



TANENBAUM INSTITUTE FOR SCIENCE IN SPORT

CONFERENCE 2025



ABSTRACT BOOK

September
26 & 27, 2025

Goldring Centre for High
Performance Sport, Toronto

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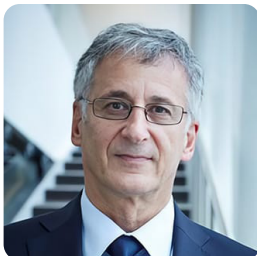
WELCOME

Welcome to the 2025 Tanenbaum Institute for Science in Sport (TISS) Research Conference. On behalf of TISS and its conference planning committee, welcome to this landmark conference entirely devoted to presenting and mobilizing the latest research to ultimately support the performance, wellness, and safety of high-performance athletes.

We are very fortunate that this year's cadre of such well respected researchers and practitioners accepted our invitation and travelled from afar to share their expertise with us in this third year of our operations. And all of this is possible because of the generous benefaction of the Larry and Judy Tanenbaum Family Foundation that established the TISS.

It is incredibly exciting to come together for two intense days of experts sharing their accumulated knowledge across a broad spectrum of sport science, medicine, and analytics disciplines. Speakers whose research has been instrumental in supporting the physical and mental needs of high-performance athletes who train and compete at the highest levels of competition. This conference provides a rare opportunity to share knowledge that is very current, very timely, and all focused on the high performance athlete, including those recreational athletes who aspire to achieve their own personal vision of "high performance".

We hope that over the next two days you enjoy, learn, and network with the high-performance sports research and athlete communities. Thank you for being part of this conference and furthering the TISS mission of "translating discoveries into innovations that positively impact athlete health and performance across all athlete populations."



Best wishes,

Ira Jacobs DrMedSc FCAHS FNAK FACSM
Director, Tanenbaum Institute for Science in Sport
Professor, Faculty of Kinesiology & Physical Education, University of Toronto

CONFERENCE DAY 1: SEPTEMBER 26, 2025

The Latest Research in Sport Science and Sport Medicine

TIME	SESSION
0900	Registration & Continental Breakfast
0930	Day 1 Welcome and Opening Remarks <i>Larry Tanenbaum, Adam van Koeverden, Gretchen Kerr, Ira Jacobs</i>
1000	Sex Differences in Athletic Performance and the Transgender Athlete Session Chair: <i>Gretchen Kerr</i> Presenter: <i>Sandra Hunter</i>
1100	Transition Break
1105	Navigating the Efficacy and Safe Use of Medically Prescribed Performance Enhancing Drugs in the Care of Athletes Session Chair: <i>David Lawrence</i> Navigating the Efficacy and Safe Use of Medically Prescribed Performance Enhancing Drugs in the Care of Athletes Presenter: <i>David Wasserstein</i> Therapeutic Use Exemptions and Medically Prescribed Drugs in the Care of Athletes Presenter: <i>Kathryn Ackerman</i>
1205	Paralympic Sports Science Challenges in Sports and Exercise Sciences Session Chair: <i>Andy Van Neutegem</i> Emerging Research Priorities in Canadian Paralympic Sport Presenter: <i>Andy Van Neutegem</i> Advancing Wheelchair Performance: Integrating Ergonomics, Thermoregulation, and Wearable Technology in Paralympic Sports Presenter: <i>Vicky Goosey-Tolfrey</i>
1305	Morning Closing Remarks <i>Ira Jacobs</i>
1315	Lunch (provided) & Poster Viewing
1415	The Enhanced Games: Platform for Disrupting Human Performance Limitations, Sport Medicine and Sport Science Session Chair: <i>Ira Jacobs</i> Presenter: <i>Aron d'Souza</i>
1515	Transition Break

AGENDA

TIME	SESSION
1520	High Impact Sport Medicine and Sport Science Research Advances and Challenges for the Female High Performance Athlete Session Chair: <i>Kathryn Johnston</i> Presenters: <i>Kathryn Ackerman, Catherine Sabiston</i>
1620	Day 1 Closing Remarks <i>Ira Jacobs</i>
1630	Networking Reception & Poster Viewing
1730	Day 1 Adjourns

