume as the agreement in the

amount of work completed across two consecutive testing sessions was not acceptable. Regardless of the load used, females completed more repetitions than males across velocity loss thresholds, while males performed repetitions at higher velocities. In addition, individuals with higher levels of emotional stability also tended to perform more repetitions across velocity loss thresholds. Finally, sex, choice of load, strength levels, and training practices, as well as emotional stability affected the linearity of the repetition-velocity relationship and when sets terminated. **Discussion:** Using the same velocity loss thresholds for all individuals, while assuming generalisability of the stimuli applied, would likely lead to variable acute physiological responses to RT and divergent neuromuscular adaptations over the long term. **Take home message:** Therefore, velocity loss monitoring practices could be improved by considering sex, training status, history, and psychological traits of individuals due to their effects on the variability in responses to different velocity loss thresholds.

Fatigue and the recovery of neuromuscular function following consecutive days resistance exercise in trained men

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Introduction: This study measured the self-reported level of fatigue, pain, and neuromuscular function of the knee extensor muscles over a three-day period that included two consecutive days of full-body resistance exercises. **Methods:** Ten resistance-trained men performed two consecutive days of full-body resistance exercise. Muscle activation (electromyography and voluntary activation), contractility, and presynaptic inhibition of Ia afferents (homosynaptic and GABA mediated presynaptic inhibition) for the quadriceps were examined from femoral and posterior tibial nerve stimulation. **Results:** Fatigue and pain were elevated after Day 1, and were not reduced to pre-exercise levels at the start of Day 2 ($p < 0.05$). Maximal voluntary torque (-51.4 Nm, $p = 0.005$, 95% CI [12.4, 90.4]) and rate of torque development (-469 $Nm \cdot s^{-1}$, $p = 0.006$, 95% CI [109, 829]) were reduced after Day 1, had recovered by Day 2, and did not change after the second training session. The maximal amplitude and rate of rise for the quadriceps twitch were reduced after both training sessions ($p < 0.01$), with recovery 24 h each session. The maximal amplitude and rate of early muscle activation were reduced after Day 1 ($p < 0.01$), but no changes were observed for voluntary activation, H-reflex size and shape, or measures of Ia presynaptic inhibition. **Discussion:** Resistance exercise in the presence of elevated fatigue and pain from a previous training session does not worsen recovery, or lead to significant alterations in quadriceps neuromuscular function. Reduction in muscle contractility, in the absence of declines in muscle activation, does not lead to decreased voluntary torque. **Take home message:** Consecutive days of resistance exercise are a practical and viable solution to the programming difficulties encountered in high-level sport and recreational weightlifting. Resistance exercises performed in the presence of elevated levels of fatigue and pain do not worsen overall recovery.

Performance Analysis

Combining Sportscode and GPS metrics to monitor locomotion and contact workloads in rugby union

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Rugby union involves high levels of locomotion and contact workload, and understanding these demands across different positions, roles and matches helps to provide useful match analytics and inform best practice training interventions. GPS technology currently lacks the ability to measure contact workload with any semblance of accuracy so we developed a method to generate key contact metrics via Sportscode. Unfortunately, there is currently no commercially available system to integrate Ball-in-Play GPS locomotion metrics and Sportscode contact metrics, so we constructed an online software package to perform this integration in WordPress. This presentation will briefly outline the process of generating the key metrics, integrating the two disparate data sources and discuss some results from various professional rugby teams across different levels and nations.

How New Zealand Rugby transition our people from not using data and technology to using it

Healy, J.[1]

[1]*New Zealand Rugby, New Zealand*

A collection of learnings of things we have tried and what we have learnt.

Performance analysis and its role at High Performance Sport New Zealand

McAlpine, P.[1]

[1]*High Performance Sport New Zealand, New Zealand*

Aided by case examples this presentation will highlight the situationally specific athlete needs and considerations for Performance Analysts working at HPSNZ. Current practices will be discussed alongside future visions. Links to performance planning, investment and decision-making processes will also be discussed.

Behind Closed Doors: a preview into the Silver Ferns implementation of performance analysis

Croft, H.[1]

[1]*Otago Polytechnic, New Zealand*

This talk will preview research into a larger multiyear study which describes how the Silver Ferns netball team implements performance analysis into their campaigns. The study includes ethnography by two performance analysts (PA) and also player interviews. The two PA's bring different strengths to the environment, data analytics and video feedback, and insights will be discussed around how these approaches are combined. The purpose of this research is to provide insights for other performance analysts and coaches around success and failures within our practice.

Managing data at scale to drive performance

Wilson, E.[1]

[1]*Qrious, New Zealand*

With advances in technology we now have the ability to collect and analyse more data than ever before. NZ Cricket have been leading the way in the effective use of data to drive performance. This presentation will share key concepts for managing data at scale and how NZ Cricket have applied these successfully.

Maximising efficiency and workflow with limited resources

Mulholland-Goad, S.[1]

[1]*New Zealand Hockey, New Zealand*

Hockey New Zealand strives for world class analysis while under some significant constraints. This presentation will walk you through the workflow that HNZ adopts to enhance value and maximise efficient.

Mapping sport performance analysis: Integrated landscape of sport

Croft, H.[1]

[1]*Otago Polytechnic, New Zealand*

The talk will link with the panel discussion on the integration of PA processes and data in the sporting environment.

Biomechanics

Functional compartmentalisation of motor units during the stretch reflex

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Introduction: Within the biceps brachii muscle, the activation of anatomically localized subsets of motor units depends on the function the muscle is performing, either flexion, supination, or exorotation. However, the relationship between this functional compartmentalisation and the stretch reflex has not been characterised. Our study aims to determine if the stretch reflex elicits a functionally-relevant subset of motor units. **Methods:** High density surface electromyography (HDsEMG) data were recorded from the biceps brachii muscle during voluntary isometric flexion and supination and evoked stretch reflex responses while we varied experimental task. Convolutive blind source separation software was used to extract individual motor unit action potential spike trains from the EMG and 2-D cross correlation was used to track these motor units both within task and between tasks. **Results**: First, we found that motor units active during flexion trials at high contraction intensities are different from those active during supination (p = 0.027), and that motor units active during flexion or supination only are different from those active during both tasks at both low and high contraction intensities (p = 0.039). Second, we found that motor units active during the stretch reflex only are different from motor units active during both the stretch reflex and voluntary tasks (p = 0.002). **Discussion:** HD-sEMG is an emerging non-invasive technique to study both muscle and motor unit activity. The stretch reflex is integral to motor control, and characterisation of the stretch reflex at the level of the motor unit provides insight into how muscles physically enact the reflex spinal loop signals and contributes to our understanding of how these pathways and motor units are affected in disorders including cerebral palsy and stroke. **Take home message:** We provide evidence for the first time of functional compartmentalisation of motor units involved in the stretch reflex, and that this subpopulation of motor units differs from that active during voluntary contraction.

Measurement and reporting of footwear characteristics in running biomechanics: A systematic search and narrative synthesis of contemporary research methods

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Introduction: This review aimed to synthesise the methods for assessing and reporting footwear characteristics among studies evaluating the effect of footwear on running biomechanics. **Method:** Electronic searches of Scopus®, EBSCO, PubMed®, ScienceDirect®, and Web of Science® were performed to identify original research articles of the effect of running footwear on running biomechanics published from 1st January 2015 to 7th October 2020. Risk of bias among included studies was not assessed. Results were presented via narrative synthesis. Eligible studies compared the effect of two or more footwear conditions in

adult runners on a biomechanical parameter. **Results:** Eighty-seven articles were included and data from 242 individual footwear were extracted. Predominantly, studies reported footwear taxonomy (i.e., classification) and manufacturer information, however omitted detail regarding the technical specifications of running footwear and did not use validated footwear reporting tools. **Discussion:** These findings point toward a need for consensus regarding the reporting of these characteristics within biomechanical studies to facilitate the conduct of systematic reviews and meta-analyses pertaining to the effect of running footwear on running biomechanics. **Take home message:** There is inconsistency among contemporary studies in the methods by which footwear characteristics are assessed and reported.

How accurate is 3D body scanning technology at estimating body fat percentage?

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Introduction: The accurate assessment of body composition is important in sport and health to monitor changes in response to exercise, nutritional interventions, injury, and illness. In the military, there is a need for quick, portable, and practical tools that provide accurate results. The aim of this collaborative study was to evaluate the use of a 3D laser body scanner, currently employed by the NZDF for surveying body size and shape, as a field-based body composition assessment tool. **Method:** Individuals between 18 to 30 years and with a BMI between 18.5 to 40.0 kg/m^2 underwent dual energy X-ray absorptiometry (DXA) (iDXA, *GE-Healthcare*), the current gold standard, and 3D laser body scanning (VITUS XXL, *Human Solutions*) for estimation of percentage body fat (%BF). Bland-Altman plots and 95% limits of agreement (LOA) were used to quantify differences between DXA and 3D scan results for the overall cohort and for gender and BMI subgroups. **Results:** The study cohort comprised 334 individuals (182 females, 152 males; M_{age} = 24 years; M_{BMI} = 25 kg/m^2; $M_{\%BF\ by\ DXA}$ = 28.2%) of various ethnicities. A comparison between the two methods showed large variability. The 3D scanner overestimated %BF for the overall group (M_{bias} = 6%, LOA = 10.3% to 22.3%) and across all gender and BMI sub- groups, with increasing overestimation at higher %BF levels. **Discussion:** The observed discrepancy in body fat estimation by the 3D scanner may reflect errors in body volume quantification, or subsequent translation of volume to body fat percentage. More work is needed to address this error and improve the fat prediction algorithm and accuracy of results. **Take home message:** Although a quick and accurate tool for assessing anthropometry, the VITUS XXL body scanner is not currently an accurate body composition assessment tool when compared to the gold standard and should not therefore be used for this purpose.

Lower-limb asymmetry decreases when fatigued during maximal sprinting in humans

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Introduction: Running prolonged distances with sudden periods of high-intensity acceleration to reach maximum sprinting speed, which is often seen in field-based team sports, has been associated with acute bouts of fatigue. Acute fatigue, or the fatigue experienced during a match, could influence specific joint kinetics and kinematics when sprinting at or near maximal speed. The effect of fatigue on individual joint kinetics and kinematics of the dominant and non-dominant limbs during sprinting is poorly understood. **Methods:** 3D kinematics and ground reaction force production (dominant (DL) and non-dominant (NDL) legs) were collected during three 50-m maximal sprint efforts performed before and after a 45-min simulated soccer match in thirteen semi-professional soccer players. Statistical parametric mapping was used to compare joint kinematics and kinetics before and after the fatiguing protocol. **Results:** In non-fatigued sprinting, DL produced greater propulsive impulse and had greater positive and negative work done at the ankle, whilst NDL produced greater vertical impulse and had greater peak hip flexion. After fatiguing exercise, little change was detected in DL, whereas NDL produced greater propulsive impulse as well as increased joint moments and power at the ankle joint. After fatiguing exercise, the joint kinematics and kinetics indicated that interlimb asymmetry was reduced. **Discussion:** Despite a decrease in running speed, DL remained largely unchanged after fatigue, while a substantial shift toward propulsive impulse was observed in NDL and likely due to greater joint moments and power generated at the ankle. An interesting finding was that interlimb asymmetry was greater in non-fatigued conditions, but after fatiguing exercise, this asymmetry decreased, primarily as a result of alterations in NDL. **Take home message:** We speculate that reducing interlimb asymmetry may be an adaptation to more equally distribute load between limbs and minimise injury risk during fatigued sprinting, but may also incur a cost to running speed.

A step-by-step analysis of sprinting acceleration in adolescent boys spanning maturation

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Introduction: The role of the acceleration phase of sprinting is of particular importance in many sports, due to the short nature of most sprints. Understanding acceleration and its spatiotemporal determinants is important for research, practitioners, and performance tracking. This study compared changes in spatiotemporal determinants of acceleration in adolescent boys spanning Pre-, Circa-, and Post-Peak Height Velocity (PHV). It also considered the quantification and functional relevance of lower limb asymmetries in each group. **Methods:** Adolescent boys (n = 64) were grouped by maturational status into Pre-PHV (n = 16; age = 12.4 ± 0.7 years), Circa-PHV (n = 29; age = 13.7 ± 0.5 years), and Post-PHV (n = 19; age = 14.6 ± 0.4 years)

based on a regression equation considering interactions of anthropometric measures. Data collection consisted of four 10 m sprints with 5 m splits. Spatiotemporal measures of contact-time, step-frequency, and step-length were obtained for steps two to six via a ground level optical measurement system. **Results:** The Post-PHV group displayed the fastest accelerations and greatest step-lengths ($p \leq 0.05$), followed by the Circa-PHV group ($p \leq 0.05$). Asymmetry remained low (< 4%) and mostly non-significant ($p > 0.05$) for spatiotemporal determinants at steps two to six in each stage of maturation. **Discussion:** Findings confirmed that maturity leads to significant increases in sprinting performance and aligns with literature supporting an association with significant increases in step-length. Small levels of asymmetry are to be expected in spatiotemporal determinants of acceleration throughout maturation, and there does not appear to be any stage at which heightened asymmetry is worthy of concern. **Take home message:** The current findings, with support from literature, suggest that increased step-length appears to be a driver for better acceleration in adolescent boys throughout maturation. Small amounts of asymmetry (< 4%) appear normal; however, more sensitive thresholds for concern may be required.

Impact of reduced training load on Royal New Zealand Navy recruits' injury and fitness

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Introduction: The Royal New Zealand Navy (RNZN) Basic Common Training (BCT) course is designed to produce competent, self-disciplined sailors, over three-months. For most recruits, BCT imposes a significant increase in moderate-to-vigorous physical activity (MVPA), beyond pre-course levels. Increased MVPA, alongside heightened time-on-feet, contributes to lower-limb injury incidence. An observational study of a course in 2015 highlighted areas for improvement in terms of physical training (PT) and injuries. The aim of this study was to evaluate the impacts of the resulting changes to the course. **Methods:** Injury incidence data and Multistage Fitness Test (MSFT) results were collated for all recruits undertaking a BCT course in 2019 and compared with a 2015 course. A subset of the cohort (26 recruits; 10 females) wore a GENEActiv Actigraphy Watch throughout the course to record MVPA. **Results:** Mean daily MVPA was almost 3.5 hours, with some recruits accumulating over 25 hours per week. Twenty-five percent of recruits reported to a medic with an injury throughout BCT; most to the lower limb. In contrast, during a 2015 course, 95% of recruits reported similar injuries. In 2019, 97% passed the MSFT standard at baseline (31% with a First-Class result), increasing to 100% at the end of BCT (87% First-Class). These numbers are comparable to 2015, despite the earlier course being longer and more physically demanding. **Discussion:** Despite high MVPA compared to pre-course levels, reduced injury incidence between the 2015 and 2019 BCT courses may reflect modifications to the PT programme to (i) account for differing fitness abilities, (ii) progressively build intensity, (iii) reduce physical demands outside PT, (iv) promote recovery, and (v) limit the use of exercise as punishment. Injury surveillance needs improvement, but injury incidence appears to be reduced without compromising aerobic fitness gains. **Take home message:** Reducing PT intensity and building movement skills early on in recruit training appear to reduce injury incidence without compromising fitness improvements.

Automated body segment inertial parameters for the purpose of personalised injury prevention

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Introduction: Previous research has associated individual morphology with running- related risk factors, however these factors are often overlooked. Body segment inertia parameters (BSIP) could be important for understanding personal injury risk. Previous quantification of BSIP has involved time-consuming manual measurement methods with low levels of inter- and intra-reliability. Advances in 3D laser scanning technology provide the potential for new methods of calculating BSIP. Therefore, we sought to design and pilot automated methods for the calculation of BSIP measures. **Methods**: Wearing tight-fitting clothing and a swim cap, individuals adopted a standardised pose while they were scanned in a 3D body scanner (Vitus XXL, Human Solutions). A front and side view of the scan output were used for further analysis. The two images were converted to binary images in Excel software, where the background is represented by 1's and the participant by 0's. Scan files were input into a custom-designed BSIPauto software for the calculation of BSIP according to the methods of De Leva. **Results:** BSIPauto was developed to calculate segment masses by initially multiplying the Dempster density values by the segment volume, and then adjusting these until the sum of the calculated segment masses equals the participant's actual mass. Segment length, width, and depth calculations were calculated for eight segments based on the binary data from the 2D images. The radius of gyration along the longitudinal axis of the segment was applied according to De Leva's model, and the subsequent moment of inertia calculated for each segment. **Take home message:** The use of BSIPauto software enabled automatic BSIP outputs to be calculated from 3D body scan images. The method allows a rapid collection of body surface characteristics, and ultimately BSIPs. Further work is required to validate and establish the reliability of the model.

Collisions in junior rugby

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Introduction: In recent years there has been increased public and media awareness regarding players' safety and brain health after a concussion or long-term participation in rugby union. Because of the nature of rugby, players are exposed to repeated collisions which may or may not result in concussion. These impacts are of linear (direct: g) and rotational (indirect: rads/s^2) nature. At present there is sparse research investigating the role of collisions in junior rugby

on players' brain health, especially junior female rugby players. **Methods:** Sixteen U17 female rugby players and twenty U16 male rugby players aged 12 to 16 years completed pre-season and post-season assessment which included: advanced magnetic resonance imaging (MRI) of the brain, neurocognitive testing, health history questionnaire and motor control questionnaire. Participants wore instrumented mouthguards during their club and school season (recording collisions > 8 g) for all games and contact trainings. The collisions were video verified. Players completed 14 – 66 contact sessions over the 2022 season. **Results:** Results are expected in 2024. Results will identify incidence and magnitude of impacts for both teams across their club and school season; we hypothesize higher acceleration forces will be recorded in games compared to trainings. Cognitive testing, motor control questionnaires, and MRI scans will be analysed within-subject; we hypothesize those exposed to a lower incidence and magnitude of collisions will show fewer changes (pre versus post season) in white matter fibre cross sectional area and density, neurocognitive testing scores and conscious motor control than those exposed to higher total exposures. **Discussion:** There is conflicting research investigating the correlation between magnitude and incidence of collisions and brain health. Our study is the first to investigate this association in male and female adolescent rugby players. Current research shows increased reduction of white matter in older athletes; however white matter is still developing in adolescents, highlighting the importance of investigating adolescent rugby players. **Take home message:** The study highlights the need for objective data to measure head impact exposure in rugby union. Emerging data shows more impacts in games vs. training, and that non-collision game events, such as lineout lifting or side-stepping, generally do not trigger the 8 g mouthguard threshold. Data is beginning to show correlations between game events and levels of linear acceleration.

Recreating field head impact kinematics using machine learning

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Introduction: Despite decades of headgear research, few studies have com- pared the kinematics of laboratory-simulated head impacts to those in sports. Most limited their investigation to single-value features, such as peak accelerations. Brain injuries result from a complex interaction of deformation waves travelling through the brain. Single-value features do not capture this. Protective headgear, therefore, is developed under impact testing conditions that may not reflect the intended use. Therefore, this study developed a method for matching the characteristics of head impacts recorded on the field to those in laboratory drop tests for a deeper analysis of the temporal data and associated brain strain. **Methods:** From the linear and rotational kinematics of laboratory head impacts, 28 features were extracted. A k-nearest neighbours algorithm (KNN) underwent 10-fold cross-validation on various combinations of these features. Following this, principal component analysis (PCA) was carried out on the axis-wise linear accelerations to predict the impact direction. **Results:** The KNN achieved correct prediction rates of 99.6% and 99.1% for impact location and impact surface angle, respectively, using the relative peak linear and rotational accelerations in each axis. The change in linear velocity also showed a 94% correct prediction rate of drop height. PCA correctly identified the impact direction across all methodologically different head impact scenarios. **Discussion:** Our results suggest that KNN and PCA could inform the reconstruction of sporting head impacts in the laboratory. In the future, the strain developed in the brain during a head impact and analysis of the kinematic time-series will further quantify differences between the lab and field head impact conditions. This could better inform headgear testing practices and allow more realistic assessments of the protective performance of new headgear. **Take home message:** The simple set of algorithms proposed here could inform the basis of a new headgear impact testing methodology that, once developed, would better reflect the intended use.

Applied/Clinical Exercise Physiology (AEP/CEP) and Health

The effect of exercise engagement on low back disability at 12-months is mediated by pain and catastrophizing

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Introduction: Despite being a first-line treatment recommendation, there is uncertainly for how exercise helps people with chronic low back pain. We designed this study to examine how exercise might help people with chronic low back pain by following a large community sample for 1-year. **Methods:** Qualitative questionnaires and self-report measures were collected every 3-months for 1-year in 400 people with chronic low back pain. People were not provided any specific treatment advice as part of this study but were allowed to engage with any normal physical activity, treatment, or medication as part of their normal life. Exercise engagement was defined from inspection of participant qualitative responses, according to minimum acceptable levels of exercise that elicit symptom reduction. Multiple mediation analysis with bias-corrected bootstrapping was performed to examine the effect of

exercise engagement on disability through the proposed mediators (pain, fear, catastrophizing, depression, anxiety, self-efficacy). **Results:** The significant effect of exercise engagement on reductions in disability at 6- and 12-months was explained through pain and catastrophizing. Evidence for reverse causality showed that higher disability led to exercise seeking behaviour, with this effect mediated through lower levels of fear. People with chronic low back pain who reported worsening of symptoms over the year had similar reporting of exercise throughout the 12-months to people who had improvements in disability. **Discussion:** Exercise can reduce disability through the effect on pain and catastrophizing, but how this effect occurs (i.e., an active or passive component of exercise) is unclear. **Take home message:** Exercise is effective for people with chronic low back pain, but AEPs and other health professionals need to identify the treatment components that best influence pain and negative pain perceptions to effect long-term disability change.

Promoting mental health: Building resilience in teenage children

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Introduction: Resilience is the ability to bounce back, and move forward, from periods of change and adversity, stress and trauma, loss, and disappointment, and perhaps most importantly, the strain and intensity of simply doing the "day-to-day" in today's world. Health data shows that today's youth are among those most at risk from a lack of resilience and, in many cases, critically need better tools and skills for dealing with social, academic, sport; developmental, and family challenges more effectively. **Method:** A behaviour-based Resilience Training Programme, "Let's Make Me Resilient", sponsored by Health Hawke's Bay, was integrated into the curriculum of seven regional secondary schools, over 18 months, to 880+ students. Contributing theoretical program principles draw most heavily on Sport and Performance Psychology, along with Behavioural Psychology, Change Theory, and Cognitive Behavioural Theory. **Results:** The study found that participation in the resilience programme assisted participants in working out strategies and behaviours for coping with a range challenging situations and feelings. The research design using an anonymous survey consisting of resilience measure questions from the State Trait Assessment of Resilience Scale (STARS) and (Child and Youth Resilience Measure) CYRM-12 questionnaires, along with resilience knowledge recall questions was administered to participating students prior to commencement, and after completion, of the programme, along with subjective teacher evaluations. Demographic data was collected from all participating schools. **Discussion:** The four-module programme aims to support participants to develop attitudes and skills that would increase their functional resilience through the instruction, practice, and integration of; specific problem-focused cognitive strategies, applied stress management techniques, and outcome focused interactive communication skills. **Take home message:** Principles and methods inherent to effective sport psychology; performing under pressure, resilience, hardiness, self-awareness, functioning in real time, responding to coaching, teamwork, self-care, stress management, recovery, are applicable everywhere, and in every context, and nowhere more so than in the lives of today's youth.

Autonomic dysfunction alters heart rate responses during non-contact boxing in Parkinson's disease

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Introduction: Non-contact boxing training (boxing) is a popular intervention used by exercise professionals to improve health in people with Parkinson's disease (PD). However, little is known about the effect of boxing on heart rate (HR) response which is relevant to training protocols and outcome. HR response is likely to vary in people with PD, particularly for those with chronotropic incompetence (CI), a feature of autonomic dysfunction. **Method:** Participants underwent a cardiopulmonary exercise test (CPET) to determine CI, maximum HR (HRmax), and training zones. Two sessions of boxing were then performed on different days. During the sessions HR response was measure via Polar H10, and further expressed as %HRmax predicted (220 − age) and as %HRmax obtained during CPET. Main outcomes measures were HRmax, mean HR, and percentage of HRmax. **Results:** At each boxing round HRmax and mean HR were significantly lower in the PD-CI group compared with PD non-CI and controls ($p \leq 0.001$). PD-CI exercised at approximately 82% of estimated HRmax which was significantly lower than PD non-CI (97%) and control (100%). However, all participants exercised at approximately 100% of HRmax attained during CPET. **Discussion:** PD-CI present with lower HRmax and mean HR during boxing compared with PD-nonCI and controls. However, when expressed as %HRmax from CPET, these individuals exercise at similar exercise intensity (high-intensity training zone) during boxing, which is underestimated using traditional predictive equations. **Take home message:** People with PD (with and without CI) attain high intensity training zone during boxing. HRmax derived from CPET more accurately reflects exercise intensity than estimated HRmax, which is important to recognise given the latter is commonly used in clinical practice.

The effect of high-intensity interval training and heat therapy on cardiorespiratory fitness in patients with severe lower-limb osteoarthritis

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Introduction: Osteoarthritis is a degenerative joint condition making traditional exercise painful and difficult to perform. Due to the lack of activity, osteoarthritis sufferers have lower peak oxygen consumption (peak $\dot{V}O_2$) and anaerobic threshold, compared to those without osteoarthritis. The purpose of this study was to compare the effect of three low-/no-impact interventions on cardiorespiratory fitness (i.e., peak $\dot{V}O_2$, anaerobic threshold) and the subjective impact of osteoarthritis in patients with severe lower-limb osteoarthritis scheduled for total hip or knee arthroplasty. **Methods:** Ninety-three patients with severe knee or hip osteoarthritis awaiting total joint replacement were recruited. Participants were randomised to heat therapy (Heat; 20 – 30 min immersed in 40°C water followed by ~15 min light resistance exercise), upper-limb high-intensity interval training (HIIT; 6 – 8 × 60 sec intervals on a cross-trainer or arm ergometer at 100% peak $\dot{V}O_2$, 60 – 90 sec recovery) or home-based exercise (Home; 15 – 20 min light resistance exercise); all for 36 sessions (3 sessions per week for 12 weeks). **Results:** Across the interventions, peak $\dot{V}O_2$ increased by 16% following HIIT (+3.0 $mL \cdot min^{-1} \cdot kg^{-1}$ [1.9, 4.1], $p < 0.001$) but not Heat (+0.5 $mL \cdot min^{-1} \cdot kg^{-1}$ [-0.6, 1.6], $p = 0.366$) or Home (-0.3 $mL \cdot min^{-1} \cdot kg^{-1}$ [-1.4, 0.9], $p = 0.634$). The anaerobic threshold increased by 10% following Heat (+1.2 $mL \cdot min^{-1} \cdot kg^{-1}$ [0.4, 1.9], $p = 0.004$) and 12% following HIIT (+1.5 $mL \cdot min^{-1} \cdot kg^{-1}$ [0.7, 2.3], $p < 0.001$), but not Home (-0.5 $mL \cdot min^{-1} \cdot kg^{-1}$ [-1.3, 0.3], $p = 0.248$). Osteoarthritis impact, as assessed by the WOMAC Osteoarthritis Index questionnaire (0 [no impact] – 96 [most impact]), was unchanged with Heat (-1 [-7, +5]), HIIT (+2 [-4, +8]), or Home (-2 [-7, +4]) ($p = 0.532$). **Discussion/Take home message:** Upper-limb HIIT was an effective intervention for improving peak $\dot{V}O_2$ in patients who have difficulty performing lower-limb exercise. Furthermore, both Heat and HIIT improved the anaerobic threshold, but neither intervention improved patients' subjective impact of osteoarthritis.