CONFERENCE DAY 2: SEPTEMBER 27, 2025

Knowledge Application for the High Performance Sport and Athlete Community

TIME	SESSION
0900	Registration & Continental Breakfast
0945	Day 2 Welcome and Opening Remarks <i>Larry Tanenbaum, Gretchen Kerr, Ira Jacobs</i>
1000	Climate Change and Sports: Athlete Health and Performance; Understanding and Mitigating the Risks Session Chair: <i>Timothy Welsh</i> Presenters: <i>Michael Koehle, Madeleine Orr</i>
1100	Transition Break
1105	Looking Towards the FIFA World Cup 2026: Return-to-Play Risks and Tolerances Considerations Session Chair: <i>Daniel Whelan</i> The Return to Sport Process; Concepts and Considerations Presenter: <i>Margot Putukian</i> Intrinsic and Extrinsic Factors Affecting Return-to-Play Presenter: <i>Alex McKechnie</i>
1205	Performance Technology for Sport Analytics and Talent Identification: 2026 and Beyond? Session Chair: <i>Joe Baker</i> Presenters: <i>Nicolas Evans, Jen Herst, David Nutt</i>
1305	Morning Closing Remarks <i>Ira Jacobs</i>
1315	Lunch (provided) & Poster Viewing
1415	Relative Energy Deficiency in Sport (REDs): Much More Than the Athlete Triad Session Chair: <i>Daniel Moore</i> The REDs Clinical Assessment Tool (CAT2) – Improving Diagnostic Accuracy Presenter: <i>Trent Stellingwerff</i> The REDs Physiological Model – New Ideas to Manage Complexity Presenter: <i>Louise Burke</i>
1515	Transition Break

AGENDA

TIME	SESSION
1520	Optimizing Mental Health Interventions in High Performance Sport Session Chair: <i>Erica Gavel-Pinos</i> Presenters: <i>Carla Edwards, Erin Ambrose</i>
1620	Day 2 Closing Remarks <i>Ira Jacobs</i>
1630	Networking Reception & Poster Viewing
1730	Conference Adjourns

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T01

Electroarthrography to Non-invasively Assess Cartilage Health During Rehabilitation from Anterior Cruciate Ligament Injury

Adele Changoor, Lunenfeld Tanenbaum Research Institute

Timothy Burkhart, University of Toronto

Andy Kin On Wong, Toronto General Hospital

John Theodoropoulos, Sinai Health System

Research Area: Rehabilitation, ACL injury

Research Question: This study investigates the ability of the non-invasive and quantitative electroarthrography (EAG) method to track cartilage changes in individuals recovering from injury to the anterior cruciate ligament (ACL).

Background Rationale: Electroarthrography (EAG) is a non-invasive method for measuring cartilage streaming potentials, which are electrical signals produced by cartilage during loading. Streaming potentials result from the specialized composition and structure of cartilage and are correlated to cartilage load bearing properties. EAG is analogous to the measurement of other bio-potentials, such as electrocardiography, as contact electrodes are placed on skin around the knee and streaming potentials acquired when body weight is shifted to compress the joint. This study aims to assess the sensitivity of EAG to cartilage changes in the knees of participants who have experienced acute injury to the anterior cruciate ligament (ACL) and are participating in a rehabilitation program.

Proposed Approach: Participants will be asked to come to the Biomechanics of Orthopaedic Sports Medicine Laboratory, where they will perform four movements to load their knee joints while EAG and biomechanical measurements are collected simultaneously. A total of 60 participants will be recruited, 30 who have experienced a mid-substance tear to the ACL within the past six months due to sports participation and are scheduled to undergo surgical reconstruction, and 30 age-matched controls. Participants will have EAG & biomechanical parameters assessed one month after ACL reconstruction surgery, every three months thereafter while participating in a rehabilitation program until they are cleared to return to sport (RTS), and two months post-RTS. Control participants will undergo 5 data collection sessions spaced approximately three months apart. ACL-reconstructed participants will undergo two magnetic resonant imaging (MRI) sessions, once approximately 1 month post-operatively and once when cleared to RTS. All participants will complete questionnaires including those that self-report pain, activity and quality of life.

Potential Impact: We hypothesize that EAG will contribute new, quantitative information about cartilage health over the course of the rehabilitation process and after return-to-sport (RTS). We predict that EAG will correlate with MRI cartilage measures and offer advantages over MRI including efficiency, lower cost and accessibility, as it can be performed frequently at the point-of-care without specialized facilities. Similarly, EAG is hypothesized to assess joint loading symmetry without the need for a biomechanics laboratory. EAG is expected to add new quantitative data to the rehabilitation program after ACL reconstruction that may enhance RTS decision making.