Kī o Rahi He Taonga Tuku Iho: Exploring how Kī o Rahi influences hauora

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Introduction: Kī o Rahi is a taonga tākaro (traditional Māori game) that encapsulates many aspects of Te Ao Māori (Māori worldview) including mātauranga Māori (traditional Māori knowledge) and tikanga (cultural practises, customs), which supports hauora, a holistic understanding of health. There is limited research that explicitly examines all elements of hauora including the physiological and movement profile of Kī o Rahi. This study sought to explore the hauora benefits of Ki o Rahi for Māori and all New Zealanders. Using Te Whare Tapa Whā as a framework, the two research questions were: (i) how does engaging in Kī o Rahi influence hauora? and (ii) what are the physiological and movement profiles of Kī o Rahi that may contribute to improved hauora? **Methods:** This research utilised Kaupapa Māori Theory, which privileged Māori ways of knowing and doing, alongside a mixed methods approach. Hauora was examined using qualitative methods via questionnaire, analysed via inductive and deductive thematic analysis. Physiological, perceptual and movement measures were collected and analysed using quantitative methods. **Results:** The main findings of this research conveyed the message that Kī o Rahi is a taonga. The qualitative data demonstrated that Kī o Rahi strengthens hauora, using Te Whare Tapa Whā as a framework. The quantitative data provided evidence that Kī o Rahi elicits important physiological stressors to the extent that is valuable for taha tinana (physical well-being). Mean and peak heart rates were 75% (144 ± 16 bpm), 94% of age-predicted maximum (178 ± 15 bpm); distance covered was 2.3 ± 0.4 km, and mean blood lactate was 3.2 ± 1.2 mmol/L. **Discussion/Take home message:** These findings contribute to a deeper understanding of Kī o Rahi; it is a taonga, a cherished treasure from Māori ancestors that enables the transmission of mātauranga between generations, enhancing all aspects of hauora for Māori and all New Zealanders.

Moving in the Margins: A qualitative study into the role of physical activity in marginalised communities

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Introduction: Regular physical activity is essential in maintaining health and well-being, and has been described as human right. However, people in marginalised communities who experience financial insecurity or housing insecurity often face significant barriers to physical activity. In Wellington, the charitable organisation Wellington City Mission works to reduce financial barriers to physical activity by providing clients with passes to facilities such as leisure clubs and swimming pools, or sports equipment. The aim of this study was to investigate the health and well-being outcomes of the clients receiving these physical activity subsidies. Prior to this study, no research has investigated these outcomes in marginalised communities in Aotearoa. **Method:** Using a qualitative approach, 12 semi-structured one-to-one interviews were conducted with clients of Wellington City Mission. Interview transcript data was analysed using inductive thematic analysis. **Results:** The overarching theme that we identified was that physical activity support resulted in participants actively shaping their health and well-being in four key areas: mental, physical, social, and behavioural health. **Discussion:** The results closely align with two established frameworks that describe well-being outcomes: Self-Determination Theory and Te Whare Tapa Whā (Māori Model of Health). Participants reported improvements in their psychological needs of autonomy, competence, and relatedness, which are outlined within Self-Determination Theory. Participants also reported strengthening of three of the four pillars of Te Whare Tapa Whā – hinengaro (mental health), tinana (physical health), and whanau (social health). **Take home message:** This research highlights the significance of physical activity in improving the well-being of people in marginalised communities. Furthermore, it demonstrates the value of the mahi that organisations such as Wellington City Mission do in the community. Our hope

is that this research will support ongoing funding towards organisations and initiatives like this, to further improve the social capital, health, and well-being of marginalised people in Aotearoa.

He hauora te taonga: Exploring Kī o Rahi as a tool to assess components of fitness

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Introduction: Many components of fitness are important for both Te Ao Māori and Pākehā contexts. The way these are tested in western environments is mostly insensitive to Te Ao Māori and considers only Taha Tinana within hauora. Kī o Rahi is a traditional taonga tākaro that incorporates all aspects of fitness whilst also fostering the other aspects of hauora and thus providing a more culturally appropriate setting. Therefore, the purpose of this research was to explore if relevant physical measures obtained from players within the more culturally safe environment of a game of Kī o Rahi can accurately reflect all aspects of physical fitness. **Methods:** Participants were 18 volunteers, all of whom knew the rules of Kī o Rahi. Their fitness was measured using lab-based tests for lower and upper-body strength and explosive power, and aerobic fitness (ventilatory thresholds and $\dot{V}O_2$ max). Movement parameters were obtained from a game of Kī o Rahi, to determine if these predicted the criterion fitness measures. A Te Ao Māori perspective was used throughout the study, including explaining the pūrākau behind Kī o Rahi, saying karakia, and eating kai after the game to remove any tapu. **Results:** Kī o Rahi was found to be an effective means of measuring aspects of fitness, as indicated by significant ($p \leq 0.045$) and moderate to strong correlations ($r = 0.48$ to 0.77) across seven of the eight investigated relationships. **Discussion:** These findings provide evidence that Kī o Rahi relates to most aspects of fitness and may thereby provide an effective and more culturally-appropriate means to assess fitness. **Take home message:** There is the potential for cultural aspirations and mātauranga to be acknowledged within the topic of exercise science and fitness, which would benefit not only Māori communities, but also other Indigenous communities around the world.

Patient education and different exercise modalities for people with chronic low back pain, as scoped for accredited exercise physiologists

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Introduction: Patient education and exercise are key components of clinical practice guidelines for the treatment of people with chronic low back pain. However, we do not understand whether different types of exercise prescription better complement a pain education programme. The objective of this study was to compare outcomes between a Powerlifting inspired and typical bodyweight 'core' stability exercise programme, with both programmes combined with a patient education programme scoped for delivery by Accredited Exercise Physiologists (AEPs). **Methods:** An 8-week single-blind randomised controlled trial was conducted comparing bodyweight exercise (n = 32) with powerlifting (n = 32) paired with the same education, for people with chronic low back pain. Exercise sessions were one-on-one and lasted 60-min, with the last 5 – 15 min comprising patient education of pain education and cognitive behavioural therapy techniques, scoped for delivery by AEPs. Pain, disability, fear, catastrophizing, self-efficacy, anxiety, and depression were measured at baseline, 8-weeks, 3-months, and 6-months. **Results:** No significant between-group differences were observed for pain ($p \geq 0.40$), or disability ($p \geq 0.45$) at any time-point. Significant and clinically meaningful reductions for pain ($p \leq 0.04$) and disability ($p \leq 0.04$) were observed at all time-points for both groups ($p = 0.1$). Changes in fear and self-efficacy at 8-weeks were significant predictors of disability and pain reductions at both 3- and 6-months ($p \leq 0.05$). **Discussion:** Both powerlifting and bodyweight exercise were safe and beneficial when paired with pain education for chronic low back pain, with reductions in pain and disability associated with improved fear and self-efficacy. **Take home message:** When combined with patient education, AEPs should be encouraged to explore any exercise modality ranging from bodyweight to near 1-RM load that a patient with chronic back pain would like to perform.

The biomedical and biopsychosocial beliefs of physiotherapists and accredited exercise physiologists in the treatment of people with low back pain

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Introduction: This study surveyed the attitudes and beliefs of physiotherapists and accredited exercise physiologists (AEP) toward chronic low back pain (CLBP), in Australia. Literature regarding physiotherapists suggests a biomedical approach leading to more conservative treatment and on occasion, treatment going against practice guidelines. **Methods:** Seventy-five AEPs and 75 physiotherapists were surveyed using the pain attitudes and beliefs scale for physiotherapists, which consists of both a biomedical and biopsychosocial subscale. Clinical decision making was assessed using two patient vignettes. **Results:** AEPs held higher biomedical beliefs compared with physiotherapists. No between-group differences were observed on the biopsychosocial subscale. Indeed, biomedical attitudes and beliefs did explain clinical decision making with higher scores reflecting a more conservative approach. However, biomedical beliefs influenced decision making regardless of profession. **Discussion:** Biomedical attitudes and beliefs regarding CLBP influence clinical decision making in exercise-based practitioners, regardless of profession. AEPs reported higher biomedical scores, suggesting more

frequent choice of conservative care. Thus, patients may receive inconsistent care and advice from practitioners within the same field. **Take home message**: Based on clinical practice guidelines and the positive associations on clinical decision making of the biopsychosocial model, it is necessary to provide exercise-based practitioners with tailored up-to-date education on how to apply a biopsychosocial approach to treat people with CLBP.

Sport and Exercise Psychology

The effect of cognitive fatigue on swimming technique and performance in competitive swimmers

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Introduction: Swimming, a traditional Olympic sport, is a sport where the objective is to complete the race in the fastest possible time and outswim all opponents. Recent studies have investigated the role of mental fatigue on swimming performance in competitive swimmers. **Method:** Nine online databases were searched with the following inclusion criteria: (1) journal articles with outcome measures related to swimming performance or technique, and (2) journal articles that have a mental fatigue intervention protocol. Exclusion criteria were (1) journal articles that study sports other than swimming, (2) untrained, novice and paraplegic swimmers, (3) triathletes and water polo players, (4) swimmers with injuries or illness, (5) studies of only starts and turns, and (6) the journal article does not have a mental fatigue intervention. **Results**: 2,813 studies were screened and 6 were included for quality assessment. The Cochrane risk-of-bias tool was used for the 5 crossover randomised control trials and 1 parallel-group randomised control trial investigating mental fatigue and swimming performance. No articles studied the effect of mental fatigue on swimming technique. **Discussion:** Although most studies found a link between mental fatigue and swimming performance, none had a low risk-of-bias, and some had a high risk-of-bias meaning that their findings should be interpreted with caution. Interestingly, the more recent studies analysing this relationship had better protocol and less risk-of-bias. This indicates that the research field is heading to the right direction, but more research is necessary. Additionally, the relationship between mental fatigue and swimming technique should also be analysed to explore the mechanisms by which swimming performance may be affected. **Take home message:** Mental fatigue seems to affect swimming performance, but the mechanisms by which this occurs remain unknown.

Sport psychology: The attitudes of New Zealand athletes

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Introduction: The purpose of this study was to examine New Zealand athletes' attitudes towards sport psychology consultation. As a field, sport psychology is receiving increasing attention within New Zealand, yet the last study examining this area involving New Zealand athletes was conducted in 2004. **Method:** Sixty-two athletes (ranging from age-group to international-level) were administered the Sport Psychology Attitudes – Revised questionnaire (SPA-R). **Results:** It was found that overall athletes' attitudes towards sport psychology improved since 2004. Independent group t-tests demonstrated that athletes in 2020 had significantly higher confidence in sport psychology, and significantly lower levels of personal openness and cultural preference. There was no significant difference found in stigma tolerance scores. Chi-squared tests revealed that non-contact sport athletes were found to have significantly higher confidence in the field than contact sport athletes, and individual sport athletes were found to have significantly higher confidence and cultural preference than team sport athletes. A trend was found with higher level athletes having greater confidence in sport psychology and national level athletes were found to have higher cultural preference than junior athletes. **Discussion:** When compared with the rest of the world, New Zealand athletes have positive attitudes towards sport psychology, and these attitudes have improved since 2004. The results showed low levels of stigma associated with seeking sport psychology consultation, high levels of confidence in the efficacy of sport psychology, moderate levels of personal openness and low to moderate levels of cultural preference. **Take home message:** Overall, athletes' perceptions and attitudes towards this rapidly growing field appear to be positive. Such information is useful for organisations and practitioners as they work to establish sport psychology support that nurtures athlete performance and wellbeing.

Influence of an evaluative audience on conscious motor processing and performance during a stop-signal soccer penalty shooting task

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Introduction: The Theory of Reinvestment predicts that pressure can negatively impact performance of perceptual-motor skills by experts, due to conscious reinvestment of explicit knowledge about how to perform the skills (i.e., 'conscious motor processing'). A recent systematic review confirmed that performance pressure generally leads to an increase in conscious motor processing; however, there was insufficient evidence to conclude that pressure-induced increases in conscious-motor processing are associated with negative impacts on performance. **Method:** The current study directly addressed this issue by investigating effects of pressure on conscious motor processing and performance in a soccer penalty shooting task. Fifteen experienced soccer players performed two different versions of the task ('Go-only' vs. 'Stop-and-Go'), which allowed for more, or less,

conscious motor processing to occur. In both cases, pressure was manipulated by means of an evaluative audience (audience vs. no audience). Conscious motor processing was assessed with the Movement Specific Reinvestment Scale (MSRS) and by means of a skill-focused dual-task. Measures of performance included movement times and penalty shooting accuracy. **Results:** Preliminary analyses indicate that penalty shooting accuracy was lower in the Stop-and-Go than in the Go-only task context. Presence of an audience did not cause participants to experience an increase in competitive anxiety, nor did it result in significant effects on conscious motor processing or penalty shooting performance. **Discussion:** These findings indicate that penalty shooting performance is negatively affected by the possibility of stopping. Further analyses (e.g., between subgroups) are required to clarify associations between increases in pressure, conscious motor processing and performance. **Take home message:** Football players should be aware that shooting accuracy may be impacted when multiple opportunities for action are considered.