T02

A Multi-Variate, Multi-Systems Approach to Post-ACLR Return-to-Play

Timothy Burkhart, University of Toronto

Daniel Whelan, Womens College Hospital

Jas Chahal, Womens College Hospital

Michael Catapano, Mount Sinai

Tim Dwyer, Womens College Hospital

John Theodoropoulos, Mount Sinai

Research Area: Orthopaedic Sport Medicine

Research Question: The overall goal of this research is to develop a technology-based return to-play-assessment tool that places a focus on lower extremity motion quality assessment and the integration of the biomechanical, biological, and psychological factors

Background Rationale: Although ACL reconstruction (ACLR) is a highly developed and researched procedure, 3% - 30% of persons experience re-injury following return-to-play (RTP). Injuries to the ACL primarily occur in young active individuals and can be devastating as the relatively high complication rates have long-term effects on patient quality of life (QoL). There are a number of limitations inherent in current RTP assessments that may be contributing to their inability to identify those individuals who are ready to safely RTP.

Proposed Approach: Patients who have had an ACLR will be recruited and will perform the following tasks in the Biomechanics of orthopaedic sport medicine lab while forces and motions are measured

single-leg vertical jump – patients will start from a stationary position balancing on one leg. They will be instructed to jump as high as possible before landing on the force plate on the same foot. A vertec jump tester will be used to measure the total height of the jump.

single-leg horizontal jump – patients will start by standing on one leg and will jump as far as possible, landing on the same leg. Total horizontal distance will be measured.

single-leg triple jump – patients will begin by standing on one leg, and will perform three consecutive hops as far as possible along a straight line and landing on the same leg. Total horizontal distance will be measured.

stop jump – participants will be instructed to run 5m towards the force plates, decelerate, perform a two-foot jump onto the force plates, and immediately perform a maximal countermovement vertical jump.

cutting – participants will be instructed to run 5m towards the force plates, decelerate, and perform a 90° cutting maneuver off of the force plate.

Machine learning, with its ability to learn patterns from multi-dimensional data, and be applied to future data sets, is ideally suited for this application. To identify the variables that will allow clinicians to categorize an athlete's readiness to RTP we will employ statistical machine-learning algorithms, namely a stepwise logistic regression model and then an artificial neural network

Potential Impact: Using advanced data analytic techniques we aim to identify the multivariate predictors of graft and contralateral limb injury after RTP and package the appropriate assessment and decision-making tools into a clinically relevant and accessible technology platform. Shifting the paradigm from a performance-based assessment to a systems approach that integrates movement quality, biomechanical, biological, and psychological factors will improve return-to-play decision making and reduce the risk of secondary injury. The results of this research will identify more efficient pathways through the rehabilitation process, accelerating an athlete's recovery from injury in a safe and effective manner. Better treatment outcomes, improved patient satisfaction and quality of life in the form of improved physical and mental health will ultimately lead to enhanced sport and activity performance.

T03

Investigating the Effects of Menstrual Cycle Phase and Oral Contraceptive Use on Muscle and Whole-Body Protein Metabolism Post-Resistance Exercise in Active Females

Ines Kortebi, University of Toronto

Nicki Pourhashemi, University of Toronto

Daniel Moore, University of Toronto

Research Area: Protein Metabolism, Exercise, Menstrual Cycle, Oral Contraceptives.

Research Question: To examine how menstrual phases (early follicular vs. mid-luteal) and oral contraceptive (OC) phases (active vs. placebo) influence post-exercise muscle protein synthesis (MPS) and whole-body protein synthesis (WBPS) in resistance-trained females using concurrent non-invasive IAAO methodology and muscle biopsies.

Background Rationale: Fluctuating hormone levels across the menstrual cycle and with OC use have received relatively little attention in muscle physiology and sports nutrition fields. This study will investigate whether menstrual phase and OC status affect post-exercise MPS and WBPS in trained females using a modified indicator amino acid oxidation (IAAO) technique that may further provide insight into relative protein recommendations for this under-researched population.

Proposed Approach: Recreationally active females (10 OC users and 10 non-OC users) will complete two 9.5-hour IAAO metabolic trials during the active pill (AP) and placebo (PLA) phases for OC users, and in the early follicular (EF) and mid-luteal (ML) phases for non-OC users. Following a full-body resistance training protocol, frequent meals containing both [D5]phenylalanine and [13C]phenylalanine to determine concurrent rates of MPS and WBPS, respectively, via the IAAO. The daily protein intake will be clamped at 1.2g/kg/d, which we have determined to be suboptimal to maximize WBPS in order to determine the relative efficiency of protein utilizations.

Potential Impact: This study will be the first to assess post-exercise MPS and WBPS concurrently across endogenous and synthetic hormonal profiles in trained females. Findings will help clarify how sex hormones influence protein metabolism and inform the design of inclusive training and nutrition strategies for female athletes.