Effect of exercise intensity and modality on post-exercise executive function

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Introduction: Physiological changes in response to exercise are known to have implications for cognitive function. There seems to be a small positive effect of exercise on cognitive performance, specifically executive function and inhibition function. However, no study has directly investigated the differential effect of exercise at different modalities (running, cycling, and swimming) on cognitive function. The aim of this study was to investigate the effect of exercise modality, as well as intensity, on performance at a cognitive task performed during immediate recovery. **Method:** Sixteen experienced triathletes (n = 15; 11 males, 4 females; *M*age = 25.9 years, SD = 9.3; training > 1 × per discipline per week) performed a total of nine exercise testing sessions: a VO_2max test, a 20-minute protocol at the first ventilatory threshold (VT_1, based on VO_2max data), and a training-load-matched protocol at the second ventilatory threshold (VT_2) in each discipline (swim, bike, run). During each test, participants' auditory canal temperature, heart rate, oxygen consumption, and rate of perceived exertion were assessed. Before and 10 minutes after exercising, participants performed a cognitive task battery (Stroop colour-word test, Go-no go test, simple reaction time (SRT) test) with randomized stimuli. **Results:** Heart rate, VO_2 and rate of perceived exertion data support that the interventions were successful at producing the intended intensities. Analyses of inhibition function showed no main effect of intensity (p = 0.350) or modality (p = 0.584) and no interaction of intensity and modality (p = 0.635). Similarly, simple reaction time was not differently affected by exercise of different intensities (p = 0.112) or modalities (p = 0.842, interaction p = 0.778). Visual inspection of the data shows a trend towards faster reactions and better inhibition function after light exercise but not after maximal (VO_2max) exercise. Near-maximal exercise produced mixed results. **Discussion:** Large variability in the responses indicates that there may be individual differences in how exercise affects inhibition and other cognitive functions. Finding out which modes and intensities (and potentially their ideal combination) lead to the greatest benefits will have implications for the design of health interventions, breaks at school and in the workplace, and targeted support wherever executive functions are relevant. **Take home message:** The present study suggests that there may be a positive effect of light exercise on executive functions, and that this effect may be reversed at higher intensities, however the strength of the results is weak.

Elite hockey performance: Examining the relationship between propensity for reinvestment and performance in different game situations

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Introduction: The theory of reinvestment suggests that individuals who have a higher propensity to consciously control their movements are more likely to display disrupted performance when they are highly motivated to perform effectively. However, tendency to reinvest might depend on the attentional demands of a game situation. In this pilot study we investigated the association between the propensity to reinvest and performance in two different hockey game situations (i.e., game and shootouts), to gain insight into the effects of different attentional demand situations on this association. **Method:** Twenty-two elite hockey players completed the Movement Specific Reinvestment Scale (MSRS) prior to an U21 New Zealand hockey tournament. Game and shootout performance was assessed in each individual by independent coaches. Correlation analysis was conducted to examine the associations between MSRS and both game and penalty shootout performance. **Results:** No association was found between MSRS and game performance ($p > 0.05$). However, a negative correlation was evident between MSRS and shootout performance (r = -0.591, $p < 0.01$). **Discussion:** A high propensity to consciously control movements (reinvestment) was negatively associated with shootout performance by elite hockey players, but not in-game performance. We speculate that the necessity to shift between many non-static attentional cues during game play (e.g., teammate positions, opposition attacks, referee whistles etc) may reduce likelihood, or capacity, to reinvest during performance. **Take home message:** The tendency to consciously control movements under pressure might depend on the attentional demands in a game situation.

Effect of acute exercise on the state anxiety and autonomic regulation of moderately-anxious, sedentary individuals

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Introduction: Anxiety is a prevalent and debilitating mental health disorder associated with autonomic dysfunction. Autonomic dysfunction is defined as a failure to effectively balance between the sympathetic (SNS) and parasympathetic (PNS) nervous system and is associated with heightened cardiovascular morbidity and mortality due to excessive chronic activation of the SNS. One proposed treatment is exercise. This study aimed to compare the effects of an acute self-selected intensity aerobic exercise bout with a stretching control on state anxiety and autonomic dysfunction, measured through physiological and perceptual reactivity to hypercapnia (elevated carbon dioxide; CO_2), as well as resting heart rate variability (HRV). **Method**: Moderately-anxious, sedentary individuals (n = 24, aged 18 – 46 years) were randomised to self-selected intensity aerobic exercise or guided static stretching. Autonomic regulation was assessed at rest pre- and post-intervention through 10 min of HRV, 2 min of hypercapnic breathing (5% CO_2) and 2 min of room-air breathing (single-blinded and randomised). Ventilation and HRV measured physiological hypercapnic reactivity via a gas analysis system, while breathlessness and anxiety towards breathing measured perceptual hypercapnic reactivity through visual analogue scales. **Results:** Results showed that both groups experienced significant improvements in state anxiety from pre- to post-intervention (p = 0.002). However, there were no significant pre-to post-intervention differences in ventilation, breathlessness, or anxiety towards breathing during hypercapnic breathing for either the aerobic or stretching group. Resting HRV significantly decreased from pre- to post-intervention in the stretching group (p = 0.03). **Discussion:** The results suggest an acute bout of self-selected intensity aerobic exercise and static stretching both improve state anxiety. While the aerobic exercise did not improve autonomic dysfunction in people with subclinical anxiety immediately post-exercise, static stretching session improved resting HRV. **Take home message**: Low participant numbers and insufficient post-exercise recovery may have influenced results, therefore future research should overcome these limitations and continue to investigate autonomic regulation.

Increasing exercise workload degrades the precision of rapid eye movements

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Introduction: Exercise involves rapidly changing and unpredictable visual environments. To be safe and successful in sports, rapid eye movements (saccades) must accurately locate targets of interest. The physiological effects of acute exercise on the kinematics of saccades are currently unexplored. **Method:** To test if exercise intensity is a mediating factor in oculomotor control, twenty-five participants completed an incremental workload cycle ergometry protocols composed of 4-minute stages. Relative exercise intensity was determined via expired air analysis, with saccadic eye movements recorded between 40% – 90% VO_2max via infrared oculography cameras mounted within virtual reality goggles. **Results:** Several saccadic kinematic variables scaled linearly with exercise intensity. From 40% – 90% of VO_2max, both peak saccade velocity and amplitude significantly increased by 86 ± 27º/s (p < 0.01) and 2.2 ± 0.8º (p < 0.01), respectively. Participants' eyes therefore moved quicker and less accurately as workload increased. The latency and duration of saccades did not change significantly during the exercise protocol. A follow-up experiment assessed visuospatial attention across the same range of exercise intensities to confirm that alterations in eye kinematics were not attributable to changes in attention. **Discussion:** Our novel approach to assessing oculomotor function during exercise reveals that the precision of eye movements degrades as exercise intensity increases. At the higher intensities, participants gazed beyond the visual target (dot). The magnitude of the exercise- increased displacement of the eyes exceeded foveal vision (the central area of vision where eyesight is sharpest). These findings suggest that the intensity of exercise can alter oculomotor function to the point where visual acuity may be impaired. **Take home message:** The precision of saccadic eye movements is degraded during strenuous exercise, to an extent that could prevent effective scanning of a dynamic visual environment. These findings might have implications for safety and performance in sports where surroundings rapidly change in an unpredictable manner.

To pass or not to pass: Investigating the effect of uniform colour on inhibition when passing

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Introduction: Response inhibition, defined as the ability to withhold a response, can be influenced by colour. We asked whether response inhibition can be influenced by uniform colour in sport. **Method:** In Experiment 1, an image of a basketball opponent in a red, green, or grey (control) uniform was presented in off-center positions on the screen (computer-based) or against a wall (motor-based) (counterbalanced). Thirty-seven participants were instructed to pass a ball to the side with more space, but to inhibit passes when the side with more space was defended by the opponent (e.g., arms-out). **Results:** Inability to inhibit passes (i.e., commission error) was higher when viewing an opponent in a green uniform compared to a grey uniform (computer-based p = 0.011, motor-based p = 0.021, one-tailed), suggesting that the colour green

impaired inhibition. In Experiment 2, we examined archival data, which showed that significantly more passes were intercepted by opposing teams that wore green uniforms compared to other colours (p = 0.015, one-tailed), suggesting that the colour green impaired the ability to inhibit ill-chosen passes. **Discussion/Take home message**: Colour may influence inhibition in sport due to a colour-meaning association (e.g., green means "go"). Colour research in sport is still at an early stage; however, our findings raise the question of whether sports teams can use uniform colour to influence opponents' performance.

Using the Müller-Lyer illusion as a tool to investigate visual size perception in concussion

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Introduction: Contextual processing is known to be impaired following a concussion. However, it is unclear whether impairments influence visual size perception, a modality that depends heavily on low-level contextual processing. To address this question, we presented the Müller-Lyer illusion to concussed individuals and healthy controls in order to assess the effect of surrounding context on visual size perception. **Method:** Nineteen university students with a history of concussion(s) and forty-three healthy controls completed a computer-based side-by-side comparison task in which they judged the length of two lines (the Müller-Lyer illusion). The length of the lines were either identical in size or different, ranging from 2.0 cm, 2.5 cm, or 3.0 cm in size. The two lines appeared with outward or inward pointing arrow heads attached at the ends of the line (context condition) or without arrow heads (no context condition). **Results/Discussion:** Judgement of whether the lines were of equal length or different was equivalent for the two groups in the no context condition (concussed M = 94.84; control M = 92.30). However, concussed participants made more accurate judgements in the context condition (p < 0.05), suggesting that they were less susceptible to the Müller-Lyer illusion. **Take home message:** People with concussion may have reduced sensitivity to visual context, which facilitates more accurate size judgments when viewing multiple features in the visual field.

Sport Nutrition

Full-time nutrition practitioner support may positively influence meal distribution of dietary protein in provincial academy Rugby Union athletes

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Introduction: Nutrition is an important consideration for optimising health, well-being, performance, recovery, and injury risk in rugby union athletes. Emerging evidence suggests the timing of meals and thus nutrient intake may be particularly important for modulating these factors. An even distribution of 0.4g·kg·meal dietary protein across 4 – 6 meals is suggested to optimise skeletal muscle hypertrophy and re-modelling and facilitate the meeting of broad daily requirements. Despite this, developmental provincial rugby athletes often receive minimal support from qualified practitioners which may negatively influence dietary habits and food choices. **Methods:** Ten provincial academy rugby players (age = 20.7 ± 1.7 years, body mass = 103.3 ± 18.8kg, height = 186.8 ± 9.1cm) engaged in support protocol whereby they received full-time practitioner support. The support protocol was informed by behaviour change techniques and involved group and individual-level engagement, accounting for individual lifestyles, position demands and body composition goals. Dietary intake was estimated on a training and non-training day weekly across a 4-week pre-intervention and 4-week post-intervention period at six daily eating occasions. The remote food-photography method (MealLogger, Wellness Foundry, Ashburn, VA) was used to collect dietary intake information that was subsequently analysed (FoodWorks, Version 10.0.4266, Xyris Software, Australia) for protein intake. **Results:** Protein intake were greater at 'Breakfast' (pre: 0.28 ± 0.22g·kg; post: 0.40 ± 0.20g·kg), 'AM Snack' (pre: 0.06 ± 0.13g·kg; post: 0.10 ± 0.15g·kg), 'Lunch' (pre: 0.34 ± 0.22g·kg; post: 0.38 ± 0.24g·kg), and 'Evening Snack' (pre: 0.03 ± 0.09g·kg; post: 0.08 ± 0.16g·kg) in response to the intervention. **Discussion:** Consumption of dietary protein increased at multiple eating occasions following intervention towards the proposed 0.4g·kg·meal, suggesting short-term practitioner presence may assist athletes optimise eating patterns. As significant eating habit changes are unlikely to occur in a short-time frame, future research should explore the impact of practitioner support in athletes over a prolonged period. **Take home message:** Clubs and governing bodies are encouraged to provide full-time practitioner support to developmental athletes to ensure eating habits are conducive to supporting health, performance, and recovery.

The influence of dietary carbohydrate on perceived recovery status differs at the group and individual level: Evidence of nonergodicity among endurance athletes

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Introduction: Research findings are typically reported at the group level but applied to individuals. However, an emerging issue in sports science concerns nonergodicity -

whereby group-level data cannot be generalized to individuals. The purpose of this study was to determine if the relationship between daily carbohydrate intake and perceived recovery status displays nonergodicity. **Methods:** Fifty-five endurance athletes recorded daily measures of self-selected dietary intake, training, sleep, and subjective wellbeing for 12 weeks. We constructed linear models to measure the influence of daily carbohydrate intake on perceived recovery status while accounting for training load, sleep duration, sleep quality, and muscle soreness. Using linear model coefficients for carbohydrate intake we tested whether the distributions (mean and SD) differed at the group and individual levels (indicating nonergodicity). Additionally, a decision tree was created to explore factors that could provide an indication of an individual athlete's relationship between carbohydrate intake and perceived recovery status. **Results:** Mean values were not different between group- and individual-level analyses, but SDs at the individual level were ~2.5 times larger than at the group level, indicating nonergodicity. Model coefficients for carbohydrate intake were negative for five participants, positive for four participants, and non-significant for 31 participants. The Kappa value measuring accuracy of the decision tree was 0.54, indicating moderate prediction accuracy. **Discussion:** The main outcomes of this study are 1) daily carbohydrate intake does not influence perceived recovery status the following morning for most athletes, after accounting for other influential variables such as training load, muscle soreness, and sleep, 2) for those that are affected the influence can be positive or negative, and 3) group-level findings cannot be generalized to the individual. **Take home message:** The influence of dietary carbohydrate intake on daily recovery differs at the group and individual level. Therefore, practical recommendations should be based on individual-level analysis.

The hydrating effects of hypertonic, isotonic, and hypotonic sports drinks and waters on central hydration during continuous exercise

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Introduction: Body-fluid loss during prolonged continuous exercise can lead to dehydration, which can impair cardiovascular and thermoregulatory function and performance. Delta percent plasma volume (*d*PV) represents the change in central and circulatory body-water volume and therefore hydration during exercise. Accordingly, *d*PV is the most accessible measure of real-time hydration status during exercise. Surprisingly, the effect of carbohydrate-electrolyte drinks of differing carbohydrate composition and osmolalities, and water, on the *d*PV response was unclear. Therefore, the objective was to determine by meta-analysis the effects of ingested hypertonic (> 300 mOsmol·kg^{-1}), isotonic (275 – 300 mOsmol·kg^{-1}), hypotonic (< 275 mOsmol·kg^{-1}) drinks containing carbohydrate and electrolyte ([Na^+] < 50 mmol·L^{-1}), and non-carbohydrate drinks/water (< 40 mOsmol·kg^{-1}) on *d*PV during continuous exercise. **Methods:** A systematic review was conducted that produced 28 qualifying studies and 68 drink treatment effects. A random-effects meta-analyses with repeated measures provided estimates of effects of the drinks on *d*PV and probability of superiority (p_+) during 0 – 180 min exercise, adjusted for drink osmolality, ingestion rate, metabolic rate, and a weakly informative Bayesian prior. All posterior contrast estimates were expressed relative to the smallest important effect (*d*PV=0.75%). **Results:** Mean drink effects on *d*PV were: hypertonic -7.4% (90% CL [-8.5%, -6.3%]), isotonic -8.7% (90% CL [-10.1%, -7.4%]), hypotonic -6.3% (90% CL [-7.4%, -5.3%]), water -7.5% (90% CL [-8.5%, -6.4%]). Differences between the drinks were: hypertonic-isotonic 1.2% (90% CL [-0.1%, 2.6%]; p_+ = 0.74), hypotonic-isotonic 2.3% (90% CL [1.1%, 3.5%]; p_+ = 0.984), water-isotonic 1.3% (90% CL [0.0%, 2.5%]; p_+ = 0.76), hypotonic-hypertonic 1.1% (90% CL [0.1%, 2.1%]; p_+ = 0.71), hypertonic-water 0.1% (90% CL [-0.8%, 1.0%]; p_+ = 0.12), hypotonic-water 1.1% (90% CL [0.1%, 2.0%]; p_+ = 0.72). **Discussion**: Hypotonic drinks were very likely superior to isotonic and likely superior to hypertonic and water. Metabolic rate, ingestion rate, carbohydrate characteristics and electrolyte concentration were generally substantial modifiers of *d*PV, with drinks containing multiple-transportable carbohydrates and salt having a superior influence on attenuating the decline in *d*PV. **Take home message:** Hypotonic carbohydrate-electrolyte drinks ingested continuously during exercise provide the greatest benefit to hydration.

Poster Presentations

Reliability analysis of the spatiotemporal determinants in sprinting acceleration of adolescent boys

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Introduction: The non-linearity of growth and the development of sprinting speed throughout maturation makes understanding acceleration, its spatiotemporal determinants, and their collective reliability important for research and performance tracking. The current study investigated the reliability of short acceleration efforts and associated spatiotemporal determinants in adolescent boys spanning Pre-, Circa-, and Post-Peak Height Velocity (PHV) groups. **Methods:** Adolescent boys (n = 46) were grouped by maturational status into Pre-PHV (n = 6; age = 12.3 ± 0.8 years), Circa-PHV (n = 24; age = 13.7 ± 0.5 years) and Post-PHV (n = 16; age = 14.6 ± 0.4 years) based on a regression equation considering interactions of anthropometric measures. All participants attended two testing sessions comprised of four 10 m sprints with 5 m splits included; spatiotemporal measures (contact-time, step-frequency, and step-length) were obtained for steps two to six via a ground level optical measurement system. **Results:** Short accelerations (5 m and 10 m), contact-time, step-frequency, and step-length were deemed reliable (ICC > 0.70; CV < 10%) across all maturational groups. Flight-time consistently lacked reliability (ICC < 0.70 and/or CV >10%) between steps two to four in all maturational groups. **Discussion:** Short accelerations and key spatiotemporal variables were shown to be reliable measures during maturation adolescent boys. The lack of reliability in flight time was not unexpected and aligns with results from previous research. Literature reports that adolescent boys may manipulate flight and contact-time to optimise step-frequency. So, in the current research, it appears flight-time was variably manipulated between efforts. Variability may also indicate a lack of experience in the current cohort. **Take home message:** Short accelerations, contact-time, step-length, and step-frequency can be reliably measured throughout maturational stages in adolescent boys. However, some interactions like that between flight and contact-time, may need more detailed examination before being used in practical applications.

Pain does not interfere with Brazilian Jiu-Jitsu athletes' shoulder performance

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Introduction: Shoulder injuries are frequent in Brazilian Jiu-Jitsu (BJJ), these injuries may impair function and performance. There is a lack of research associating shoulder pain and performance of BJJ athletes. The objective of this study was to evaluate whether there is a correlation between shoulder functional-performance and reported-performance in BJJ athletes. **Method:** Twenty-eight male BJJ athletes were divided in two groups: shoulder pain (SP) (n = 12) and no shoulder pain (NSP) (n = 16). Anthropometric and training data were collected as well as their shoulder external and internal rotation goniometry. They performed the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) and athletes with shoulder pain completed the Athletic Shoulder Outcome Rating Scale (ASORS). Results were organized as descriptive statistics with mean and standard deviation values and the Spearman's test was used to identify any possible correlation between data analyzed. **Results:** Shoulder pain appears to be connected with more years of practice (p = 0.035). There is a moderate to high positive correlation regarding power and BMI (r = 0.588; p = 0.017) and a moderate negative correlation on the average number of touches during the CKCUEST and BMI (r = -0.498; p = 0.035). The ASORS does not correlate with any of the other variables assessed. **Discussion:** Literature shows that CKCUEST was unable to differentiate people with and without symptomatic shoulders but has high reliability assessing shoulder function in athletes and non-athletes with impact syndrome. Moreover, despite the fact that ASORS is used to measure pain in athletes during sports activities, the present study showed no correlation with any of the parameters analyzed. **Take home message:** Shoulder pain may not interfere with athletic performance in Brazilian Jiu-Jitsu; the CKCUEST was unable to identify differences in athletes with and without shoulder pain; and ASORS does not correlate with CKCUEST results indicating that the shoulder performance of BJJ athletes is not interfered by pain.

The effect of environmental temperature on substrate oxidation and extracellular heat shock proteins in response to heart rate matched moderate-intensity cycling in endurance trained males

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Introduction: Endurance exercise combined with environmental heat stress alters substrate metabolism and upregulates extracellular heat shock protein 70 (HSP70) concentrations. Previous research has studied these stimulatory effects of heat stress at matched absolute, external work rates. In the real-world, however, a reduction in absolute work rate typically occurs when exercising in hot environments compared to temperate conditions. The aim of the present investigation was to determine how heat stress impacts substrate oxidation rates and plasma HSP70 expression during endurance exercise regulated by relative physiological work rates. **Method:** Ten endurance-trained, male cyclists performed two experimental trials in an acute, randomised, counterbalanced cross-over design. Each trial

involved a 90-minute bout of cycling exercise at 95% of the heart rate (HR) associated with VT_1 in either 18 (TEMP) or 33˚C (HEAT), with ~60% relative humidity. **Results:** Mean power output (17 ± 11%, p = 0.0005) and whole-body energy expenditure (14 ± 8%, p = 0.0003) were significantly lower in HEAT. Sweat rate was significantly greater in HEAT (87 ± 63%, p = 0.0003). Whole-body carbohydrate oxidation rates were significantly lower in HEAT (19 ± 11%, p = 0.002), while fat oxidation rates were not different between-trials. Plasma HSP70 expression was not increased with exercise in either environment. **Discussion:** The heat stress-induced reduction in carbohydrate oxidation was associated with the observed reduction in power output (r = 0.64, p = 0.05, 95% CI [0.01, 0.91]) and augmented sweat rates (r = 0.85, p = 0.002, 95% CI [0.49, 0.96]). The lack of plasma HSP70 accumulation during endurance exercise may be explained by insufficient exercise duration, inadequate thermal stress, and/or the cycling-exercise modality employed in this study. **Take home message:** Practitioners working with athletes exposed to hot environments incidentally or purposefully may take these findings into account when programming training schedules and considering nutrition.

To Make or to Break in Isometric Neck Strength Testing?

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Introduction: Concussion is the most prevalent injury in Rugby Union (RU). Isometric neck strength tests ($ISOM_{neck}$) have been used in RU to screen for modifiable injury risk factors. Several methods and variations in protocol exist for $ISOM_{neck}$, including performing these tests in the 'make' or 'break' fashion. We aimed to compare these two methods of neck strength assessment. **Methods:** A cross-sectional study with 11 semi-professional RU players and 35 healthy active university students was undertaken. Peak force from three maximal $ISOM_{neck}$ 'make' or 'break' contractions in flexion, extension, and right and left lateral flexion were recorded using a load cell connected to a head harness with participants seated. Intra-class correlation coefficients (ICC) were used to assess intra-session reliability. The Passing-Bablock procedure was used to assess systematic and proportional differences between methods. **Results:** Both tests had good precision and linearity, with no systematic or proportional differences between them based on the Passing-Bablock procedure. Both methods demonstrated excellent intra-session reliability (ICC = 0.95 to 0.97). Mean break test values (range = 21 to 26.7 kg) were generally greater than make test ones (range = 19.1 to 25.8 kg), with significant *small* differences in flexion and left lateral flexion (Cohen's d = 0.22, $p \leq$ 0.002). **Discussion:** The intra-session reliability (ICC = 0.95 to 0.97) in this study was superior to other studies in RU when using handheld-dynamometer in a make test fashion (ICC = 0.77 to 0.92) or manual resistance (ICC = 0.77 to 0.90). Both $ISOM_{test}$ methods can be used to target specific preseason training or in-season monitoring strategies, and aid the rehabilitation of cervical injuries or guide return to play protocols. **Take home message:** The break and make tests provided reliable neck strength measures and can be used interchangeably based on the Passing-Bablock assessment. Both tests are feasible to implement in RU, and can assist in the preparation, screening, and monitoring of modifiable risk factors for neck injuries and concussion.

Characterising the demands of human-powered Surf Lifeguard Rescue in New Zealand

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Introduction: Previous research characterising the demands of Surf Lifeguard rescue has generally occurred either in laboratory or highly-controlled field studies that may not be ecologically valid. This study aimed to determine the demands of performing non-powered rescue while prioritising external validity. **Method:** Five Dunedin Surf Lifeguards were filmed performing two simulated rescues of a training manikin at local beaches, utilising either a rescue board or rescue tube (randomised order). Performance analysis of the two field trials was undertaken. Heart rate and psychophysical data were also collected. Each condition was then replicated twice in the University of Otago Flume, once only swimming or paddling, and once while replicating the exact order and duration of movement patterns that were performed during the beach rescue (four total flume conditions). Flume trials allowed for the additional measurement of respiratory gases and volumes using a metabolic cart (Quark CPET, COSMED, Rome, Italy). **Results:** Board rescues were on average 39 sec (20%) quicker than tube and fin rescues. During board rescues, participants spent more time paddling (Mean ± SD: 116 ± 42 sec) than swimming during tube rescues (90 ± 37 sec). Tube rescues involved more running and walking (75 ± 22 sec) than board rescues (13 ± 6 sec). During board rescues, participants navigated 100% of waves by going over them, while in the tube and fins condition 70% were negotiated by submersion. Physiological data is being analysed and will be presented at the conference. **Discussion:** Altered characteristics of rescues conducted utilising different rescue equipment influence the demands placed on lifeguards. Further investigation is needed with more participants to develop fitness assessments that reflect these differences. **Take home message:** The type of equipment utilised in non-powered rescue influences the demands on lifeguards performing rescues. As such, the demands related to each piece of equipment should be considered separately when assessing lifeguards' capabilities.