T04

Effect of Ischemic Preconditioning on 2-km Rowing Ergometer Performance in Males and Females

Vanessa Lin, University of Toronto

Ira Jacobs, University of Toronto

Liam O'Brien, University of Toronto

Research Area: Exercise Physiology

Research Question: Does Ischemic preconditioning improve 2-km time-trial performance in trained male and female rowers?

Background Rationale: Ischemic preconditioning (IPC) is a non-invasive physiological intervention that involves brief repeated cycles of limb blood flow occlusion and reperfusion prior to exercise. It has been reported that IPC may be effective in enhancing exercise performance due to enhanced ischemic tolerance as well as the ability to stimulate vasoactive responses that promote increased blood volume and deoxygenation kinetics in the active muscles during exercise. Literature suggests that IPC may not be effective in females, but no sufficiently powered investigations have yet to be reported. With burgeoning popularity of IPC amongst high performance athletes it is increasingly important for there to be evidence to support the application of IPC, especially if there are potential negative performance outcomes for female athletes.

Thus, the proposed study is designed to test the following hypotheses:

1. That IPC will improve 2-km rowing ergometer performance and that performance will improve by a greater magnitude in males compared to females.
2. This proposed study has also been designed to test the hypothesis that the differing performance outcomes in males and females following IPC will also be accompanied by differences in physiological responses in males and females following IPC

Proposed Approach: METHODS: 40 Trained rowers (n = 20 male; n = 20 female) will be recruited to complete a 2-km rowing ergometer time-trial (TT) for 3 different experimental conditions. The TT will be preceded by local (leg) IPC (4 × 5 min intervals at individual limb occlusion pressure), placebo (PLA; electrical muscle stimulation), or control (CON; no compression) interventions. TT performance, heartrate, oxygen uptake, ratings of perceived exertion, local tissue oxygenation of the vastus lateralis, and hemodynamic parameters will be monitored during exercise. Blood lactate kinetics will also be monitored during the post-exercise period.

Potential Impact: IPC is not a banned procedure by sport governing bodies and is, anecdotally, becoming popular for training and just before competition. Therefore, investigation into the potential sex-differences that may exist in the ergogenic response to IPC is necessary to better inform appropriate recommendations for IPC application. Investigating the efficacy of IPC for both males and females will help facilitate enhanced and sustained competitive performance for athletes.

Additionally, IPC has the potential to become an innovative product for high performance sport because it is a non-invasive sport permitted technique that can be used prior to competition. The proposed research will examine the ergogenic effects of IPC on 2-km rowing performance. For a sport like rowing, IPC could feasibly be implemented on competition days since athletes are often at the competition site for the entire day and spend a significant amount of time sitting and waiting for their event.

T05

Eyes on the Prize: A Scoping Review of Coaches' Gaze Behavior

Garrett Blakey, Ontario Tech University

Nick Wattie, Ontario Tech University

Kathryn Johnston, University of Toronto

Joe Baker, University of Toronto

Introduction: Coaches and decision-makers are often tasked with evaluating and selecting athletes to teams and development pathways. However, research shows that the accuracy of these decisions is relatively low, and we need a better understanding of how coaches use information to make selection decision (Koz et al., 2012; Johnston et al., 2017). This review explores current literature on how coaches and decision-makers observe athletes for selection and what behaviors may differ between expert and novice coaches.

Methods: A scoping review of three databases (Web of Science, Sportdiscus, and Psych Info (Ovid)) from 2000 to 2025 was performed. For inclusion, studies had to contain details related to the methodology and analytical use of gaze behavior of coaches' observing players (not strictly for athlete identification or selection). The initial search returned 7013 articles after removing duplicates. The research team completed the abstract screening phase, removing 6915 articles that did not meet our inclusion criteria. The research team then reviewed the full text articles of the remaining 98 articles; 13 articles remained for final review.

Results: Many studies (92.3 %) focused on visual search strategies of coaches, decision making, and fixation behavior. Most examined expert vs. novice coaches (76.9%), perceptual cognitive processes, and gaze patterns of athlete evaluation and selection. The most common sports were soccer, futsal, and tennis (each at 15.4%). Our review revealed that experts in sport typically spend longer durations fixating on key areas of interest than novice coaches. They also use fewer fixations than novice and amateur coaches.

Discussion/Conclusion: The findings of our review indicate that expert coaches exhibit distinct visual behaviors when observing athletes. It also indicates that eye tracking is a valid tool understanding athlete observation processes. Based on the findings of our review, more work is needed to understand coaches' gaze behavior during the athlete evaluation and selection processes, specifically in basketball.