Assessing the validity of instrumented mouthguards to detect collisions compared to video analysis in Rugby Union

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Introduction: Rugby union is a contact sport with high physical demands consisting of locomotive and contact

activities which create fatigue on the body. Significant evidence exists regarding the intensity and duration of locomotive movements using microtechnology such as GPS and accelerometers. Contact load is frequently reported via notational analysis through the use of multiple video angles. This method does not, however, provide an objective measure of contact load. Our aim was to investigate the potential of instrumented mouthguards to provide an objective contact measure as part of quantifying total player match load. **Method:** Twenty elite male rugby players from one professional rugby team wore the HitIQ Nexus A9 instrumented mouthguard during five matches. Contact metrics were analysed in the Nexus App, and video verified using Hudl sportscode. **Results:** Peak linear and rotational accelerations ranged from 16.5 g to 43.9 g, and 1452 rad/s to 3722.6 rad/s, respectively. The highest values typically occurred for upper body tackle contacts. Ball carry into contact led to the most frequently detected contact events and often included a secondary contact event within a tackle sequence. **Discussion:** Our preliminary analysis suggests that there are differences in the intensity of contact or collision types as detected by instrumented mouthguard. These intensities differed when compared with traditional notational analysis. This has important implications for player recovery and quantifying overall player load. The results are in agreement with those of Waldron et al. (2021). **Take home message:** The physical contact in rugby adds to the player load above the generalized physical/locomotor demands. If we are to maintain performance for rugby players it is important to be able to accurately quantify total player load. Instrumented mouthguards appear to provide a more accurate method through which to quantify player load than notational analysis.

Is there a difference in neck strength characteristics such as peak isometric neck strength, rate of force development and electromechanical delay between male and female football players?

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Introduction: Current research indicates that female football players experience higher rates of head and neck injuries compared to their male counterparts. While there is an assumption that such disparities are associated with strength differences we actually know very little about how strength contributes to head control in football players. By better understanding the neuromuscular factors related to head control in football players we can better target female specific training programs, which aim to improve robustness of female athletes in the football sporting environment. The aim of the present study was to investigate neck strength characteristics such as, peak isometric strength, rate of force development and electromechanical delay, between male and female footballers. **Methods:** Thirty-five (16 males, 16 females) football players participated in the present study. Muscle activity was recorded from the right-side upper trapezius, the splenius capitis and the sternocleidomastoid using a 16-channel telemetered EMG system sampling at 2,000 Hz. Isometric neck strength was assessed in forward, backward and lateral flexion directions with a purpose built testing device. The force × time curve was investigated for the strength characteristics of interest. Mixed models were fitted to assess the differences in strength characteristics between sexes while controlling for intra-athlete correlations. **Results:** Sex was a significant factor for both RFD ($X^2 = 10.71$, $p = 0.001$), and Peak force ($X^2 = 10.71$, $p = 0.001$). Males had greater Peak force and RFD compared to females in all 4 test directions. **Discussion:** These results highlight the sex difference in neck strength characteristics amongst football players. Female athletes have 1.9 times the risk of experiencing concussion compared to their male counterparts. Having weaker neck muscles or slower rate of force development may explain the higher risk of concussion in female footballers. Future research will explore how these characteristics might be associated with head control during inertial head perturbations which will direct further insight into female specific concussion prevention programs. **Take home message:** Sex differences in neck strength characteristics should be considered in future research and injury prevention strategies.

Relationship between sprint running performance and explosive leg extension strength

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Introduction: During sprint running, starting from a static state, running mechanics change with the distance from the start line. Moreover, different types of explosive leg extension strength, such as leg extension force–velocity–power profile and reactive strength index (RSI), determine sprint running performance. This study investigated the relationship between split time for a 40-m sprint and explosive leg extension strength. **Method:** Sixty-two male collegiate baseball players participated in this study. Split times were measured every 10 m in a 40-m sprint. The force–velocity–power profile in the vertical leg extension was estimated based on the ground reaction force and barbell speed during jump squats with various loads. RSI was calculated as jump height divided by contact time during repeated rebound and depth jumps from 20- and 40-cm boxes. Multiple regression analyses were performed, with the split times considered as dependent variables. **Results:** For 0 – 10 m, the relative maximal power (maximal power divided by body mass) and slope of the force–velocity profile were selected as explanatory variables. For 10 – 20, 20 – 30, and 30 – 40 m, the RSI measured in the 40-cm depth jump was selected. The multiple regression models explained 23.2% and 10.5% − 14.0% of the variability in the initial 10-m split time and subsequent split times, respectively. **Discussion:** During the initial stage of sprint running, triple extension of the legs is performed for relatively long periods. As the maximal velocity phase is approached, runners begin

utilizing a stretch-shortening cycle under shorter ground contact time. The results suggest that these differences in running mechanics over distance result in different explosive leg extension strengths required for running. **Take-home message:** Different types of leg extension strength are required for the initial 10-m split time and subsequent split times during sprint running.

Relationship between leg extension strength characteristics and ground reaction force during sprint acceleration

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Introduction: Theoretically, leg extension strength is a major determinant factor of ground reaction force (GRF) in sprint acceleration; however, it remains to be clarified. This study aimed to investigate the relationship between leg extension strength characteristics and GRF during sprint acceleration. **Method:** Thirty-one male collegiate baseball players performed 15-m sprint running and squat jumps in 5 – 6 loading conditions (0 – 100 kg). Mean horizontal and resultant GRFs and leg extension speeds in the propulsive phase were calculated for the first, fifth, and ninth steps of the 15-m sprint. The leg extension force-velocity profile was assessed using mean vertical GRFs and leg extension speeds during squat jumps. Then, theoretical maximum-force (F_0), -velocity (V_0), -power (P_{max}), and leg extension strength corresponding to leg extension speed at each step during sprint running (F_{1st}, F_{5th}, F_{9th}) were calculated. Force-related variables were normalized to body mass. Correlations between GRFs and F_0, V_0, P_{max}, F_{1st}, F_{5th}, and F_{9th} were examined. **Results:** F_0 correlated with horizontal GRFs for all steps (r = 0.359 to 0.543; p = 0.002 to 0.047). P_{max} correlated with horizontal GRFs for the fifth and ninth steps, and with resultant GRF for the ninth step (r = 0.357 to 0.448; p = 0.011 to 0.049). F_{1st} correlated with resultant GRF for the first step (r = 0.364; p = 0.045). **Discussion:** As the leg extension speed for the first step was the slowest, the horizontal GRF for this step could be associated with F_0. For the fifth and ninth steps, the horizontal GRF could be correlated with P_{max} and F_0, because leg extension speeds for these steps were faster than those for the first step. **Take home message**: Greater maximal leg extension strength and power contribute to a greater horizontal GRF production in the entire and latter early phases of sprint acceleration, respectively.

What should I eat before resistance training? Effect of isoenergetic, pre-exercise meals differing in carbohydrate content on resistance training volume performance

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Introduction: The current study investigated the effects of high and low pre-exercise carbohydrate provision on resistance training performance. **Methods:** In a double-blind, randomised, cross-over design, sixteen resistance trained participants (13 males, 3 females) completed three experimental trials, ingesting a taste and texture matched breakfast smoothie (1) high in carbohydrate (HIGH; 1.5 g/kg body mass), (b) low in carbohydrate (LOW; 0.3 g/kg body mass), and (c) a zero-energy placebo (PLA). HIGH and LOW smoothies were isonitrogenous and isoenergetic. Participants were informed all three smoothies were isoenergetic. Two hours later, participants completed a high-volume resistance training session consisting of three sets of back squat, bench press, prone-row, and shoulder press at 80% of 1-repetition maximum to repetition fatigue. Linear mixed effects models were used to examine differences between conditions. Outcomes of interest were total number of repetitions and pre- and post-exercise hunger, satiety, and fullness. Conditions and exercises were treated as fixed effects, participants were treated as random effects. **Results:** No significant differences were observed between conditions (F = 0.619; p = 0.553) for total number of repetitions. There was a significant main effect of condition on pre-exercise hunger (F = 6.584; p = 0.004; HIGH and LOW < PLA), satiety (F = 7.339; p = 0.003; HIGH and LOW > PLA), and fullness (F = 20.331; p < 0.001; HIGH and LOW > PLA). There was a significant main effect of condition for post-exercise satiety (F = 6.113; p = 0.006; LOW > PLA) and fullness (F = 6.316; p = 0.005; LOW > HIGH and PLA). **Discussion:** The results suggest that a pre-exercise breakfast enhances resistance training volume performance via psychological effects. **Take home message:** The perception of adequate energy intake is necessary to augment resistance training performance.

Six skeletal muscle proteins involved in fatty acid transport explain substantial variation in fat oxidation rates during exercise

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Introduction: Several proteins are implicated with the movement of fatty acids across skeletal muscle sarcolemmal and mitochondrial membranes for oxidation. The purpose of this study was to quantify the variation in whole-body fat oxidation rates during exercise explained by skeletal muscle content of proteins involved in fatty acid transport. **Methods:** Seventeen endurance-trained males underwent a (i) fasted, incremental cycling test to estimate peak whole-body fat oxidation rate (PFO), (ii) resting vastus lateralis microbiopsy, and (iii) two-hours of fed-state, moderate-intensity cycling to estimate whole-body fat oxidation during fed-state exercise (FO), on separate occasions within one week. Bivariate correlations and stepwise linear regression models of PFO and FO during the first 30 min (Early FO) and min 90 – 120 (Late

FO) of continuous cycling were constructed using fatty acid transport proteins data. **Results:** We observed a novel, positive association between vastus lateralis FATP1 and PFO (rs = 0.48, p = 0.06), and replicated work reporting a positive association between FABP1 and PFO (r = 0.71, p = 0.004). Stepwise linear regression model of PFO retained FAT/CD36, FATP1, FATP4, and FABP1, explaining ~87% of the variation. Models of early and late FO exercise explained ~61 and ~65% of variation, respectively. FATP1 and FATP4 emerged as contributors to models of PFO and FO. **Discussion:** These data suggest a substantial degree of variation in fat oxidation rates during fasted and fed-state exercise can be explained by skeletal muscle content of proteins involved in fatty acid transport. **Take home message:** Our data can be used by researchers with limited budget and/or tissue availability when studying effects of various interventions on fatty acid metabolism during exercise.

Co-design process of the development of a healthcare professional-facing analytical tool for wearable device health data

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Introduction: Wearable technology is set to reshape healthcare however, for healthcare professionals to gain insights from vast amounts of data they need tools that support them in analysing and visualising the data. This study used a design science approach to co-design, develop and evaluate an application prototype to analyse wearable data. The first co-design phase is presented here. **Methods:** We surveyed eight (n = 8) healthcare professionals on their views of wearable device use and the application, functionality, and ease of use in client/patient care across two of five attributes of diffusion of innovation theory – relative advantage and compatibility. Descriptive statistics were used to analyse the responses to survey questions in the co-design phase of the study. **Results:** All respondents agreed that integrating wearable data in their practice would provoke more productive discussions with their patients/clients. Most (7/8) respondents reported that wearable data would benefit them and their clients by improving communication and empowering either themselves or their patients/clients. The most reported concerns by healthcare professionals in using wearable devices and data were the accuracy of the device and the privacy of the data. Most (7/8) respondents reported that wearable data was useful to assist with patient/client lifestyle monitoring and care. The respondents reported that out of healthy people, people with chronic conditions and healthcare professionals, people with chronic conditions would benefit the most from using wearable technology. There was high variability in how healthcare professionals wanted wearable data to be presented and visualised. **Discussion:** Overall healthcare professional report wearable devices useful for their practice. The high variability in the visualisation of data suggests that high customisation is required in designing an application for use in clinical practice. **Take home message:** The involvement of healthcare providers in designing and evaluating wearable device analytical tools will develop relevant applications that can be scaled in real-world settings.

Additive manufacture of therapeutic footwear to optimise comfort for runners who experience plantar heel pain

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Introduction: Plantar heel pain (PHP) is a common injury among runners yet its aetiology and most effective form of treatment are widely disputed. Whilst symptoms can subside after 12 months through a series of interventions, such as stretching, strengthening and orthotic use; the pain and discomfort can lead to reduced function in sporting and everyday activities. Hence, there is a need to provide runners with symptom relief during their rehabilitation process. Additive manufacture (AM) allows for novel therapeutic footwear designs that optimise comfort through pressure alleviation. **Method:** A proof-of-concept shoe midsole was produced from the scan of a patient's foot using parametric design to generate a continuous lattice structure with regions of varying density to alleviate pressure from affected areas of the foot. Test samples of the structure were 3D printed with TPU (Thermoplastic polyurethane) to analyse the design functionality and confirm the variation in lattice density through compression testing. **Results:** A larger compressive force was required to achieve the same displacement of the lattice structure in a high-density region compared to a low-density region, confirming a variation in density within the same structure was achieved. **Discussion:** This preliminary study indicated the capabilities of AM for developing PHP therapeutic footwear. This application will be further developed to incorporate features into the footwear that the user can adjust the properties of, such as density, shape, and traditional orthotic modification and caters to the subjective nature of comfort. **Take home message:** AM provides an exciting opportunity to produce novel designs that advance the capabilities of therapeutic footwear specific to PHP. This approach could be applied to other sporting related ailments of the foot where optimising comfort can promote improved function and a return to sport.

Effect of ammonia odor inhalation on maximum grip strength in university students

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Introduction: Numerous studies have investigated the effects of odor on muscle output, but few experiments have been conducted with an understanding of odor-emotional effects. Emotional dimensions arousal and valence are thought to influence motor activity. This study investigated the effect of inhalation of ammonia odor,

which causes high arousal and negative balance, on repetitive grip strength. **Methods:** Eight healthy active university students (21.7 ± 0.8 years) with high arousal and negative valence response to ammonia odor performed the experimental task of gripping the hand dynamometer with maximum effort for several seconds with their dominant hand, repeated five times every five seconds. Diluted ammonia (ammonia condition) or water vapor (control condition) was aspirated from the injection pipe before the task. Grip strength for each trial, and the maximum, minimum and mean values of all trials were compared by paired t-test ($p < 0.05$). **Results:** Grip strength in the ammonia condition was greater than in the control condition at minimum (31.8 ± 6.9 kg vs. 33.9 ± 6.8 kg) and at 5th trial (32.0 ± 7.1 kg vs. 34.1 ± 6.7 kg). No difference was found in the other grip strength values. For some individuals, odor inhalation resulted in 31.7% higher strength on the fifth trial. **Discussion:** Ammonia odor inhalation prior to the performance was found to be effective in maintaining exerted strength, with relatively large effects for some individuals. These results may suggest that ammonia odor affects the facilitatory (prefrontal cortex) and inhibitory (posterior cingulate and insula) systems of central nervous system for force output, as suggested in previous studies. **Take home message:** Stimulation of the sense of smell can affect the function of instantaneous exertion of force and can be particularly effective in maintaining this function.

Differences between force-velocity profiles of resistance exercises and rugby union player position.

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Introduction: Force-velocity profiles (FVPs) have been used in rugby to investigate differences between playing positions and competition levels. However, little research has compared FVP's from multiple resistance exercises between playing positions. Accordingly, this study investigated the differences between the mechanical characteristics of resistance exercises and the playing positions of semi-professional rugby players. **Method:** Twenty-two semi-professional male rugby players (weight = 102.5 ± 12.6 kg, height = 185 ± 7.4 cm, age = 24.4 ± 3.4 years) were recruited for this study. Playing positions were distributed as backs ($n = 10$) and forwards ($n = 12$). Force-velocity profiling was undertaken using four resistance exercises (sled push, sled pull, jammer push-press, and box squat). Exercises were performed at maximal velocity at progressively incremental loads. Velocity was assessed in the sled push, and sled pull using timing gates and in the box squat and jammer push-press using a linear position transducer. Linear regression analyses were performed to create FVPs. Effect sizes were calculated using Cohen's *d*. The magnitudes of effects were qualitatively described using descriptors from Hopkins. **Results:** Of the four common resistance exercises, only sled pull demonstrated a large or very large difference between playing positions. Of interest was the greater sled pull V_0 for forwards ($d = 2.6$) and sled pull F_0 for backs ($d = 1.8$). **Discussion:** The results of this study identify the importance of individualising training between forwards and backs. Furthermore, findings demonstrate the specificity of FVPs to the performed exercise. As such, FVPs cannot be generalised from one exercise to another. **Take home message:** Force-velocity profiling is exercise-specific and mechanical outputs differ between playing positions. Coaches should consider the demands of their athletes when selecting an FVP protocol.

Effects of cyclical deep pressure applied by the flowpresso on sleep and anxiety

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Introduction: Sleep is a primitive state of human beings and a daily basic need. Large fractions of the global population are under-slept, with one-third of adults sleeping below seven hours per night. The neuroendocrine consequences of poor sleep amplify basic emotional reactivity and increase negative mood states like anxiety. Insufficient sleep is pervasive and holds ecological relevance, with under-slept individuals having higher observations of over-anxious and mental distress presentations. Although deep pressure therapy has been utilised in various cohorts, the effect on sleep and anxiety in individuals working in high stress vocations, is unknown. This case study reports on the use of a novel FLOWpresso device that applies sequential cyclical deep pressure. **Method:** The effect of three, forty-minute FLOWpresso sessions over a 3-week period, with one session per week on sleep and anxiety was assessed in a total of 135 first responders in two related studies. Sleep and anxiety were investigated through a self-reported PROMIS sleep disturbance short form plus a stress-mood questionnaire. Data was collected at two time-points: prior to first FLOWpresso session and 1-week after the third FLOWpresso session. Pre and post scores were analysed via paired samples t-tests, and the magnitude of difference of means evaluated with effect size (Cohen's *d*). **Results:** Across the two studies, FLOWpresso significantly lessened self-reported sleep disturbance ($d > 1.05$, $p < 0.001$) and reduced anxiety symptomology ($d > 0.57$, $p < 0.001$). Sleep improved by 25% and anxiety decreased by ~32%. **Discussion:** The positive effects observed in this cohort demonstrates the capability of the FLOWpresso in improving self-reported measures of sleep and anxiety. **Take home message:** The FLOWpresso device may represent an important countermeasure for the global concerns of poor sleep, with the potential to have a positive impact on health and mental wellbeing.

Sensory-based climbing wall to observe sports climbing performance

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Introduction: The increasing popularity of sports climbing in the past decade and the debut at the Olympic Games in Tokyo 2020 have motivated our research to assess sport climbing in athletes. Climbing involves non-repetitive movement in comparison to other sports, i.e.,

running, cycling, and swimming, and is thus difficult to monitor. Researchers have already presented measurement devices for use on a climbing wall. Previous designs were expensive, obtrusive for climbers or required modifications to a climbing wall. Therefore, we have developed cheap and discreet instrumented climbing holds to observe performance parameters. **Method:** The developed instrumented climbing hold consists of an instrumented mounting screw (IMS) and force-sensitive resistors (FSR) between the climbing wall and hold. The IMS is equipped with three strain gauges around the shank of the screw. The three FSR sensors are inserted behind the hold with 120 degrees between each sensor. The developed measuring system is used on a climbing wall installed in our laboratory for conducting testing with sports climbers. **Results:** Our instrumented climbing hold can measure previously recognized performance parameters in sport climbing: contact time, force, and smoothness factor. **Discussion:** Assessment of a climber's performance can be defined with measured performance parameters. Contact time correlates with an athlete's fluency and is measured for each climbing hold and as a total time of climbing route execution. The smoothness factor determines the scatteredness of force over time during a climber's interaction with each climbing hold. Forces are observed as magnitude and direction on each climbing hold, and as a distribution between the lower and upper body. **Take home message:** All the above parameters can be detected with our device and will be observed on the climbing wall with sports climbers of varying ability levels. This will contribute to a better understanding of sport climbing biomechanics and will help reveal subtle differences that are not measurable with existing observational methods.

Carbohydrate intake before and during high intensity exercise with reduced muscle glycogen availability affects the speed of muscle reoxygenation and performance

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Introduction: Muscle glycogen state and peri-exercise carbohydrate (CHO) supplementation may impact responses to high-intensity interval training (HIIT). This study determined cardiorespiratory, substrate metabolism, muscle oxygenation, and performance when completing HIIT with or without CHO supplementation in a muscle glycogen depleted state. **Methods:** On two occasions, in a cross-over design, eight male cyclists performed a glycogen depletion protocol prior to HIIT during which either a 6% CHO drink ($60g \cdot hr^{-1}$) or placebo (%CHO, PLA) was consumed. HIIT consisted of 5x2min at 80% peak power output (PPO), 3x10-min bouts of steady-state (SS) cycling (50%, 55%, 60% PPO), and a time-to-exhaustion (TTE) test. A range of physiological and perceptual measures were determined throughout. **Results:** There was no difference in SS $\dot{V}O_2$, HR, substrate oxidation and gross efficiency (GE %) between CHO and PLA conditions. A faster rate of muscle reoxygenation ($\%\cdot s^{-1}$) existed in PLA after the 1st (Δ-0.23 ± 0.22, d= 0.58, $p < 0.05$) and 3rd HIIT intervals (Δ-0.34 ± 0.25, d = 1.02, $p < 0.05$). TTE was greater in CHO (7.1 ± 5.4 mins) than PLA (2.5 ± 2.3 mins, d= 0.98, $P< 0.05$). **Discussion:** CHO consumption before and during exercise under reduced muscle glycogen conditions did not suppress fat oxidation, suggesting a strong regulatory role of muscle glycogen on substrate metabolism. However, peri-exercise CHO ingestion provided a performance benefit under intense exercise conditions commenced with reduced muscle glycogen. **Take home message:** More research is needed to understand the significance of altered muscle oxygenation patterns during exercise with reduced muscle glycogen and restricted CHO supplementation.

Full-time nutrition practitioner support may positively influence meal distribution of dietary protein in provincial academy Rugby Union athletes

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Introduction: Nutrition is an important consideration for optimising health, well-being, performance, recovery, and injury risk in rugby union athletes. Emerging evidence suggests the timing of meals and thus nutrient intake may be particularly important for modulating these factors. An even distribution of 0.4g·kg·meal dietary protein across 4 – 6 meals is suggested to optimise skeletal muscle hypertrophy and re-modelling and facilitate the meeting of broad daily requirements. Despite this, developmental provincial rugby athletes often receive minimal support from qualified practitioners which may negatively influence dietary habits and food choices. **Methods:** Ten provincial academy rugby players (age = 20.7 ± 1.7 years, body mass = 103.3 ± 18.8 kg, height = 186.8 ± 9.1cm) engaged in support protocol whereby they received full-time practitioner support. The support protocol was informed by behaviour change techniques and involved group and individual-level engagement, accounting for individual lifestyles, position demands and body composition goals. Dietary intake was estimated on a training and non-training day weekly across a 4-week pre-intervention and 4-week post-intervention period at six daily eating occasions. The remote food-photography method (MealLogger, Wellness Foundry, Ashburn, VA) was used to collect dietary intake information that was subsequently analysed (FoodWorks, Version 10.0.4266, Xyris Software, Australia) for protein intake. **Results:** Protein intake were greater at 'Breakfast' (pre: 0.28 ± 0.22g·kg; post: 0.40 ± 0.20g·kg), 'AM Snack' (pre: 0.06 ± 0.13g·kg; post: 0.10 ± 0.15g·kg), 'Lunch' (pre: 0.34 ±

0.22g·kg; post: 0.38 ± 0.24g·kg), and 'Evening Snack' (pre: 0.03 ± 0.09g·kg; post: 0.08 ± 0.16g·kg) in response to the intervention. **Discussion:** Consumption of dietary protein increased at multiple eating occasions following intervention towards the proposed 0.4g·kg·meal, suggesting short-term practitioner presence may assist athletes optimise eating patterns. As significant eating habit changes are unlikely to occur in a short-time frame, future research should explore the impact of practitioner support in athletes over a prolonged period. **Take home message:** Clubs and governing bodies are encouraged to provide full-time practitioner support to developmental athletes to ensure eating habits are conducive to supporting health, performance, and recovery.

Training benefits of replacing interval running with cycle-based off-feet conditioning in junior Rugby League athletes

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Introduction: Team sports are characterised by repeated, brief, maximal intensity efforts, interspersed with low intensity activity. Due to soreness and decreased neuromuscular coaches may implement non-specific training modes in an attempt to mitigate potential negative impacts. **Methods:** Nineteen junior players from a professional Rugby League club volunteered for the 4-week training study comparing an off-feet cycling (BIKE) program with an equivalent running (RUN) training intervention of 10 – 12 repetitions of a 6 s cycle all-out effort. Pre and Post testing was comprised of a 6 s cycle sprint (6sCS), countermovement jump (CMJ), 10- and 20-m sprint, 6 s shuttle sprint (6sSS), and 1.2 km time-trial. Rating of perceived exertion (RPE) and lower body soreness were assessed using a Likert scale. **Results**: There was a significant time effect for the mean power output (MPO) from the 6sCS (p = 0.045, ES = 1.07) and 6sSS (p < 0.01, ES = 1.90). There was a difference in favour of BIKE for MPO (p = 0.04, ES = 1.06) and a difference in favour of RUN on the 6sSS (p = 0.01, ES = 1.73). Running sprint times and cycling peak power output also tended to favour BIKE (ES = 0.8 to 0.5). Perceived exertion was higher in BIKE compared to RUN (16.0 vs. 14.1, p < 0.01, ES = 1.03); whereas, soreness was significantly higher for the RUN group (4.7 vs. 1.7, p < 0.01, ES = 2.21). All other group differences were trivial. **Discussion:** BIKE training intervention had similar training responses for the shuttle run, time-trial, and CMJ when compared to RUN protocol. Off-feet conditioning may mitigate the impact of high volumes of run based training by reducing soreness. The high concentric force required in the 6sCS may have a positive effect on 10-m sprint performance, however, longer interventions should be investigated. **Take home message:** Maximal intensity sprint intervals on a cycle ergometer are effective for reducing soreness and maintaining on-feet performance in junior rugby league players.

Somatotype influences strength and hypertrophy response to biceps curls in untrained participants

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Introduction: Previous research has suggested muscle hypertrophy and strength are inherently linked. Despite this, variability exists in both training responses, while hypertrophy only accounts for a small proportion of strength gain in homogenous male populations. As morphological variances are related to baseline strength differences, an individual's somatotype (endomorphy = adiposity; mesomorphy = musculo-skeletal robustness; ectomorphy = linearity) could account for some of the variability observed in training responses. This study assessed somatotype-related differences in response to an 8-week resistance training program from the biceps curl in untrained participants. **Method:** Sixteen males from ectomorphic (n = 8; mean somatotype 1.9-3.3-4.2) and mesomorphic (n = 8; 3.8-5.8- 2.1) somatotypes completed an 8-week resistance training period. Measures of strength (10 repetition maximum [RM] bicep curl) and muscle thickness (MT) in the bicep brachii (BB), as measured by ultrasound, were recorded at baseline and on completion of the 8-week program. **Results:** The ectomorph group demonstrated a higher relative increase in bicep curl strength (50%) versus the mesomorph group (26.1%) during the training intervention, although this was not significant (p > 0.05). Percentage change in bicep curl strength correlated with change in BB MT in mesomorphs (r = 0.70, p < 0.05) but not in ectomorphs (r = -0.12, p > 0.05). **Discussion:** Hypertrophic and strength response are positively related in mesomorphic untrained males, but this is not the case for ectomorphic untrained males. Areas for future inquiry are suggested to examine the varying responses seen by different somatotypes to resistance training. **Take home message:** Differences between morphological groups may explain some of the training variance observed in previous research.