Supporting Information:

Sport	Number of Studies	Percentage of Total (%)
Soccer	2	15.4%
Futsal	2	15.4%
Tennis	2	15.4%
Basketball	1	7.7%
Volleyball	1	7.7%
Judo	1	7.7%
Climbing	1	7.7%
Swimming	1	7.7%
Gymnastics	1	7.7%
Track and Field	1	7.7%

T06

Can Elite Athletes Integrate Emergent Information to Improve Performance?

Molly Brillinger, University of Toronto

Joe Baker, University of Toronto

Kathryn Johnston, University of Toronto

Tim Welsh, University of Toronto

Nick Wattie, Ontario Tech University

Research Area: Sport Analytics, Elite Performance

Research Question: What is the best way to deliver statistical information to athletes prior to performance?

Background Rationale: The availability and use of advanced analytics to inform high-performance sport decisions is increasing at an impressive rate, to the extent that athletes have access to performance-related information in larger quantities, spanning more areas, with greater precision, and at faster rates than ever before. However, little is known about whether emergent information (i.e., information that is accessible up to the moment of performance) can be integrated by performers to improve their performance. Further, it is likely that too much information or information provided in the wrong way might actually be detrimental to performance.

Proposed Approach: We are using a two-phased approach. Phase 1 explores the information elite athletes' have access to in performance contexts; and their stated preferences for information they could use before a performance task. This work involves creating an online survey to capture players' self-reported information regarding the type of information they currently receive in their performance

contexts and how this relates to their preferences for information (Study 1a). To capture the full spectrum of information available (e.g., information players may not be aware of), a second survey gathers the types of information provided by analytics personnel working with the players, and their perceived value of these sources of information (Study 1b). In Phase 2, uses a series of experiments to examine how information about a pitcher's in game tendencies affects batting performance. In Study 2a, we will examine the impact of providing information to athletes immediately prior to the batting performance. Using the type and amount of information identified in Phase 1, we will design specific scenarios that mimic real situations in professional baseball. Participants will serve as their own controls and we will examine performance in situations where they are provided different types of information versus no information to determine how access to information affects batting performance. Based on previous work, we hypothesize that providing information will interfere with batting performance, although this hypothesis is exploratory given the general nature of how information will be provided in this experiment. In Study 2b, we examine the impact of timing of information provision on batting performance. In Study 2a, we provided information immediately prior to performance; however, previous research on expert perception and cognition indicates that the value of information changes over time in expert samples (e.g., Causer et al., 2017; Farrow et al., 2005), particularly in situations like baseball where hitters will use advanced information from the kinematics of the pitcher to anticipate the type of pitch they are about the throw. In Study 2b, we will examine the influence of information delay on hitting performance in elite players. More specifically, players will undergo batting scenarios under three conditions: Delayed Information (e.g., 5 minutes before batting such as when they are 3 positions down in the batting order), Before Performance (i.e., immediately before taking practice swings in the 'on deck' circle) and Control (no info provided). Based on previous work on anticipation and perceptual timing, we hypothesize that earlier presented information (i.e., the delayed condition) will be beneficial while the other conditions will lead to decreases in performance.

Potential Impact: This project links two fields of research (sport analytics and cognitive psychology) to explore how types, amount and timing of information affects athlete decision-making at the highest levels of performance. We begin our explorations in this area in baseball but these results will have implications for other fields of elite sport.

T07

R2Play-Rehab: Co-Designing a Multidomain and Integrative Sport Rehabilitation Tool for Youth Athletes With Concussion

Shannon Scratch, Holland Bloorview Kids Rehabilitation Hospital

Elaine Biddiss, Holland Bloorview Kids Rehabilitation Hospital

Josh Shore, Holland Bloorview Kids Rehabilitation Hospital

Sarah Munce, Holland Bloorview Kids Rehabilitation Hospital

Michael Hutchison, University of Toronto

Nick Reed, University of Toronto

Research Area: Sport-related concussion.

Research Question: How can a multidomain simulated-sport assessment tool (R2Play) be used to support integrative active rehabilitation for youth with concussion?

Background Rationale: Evaluating concussion recovery and readiness to return to sport is challenging for clinicians since current tests do not fully capture the complex demands of playing sports. Our team developed a multidomain assessment tool called R2Play which uses technology to help simulate the demands of sport within clinic settings by combining physical, cognitive, sensory, and emotional skills. Although R2Play was originally created as an assessment tool to help determine readiness to return to sport, clinician feedback suggests it could also be useful for guiding personalized rehabilitation therapy. This project therefore aims to adapt R2Play as an active rehabilitation tool (R2Play-Rehab) and develop an accompanying rehabilitation program using R2Play to help youth recover after concussions.