Low-volume high-intensity interval training programs in female Rugby Sevens players: A pilot study

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Introduction: High-intensity interval training (HIIT) is a popular training method employed in team sports to improve fitness. In this pilot study we investigated the effects of two low-volume HIIT programs on the locomotor profile of female Rugby Sevens players. **Method:** Eight professional players completed either a long-interval (n = 4, work-to-rest ratio = 40:20 s) or short-interval (n = 4, work-to-rest ratio = 15:45 s) HIIT program twice per week for three consecutive weeks. Maximal aerobic speed, maximal sprinting speed, and the anaerobic speed reserve were assessed before and after the

intervention. Within- and between-group changes in means were evaluated using standardisation and the clinical version of magnitude-based inferences. **Results:** In maximal aerobic speed, clear and possible harmful changes were observed following the long-interval program (ES = -0.16) and clear and possible beneficial changes following the short-interval program (ES = 0.18), although the difference between groups was unclear. There were small positive changes in maximal sprinting speed following both programs, with a small (but unclear) difference in favour of the short-interval program, and small positive changes in the anaerobic speed reserve following the long-interval program; however, all these changes were unclear. **Discussion:** Six sessions of short-interval HIIT lead to possible improvements in maximal aerobic speed. In contrast, six sessions of long-interval HIIT had a possible negative effect on maximal aerobic speed. A greater sample size is required to confirm these results and get more evidence about the magnitude of the unclear changes observed in this study. **Take home message:** Low-volume short-interval HIIT could be beneficial for improving maximal aerobic speed in female Rugby Sevens players. Considering how changes in maximal aerobic speed and maximal sprinting speed affect the anaerobic speed reserve in each athlete becomes important to understand the implications on performance.

Differences in sleep behaviours between academy, semi-professional, and professional Rugby Union athletes

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Introduction: Athletes display differing sleep habits to non-athletic populations; similarly, differences occur in sleep habits between athletes from different sports. Currently there is limited research investigating the differences in sleep habits and behaviours between different levels of competition within collision sports. **Methods:** A total of 224 rugby union athletes (109 academy, 38 semi-professionals, 84 professional) completed the Athlete Sleep Behaviour Questionnaire (ASBQ) and the Pittsburgh Sleep Quality Index (PSQI). **Results:** Professional athletes displayed a significantly longer self-reported sleep duration compared to semi-professional and academy athletes (7 h 52 min ± 51 min vs. 7 h 16 min ± 1 h 15 min vs. 7 h 19 min ± 1 h 12 min, $p < 0.01$). Analysis of PSQI global scores revealed a significantly lower ($p = 0.04$, $d = 0.3$) score for professional athletes (5.2 ± 2.5) than academy athletes (6.0 ± 2.7). Individual components of the PSQI revealed significant differences ($p < 0.05$) between groups for sleep duration and daytime dysfunction. No significant differences ($p > 0.05$) were observed between levels of competition for the ASBQ global score; however, significant differences ($p < 0.05$) were observed between competition levels for 6 of the 18 items. **Discussion:** This study was the first to investigate sleep behaviours across multiple levels of competition in rugby union athletes. Professional athletes displayed longer sleep duration compared to semi-professional and academy athletes. Semi-professional athletes displayed greater thought or worry about sporting performance whilst in bed. Finally, the use of electronic devices in the hour leading to bed appeared to affect sleep amongst academy level athletes. **Take home message:** The results highlighted that differences exist between levels of competition for specific sleep behaviours amongst rugby union athletes. Additionally, this study identified areas of sleep education to improve sleep for all levels of rugby union athletes.

Incorporating blood flow restriction into post-surgery rehabilitation for ACLR: A case study

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Introduction: Anterior cruciate ligament (ACL) injuries are a common and severe knee injury associated with sport participation and can involve arthroscopic surgery. Clinical tests to assess the neuromuscular function of the affected limb compared to the non-affected limb expressed by limb symmetry indices, typically inform for Return-to-Sport (RTS) decisions. Passive blood flow restriction has previously been shown to attenuate muscle atrophy following ACL reconstruction, but information regarding a return of function is lacking. **Method:** A 31-year-old, professional footballer diagnosed with ACL tear grade 3 was enrolled into a 6-week post-surgical program that incorporated 5 sets of 5-min restriction with 3 minutes of reperfusion. Isometric leg press (kg) and Y-balance composite score LSI were assessed pre- 6-, 12-, and 24-weeks post-surgery; whereas, single-leg timed hop, and single leg drop jump (DJ) were assessed at 12- and 24-weeks. **Results:** Leg strength LSI progressed from 54.0% pre-surgery to 97% and 100% at weeks 12 and 24 post-surgery. Y-balance symmetry progressed from 77% pre-surgery to 93% at week 6. Hop-test symmetry was 90% and 100% at weeks 12 and 24. While contact time symmetry in the DJ was attained within 6 weeks, DJ height was only 70% and 86% at weeks 12 and 24. **Discussion:** Recommendations typically require symmetries > 85% for strength and hop tests to clear an athlete for RTS. These tests enable to athlete to demonstrate a combination of strength, neuromuscular control, and ability to tolerate sport-specific loads. Subject to the limitations of a case study, here we show that > 85% symmetry in strength, balance, hopping, and DJ function can be attained, although DJ performance appears to follow a longer time course. **Take home message:** This study provides some evidence regarding the efficacy of implementing BFR during post-surgical rehabilitation on how it potentially allows the reach of RTS in a timelier manner.

Examining head impact risk in backward falls: Do head kinematics and control mechanisms differ in trained and untrained fallers? – Protocol Development

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Introduction: Backwards falls have been shown to be a common falling mechanism that can lead to head impacts in snow sports. These falls often occur in an unpredictable manner. It has been suggested that neck strength and continued exposure to falls may result in a reduced risk of a head impact. So far, there have been very few studies that have looked at backwards falls in humans and even fewer that have looked at this in an ecologically valid context. Therefore, the purpose of this study is to develop a protocol that is both ecologically valid and ethical using humans as the participants. **Methods:** Twelve healthy male (n = 6) and female (n = 6) people over the age of 18 participated in the study. Height and mass of all participants were measured, from which BMI was calculated. Falls were initiated using a rope and pulley system. Each participant then completed 3 falls at 3 different mat velocities which were named 2, 4, and 6 (2 being the slowest). Velocity of the mat and Time delay (which was as self-defined variable) were the variables of interest. The falls were videoed using high-speed video, capturing at 500 frames per second. A mixed model approach was used to look at the effects of the variables of interest. **Results:** A significant difference in the time delay was found for males, between speed 2 to 4 ($p < 0.001$) and speed 2 to 6 ($p < 0.001$). There was no significant difference between speed 4 to 6, whereas, no significant differences in time delay were observed for any speeds in the female data. BMI was shown to have a significant effect on the time delay ($p = 0.010$). **Discussion:** Speeds 4 and 6 are both viable mat speeds for males and females. However, only females could use speed 2 to simulate a backwards fall. Future studies should consider BMI's effect on the time delay to create a protocol that can simulate an ecologically valid fall for each individual. **Take Home Message:** All speeds are viable options for males and females apart from speed 2 which is only an option for females. BMI has an effect on the time delay during a backwards fall perturbation and should therefore be considered when designing a speed protocol.

Differences in Competitive State Anxiety Inventory between training and competition in equestrian athletes

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Introduction: Excessive anxiety may worsen sporting performance. This is uniquely important in equestrian sport where the rider and horse are both athletes, with the rider also acting as a live coach to the ridden horse. Anxiety is also multifactorial, and may comprise cognitive and somatic components. Therefore, this research primarily aimed to assess whether cognitive and somatic anxiety and self-confidence differed between training and competition in equestrians. A secondary aim was to assess whether this correlated with riding experience. **Method:** The Cognitive State Anxiety Index-2 was administered electronically to 20 New Zealand equestrians and completed using an online platform (Qualtrics). Participants were asked to complete the questionnaire prior to training and competition, or if they were out-of-season, to reflect on a past competitive experience. Data were analysed via the Wilcoxon signed rank test and accompanying matched rank biserial correlation. Spearman's rho correlation coefficients were calculated for the change scores between competitive and training values and riding experience (years). **Results:** Wilcoxon signed rank tests revealed that cognitive ($p = 0.002$; ES = -0.80) and somatic anxiety ($p = 0.008$; ES = -0.73) were significantly lower in training and self-confidence ($p = 0.007$; ES = 0.68) was significantly higher. Correlations were trivial to small (r = -0.007 to -0.340) and were all non-significant. **Discussion:** Findings are in agreement with previous literature, demonstrating that anxiety components differ between training and competition significantly. However, the difference between CSAI-2 scores does not significantly correlate with riding experience. This research forms a basis to investigate competitive state anxiety alongside equine physiological or behavioural responses associated with anxiety in a similar cohort of athletes. **Take home message:** Anxiety significantly differs between training and competition but is not correlated with experience in equestrians.

Relationship between EMG activity during training and throwing for javelin

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Introduction: Developing event-specific strength is necessary for optimising throwing performance. Currently, the movement patterns and transferability of pullover exercise to javelin throw performance is unknown. This study aimed to assess the electromyography signals during pullover variants and examine the relationships between maximum strength and release velocity and throwing performance. **Method:** Seven national-level javelin throwers performed six lifts, with a load of 85% of their one-repetition maximum of barbell pullover variants: conventional (CONV), straight-arm (STR), bent-arm (BENT), and conventional on an exercise ball (BALL), and three repetitions of javelin throw (JAV), while EMG activity was recorded from nine muscles: upper-trapezius; anterior, middle, and posterior-deltoid; triceps brachii; clavicular and sternal portions of pectoralis major; latissimus dorsi; and rectus abdominus. **Results:** BENT variant most closely approximated the peak muscle activation during JAV, especially for posterior deltoid, clavicular, and latissimus dorsi ($p > 0.05$, < 10% to JAV). Significant correlations were found for CONV, STR, BENT, and half-squat absolute strength with release velocity (r = 0.77 to 0.80), and between BENT relative strength and throwing performance (r = 0.85). **Discussion:** The levels of muscle activation varied among pullover variants, and BENT produced a muscle activation

relationship to the javelin throw for most muscles under examination. An overhand exercise like javelin throwing is a complex action involving the whole body that is performed in a synchronised manner to generate a high release velocity and attain a greater throwing distance. Overall, the clear outcome of the present study is that the correlations between both absolute and relative strength with the release velocity and throwing performance. These findings have implications for coaches and professionals, and training to improve overhand throwing. **Take home message:** The bent-arm barbell pullover demonstrated the greatest muscle activation similarity to the javelin thrown and this can inform practitioners looking to maximise training transference to performance.

Using machine learning to measure performance with Cycling New Zealand

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Introduction: The performance of athletes across all sports have improved as technology has drastically improved. The use of data analytics has now become essential in any high performing sport, as seen by the success of New Zealand cyclists in the Commonwealth Games 2022. Cycling New Zealand have recorded large amounts of data for their cyclists and want to continue to improve on their data analysis methods by utilising machine learning. This project implements machine learning algorithms to measure the performance of cyclists in order to understand what causes high performance. **Method:** This project uses the XGBoost algorithm based on past analysis of cricket match outcomes. The algorithm allows for regression analysis and also creates a ranking of how important each variable in the dataset is. This helps with determining what features contribute to performance. This algorithm will be used on various races and training data in order to narrow down a specific area of importance to help Cycling New Zealand. **Results:** The most important results show that for cyclists, training at power zones 1 and 2 or low intensity, is more important than training at power zones 5 and 6, or high intensity. However, the amount of minutes spent at each power zone vary for different cyclists. **Discussion:** Initial findings suggested that low intensity training was important to performance, however, the varying minutes spent at low intensity training suggests that training regimes are different for all cyclists. **Take home message:** The project has now evolved into looking into the different training regimes of cyclists using time series graphs. The results show that training regime vary due to external factors such as mentality and a cyclist's physical attributes, but these regimes can hopefully be modelled.

Te Kukunetanga: developing cycle of life research

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Introduction: Women undergo multifaceted changes in their health and wellbeing throughout the period of pregnancy and in the six months after birth. By monitoring the holistic changes in physical, nutritional, and mental wellbeing of pregnant wahine during this time, we are able to take a first step in developing practices to promote healthy adaptation through movement, food consumption, and physical activity, among others. Te Kukunetanga aims to improve the pregnancy journey and outcomes for wahine and their whanau through the development of evidence-informed guidelines for translation to practice. **Methods:** The multi-disciplinary team including biomechanists, midwives, nurses, clinical psychologists, and mātauranga Māori academics, have developed eight projects investigating aspects of health during pregnancy including physical changes, movement changes (balance, walking and running), maternal wellbeing, nutrition, and physical activity guidelines for NZ. Auckland-based wahine who are pregnant or trying to conceive have been recruited to the studies. **Results:** Close collaboration and engagement of a multidisciplinary team has led to the successful establishment of procedures, ethical considerations, and initial data collection for each of the projects. Data collection will continue until November 2023 to allow comprehensive longitudinal data sets to be obtained to inform the Te Kukunetanga research. **Discussion:** The projects act as a foundation that many other projects will stem from, presenting an opportunity for notable impact for women's health during pregnancy. Amalgamation of research findings are anticipated to have direct influence on pregnancy health guidelines to support wahine across New Zealand. **Take home message:** Te Kukunetanga is an ambitious research programme which has brought together health-centred researchers and encompasses eight projects to date. The common aim of the projects is to ultimately improve the pregnancy journey and outcomes for wahine.