Proposed Approach: To develop R2Play-Rehab, we will follow the Generative Co-Design Framework for Healthcare Innovation, a rigorous co-design process that involves user input throughout the design process. This means we will work closely with practicing clinicians and youth who have experienced concussions to ensure their needs guide the design of R2Play-Rehab. During phase 1 (pre-design), we will plan the co-design process in collaboration with two clinician partners and three youth advisors. In Phase 2 (co-design), ten clinicians will be recruited to participate in the following design activities: (1) introduction meeting to establish shared vision for the work; (2) two-to-four-week field kit reflection period to consider the application of R2Play as a rehabilitation tool within daily clinical practice; and (3) design meeting to review and build upon field kit data. Finally, phase 3 (post-design) will involve qualitative analysis of phase 2 activities and translation of study findings into a set of design requirements to guide development of the R2Play-Rehab tool and intervention protocol.

Potential Impact: This work is a critical step to help expand the utility of R2Play by enabling its use earlier in the concussion recovery process to facilitate active rehabilitation and treatment planning. Findings will inform a prototype of the R2Play-Rehab tool and accompanying intervention protocol for future evaluation. We hope that R2Play-Rehab will help youth be physically and mentally ready to return to sport after concussion in order to lower their risk for re-injury and increase confidence in the RtoP process for youth, families, and clinicians.

Supporting Information: More information about the broader R2Play project can be found at <https://linktr.ee/r2play>.

T09

Remember That Feeling? An Investigation of Interoception and Perceptual Memory in the Endurance Trained and De-Trained Athlete

Liam O'Brien, University of Toronto

Ira Jacobs, University of Toronto

Research Area: Exercise Physiology

Research Question: Does endurance exercise training experience confer lasting adaptations to interoceptive capacity and exercise strain perceptions even after de-training?

Background Rationale: Exercise strain perceptions such as the perception of effort, discomfort, etc., substantially limit athletic performance, and it is known that individuals markedly differ in how they perceive these unpleasant sensations during exercise. A key assumption is that inter-individual perceptual differences to an objectively similar stimulus reflect a systematic bias mediated by the central nervous system to augment or reduce the perceived intensity of a given absolute stressor. In this way, ‘augmenters’ perceive an identical sensory stimulus to be more salient than ‘reducers’ which may impart substantial competitive disadvantages to augmenters by hastening fatigue. This research seeks to test the applicability of a contemporary theory that we hypothesize mediates the augment-reducer phenomenon and individual differences in perceived strain. This study is investigating whether individuals differ in interoceptive capacity, i.e., the ability to accurately perceive internal sensory cues measured by heartbeat counting tasks, because of their training history, and whether that history (rather than just the absolute magnitude of the relative physiological stress) influences the perception of strain during exercise. The research explores whether previous training history influences the magnitude of sensory ‘prediction-error’, i.e., the difference between expected relative to actual sensory outcomes, during physical exercise. This theory is informed by decades of neuroscientific inquiry into the brain’s predictively regulation of the body along a desired physiological trajectory. We theorize that frequent exposure to endurance exercise refines the brain’s ‘internal model’, improving the accuracy of sensory ‘predictions’, and reducing prediction-error, which leads to reduced perceptions of strain during exercise. Thus, we postulate that habitual training imparts lasting sensory memory that renders individuals more psychologically resilient to the distressing sensations of exercise, even upon physically de-conditioning.

We hypothesize:

1. Endurance-trained (trained) and previously endurance-trained (de-trained) athletes display superior interoceptive capacities to sedentary, never trained (untrained) individuals. Interoceptive capacity will be associated with lower prediction-error and perceived strain during exercise;
2. Trained and de-trained athletes display smaller prediction-errors compared to untrained individuals, and;
3. Trained and de-trained athletes similarly perceive the same relative physiological strain (i.e., % $\dot{V}O_2\text{max}$) as lower than untrained individuals.

Proposed Approach: Thirty volunteers are being recruited with the view of having three groups of 10 participants: ‘trained’ or ‘highly trained’ endurance athletes (trained), previously ‘trained’ or ‘highly trained’ endurance athletes that have been sedentary for at least 1 year (de-trained), and habitually sedentary individuals (sedentary). The protocol involves three visits. During Visit 1, indices of cardiac interoception will be measured via validated heartbeat counting tasks. Interoceptive accuracy, awareness, insight, sensibility, and trait interoceptive prediction error are computed from this test. Participants also complete an incremental cycling ergometer test to exhaustion for measurement of aerobic fitness ($\dot{V}O_2\text{max}$). Participants also complete a brief submaximal cycling protocol to become familiarized with the strain perception scales (effort, respiratory effort, discomfort, limb discomfort, thermal discomfort, and breathlessness). On Visit 2, participants cycle for three 5 min intervals at self-selected intensities corresponding to 3 (i.e., moderate), 5 (i.e., heavy/hard), and 7 (i.e., very heavy/very hard) on the 10 point rating of perceived exertion (RPE) scale. The magnitude of change between the

pace during the first 1 min (sensory prediction) versus the pace during the final 1 min (sensory feedback) of each interval serve as a proxy of ‘prediction-error’ during the exercise. On Visit 3, participants complete four 5 min submaximal cycling intervals at controlled power outputs eliciting 35%, 50%, 65%, and 80% of their $\dot{V}O_2$ max. At the final 1 min of each interval, perceived effort, respiratory effort, whole body discomfort, limb discomfort, thermal discomfort, and breathlessness are collected using modified Borg 10-point RPE scales. During Visits 2 and 3, ventilation, respiratory exchange ratio, $\dot{V}O_2$, heart rate, arterial oxygen saturation, blood lactate concentrations, core and skin temperatures are measured as indices of physiological strain.

ANOVA techniques will be used to assess group differences in interoception, prediction-error, perceived strain, and physiological strain during exercise. Linear regression techniques will be used to determine the relationships between interoceptive capacity and perceived strain.

Potential Impact: Tolerating the unpleasant sensations of elevated exercise intensities is a crucial trait for maximizing athletic performance. Clarifying the underlying neurophysiological mechanisms that mediate how strain is perceived by the central nervous system is a critical first stage to the subsequent generation of novel strategies that may modulate exercise strain perceptions in a way that can be safely adopted by athletes of all levels to enhance training palatability and optimize performance outcomes. Explicit exploration of the role of interoception and predictive-brain theories in exercise strain perceptions is a relatively novel concept in exercise research. Our research seeks to elucidate the role of these processes on perceived strain and exercise performance. Collectively, the findings from our research hold the potential for novel and high impact knowledge for the field of sport and exercise performance. The findings from this and accompanying studies will be synthesized into scientific manuscripts that will be submitted for publication in open-access peer reviewed sport or exercise science journals and presented at scientific conferences.

T10

It’s About Time! Balancing Memory Contrasts and Micro-Consolidations to Optimize Golf Putt Performance

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Research Area: Motor Control and Learning

Research Question: What is the impact of the duration of the time between trials on memory contrasts and micro-consolidation processes during the acquisition of a sequential motor skills, such as golf putting?

Background Rationale: On one hand, it could be the case that shorter intervals facilitate sensory contrasts and feedback utilization (e.g., Cheng et al., 2008). Indeed, research from our lab has shown that reliance on visual feedback is reduced when the time between trials is as short as possible. On the other hand, it is also possible that longer intervals allow for better analysis of the performance, and thus more learning. From a neurophysiological perspective, the concept of micro-consolidations is currently being debated (i.e., unconscious neurophysiological “replays”), with some evidence of neural activity critical to motor skill acquisition taking place between trials (e.g., Buch et al., 2021).

Proposed Approach: Groups of novice participants are being recruited to practice golf putts on one day and complete 24-hr retention/ transfer tests. On Day 1, all participants perform 5 familiarization trials, putting towards a central target at their own pace. On the same day, groups will also perform 144 putts towards three (3) different targets, with one group practicing with a short inter-trial interval (~5 s) and another group practicing with a longer interval (~10 s). On Day 2, there are retention and transfer tests, wherein participants perform 10 putts with the same interval than on day 1 (i.e., retention), 10 putts with the other interval, and 10 putts without any interval restrictions.

Potential Impact: It is possible that the inter-sensory contrasts afforded by the shorter intervals will be critical to improve performance and learning, which should be reflected in better performance during acquisition, retention, and transfer with the ~5 s intervals. In contrast, it is also possible that the longer intervals will help unconsciously “replay” the putts and optimize performance during acquisition, retention, and transfer with the ~10 s intervals. Overall, this study is shedding light on the optimal inter-trial interval to employ for motor skill acquisition as well as the underlying mechanisms (i.e., memory contrasts vs. neurophysiological “replays”).

T11

Quantifying Movement Similarity for Enhanced Performance and Injury Prevention in Basketball

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Research Area: Sports analytics

Research Question: How can movement similarity analysis of 3D kinematic data quantify inter- and intra-player differences in basketball skills, and how can these insights be applied to enhance performance and prevent injury?

Background Rationale: In basketball, subtle differences in the biomechanics of movement, such as hand positioning during a shot or body alignment during a crossover, can significantly impact performance accuracy (see Chakraborty & Mondal, 2019 for a review) and injury risk (e.g., Taylor et al., 2020a, 2020b). Due to the complexity of human movement, extrapolating quantifiable insights regarding a

player's performance based on high-dimensional spatiotemporal kinematic data can be challenging. Similarity analysis offers a novel solution to this challenge by quantifying the degree of resemblance between movement patterns (Alt & Guibas, 2000; Dodge, 2011). By transforming complex, high-dimensional kinematic data into interpretable metrics, this approach enables the quantitative evaluation of nuanced differences in movement biomechanics and techniques. This evaluation, in turn, can drive player evaluation and development through personalized training and support injury prevention by flagging inconsistencies or biomechanical patterns associated with increased risk.

The goal of the current project is to develop a framework for movement similarity analysis to quantify the likeness of specific motor actions cross-sectionally between players and longitudinally within a player over time. Our team will 1) collect full-body movement data of key basketball skills (e.g., jump shots, layups, dribble, etc.) performed by athletes at different skill levels using a state-of-the-art markerless motion capture system, and 2) develop a data processing pipeline and analytical framework using machine learning techniques and deep learning architectures to quantify movement similarity.

The first objective of this project is to evaluate inter-player movement similarity, assessing how closely different players execute identical motor tasks. By generating a similarity metric based on the spatiotemporal dynamics of various basketball skills, our team can compare players and identify their unique strengths and areas for improvement. These insights will inform individualized coaching strategies, enabling targeted adjustments to enhance performance and mitigate injury risks over time.

The second objective focuses on intra-player improvement over time. This objective involves analyzing how an athlete's movement dynamics evolves overtime. We will quantify changes to a player's movement by leveraging key characteristics such as joint angles, release speed, and movement smoothness. Using this method, we can, for instance, identify inconsistencies in shooting form, evaluate balance during dribbling, and detect compensatory patterns that may produce unnecessary musculoskeletal load and lead to injury. This approach ensures that technical modifications are effective and sustainable, promoting long-term success in player performance and health.

Proposed Approach: Our team will use an existing vision-based motion capture system to record the movements of athletes performing a set of basketball actions, including jump shots, layups, dribbling, and crossovers. For the initial development and testing (the scope of the current project), we will recruit 20 skilled (varsity-level) athletes and 20 untrained (recreational level) athletes (10 women and 10 men in each skill group) to perform these movements in a UofT gym. Participants will be tested twice, a minimum of 2 months apart. Each movement will be segmented into biomechanically meaningful components (e.g., initiation, peak movement, follow-through), allowing for detailed analysis. The data will be used to generate 3D kinematic models of each movement.

Using the 3D kinematic models, our team will develop a data processing pipeline with similarity analysis and machine learning techniques for both inter-player and intra-player comparisons. First, the pipeline will reduce the complexity of the kinematic data using different dimensionality reduction techniques, such as Principal Component Analysis (PCA) and supervised temporal t-stochastic neighbor embedding (t-SNE). We will evaluate the effectiveness of these techniques in preserving essential spatiotemporal characteristics of the movement. Then, using the derived lower-dimensional data, we will quantify spatial differences in movement patterns through similarity analysis, such as dynamic time warping and cosine similarity analysis. These methods quantify movement similarity at a spatial level. Following this step, we will extend our analysis to include temporal similarities using machine learning techniques. For instance, we plan to use a bootstrapped Support Vector Machine (SVM) classifier to analyze movements performed

by different players or the same player at different times. This classifier will allow us to compare decoding accuracy as a function of the normalized time course for various movements. By doing so, we aim to identify specific temporal and spatial locations that begin to differentiate movements between players or variations of the same player's movements.

Using this analysis pipeline, we can perform inter- and intra-player comparisons. For the inter-player comparison, we will analyze the degree of similarity between movements performed by different players to identify both common and unique features. This analysis can identify invariant features between players in their biomechanical movement signatures that would result in a successful action. The intra-player analysis will focus on comparing the same athlete's movements in the 2 sessions, at least 2 months apart. No special intervention will be provided between the two sessions. Similarity metrics will determine how closely the movements align between sessions (Mackowiak et al., 2024).

Potential Impact: The outcomes of this project will have significant implications for performance analytics, injury prevention, and training interventions. The inter-player comparison will allow for more informed player evaluation and development by providing coaches and analysts with quantitative insights into individual movement patterns and behaviors. This process will enable the identification of strengths and weaknesses, facilitate personalized training regimens, and improve strategies for injury prevention by monitoring and addressing risk factors associated with specific movement profiles. The intra-player analysis will provide precise metrics to track progress during skill development or rehabilitation from injury, ensuring that training adjustments lead to biomechanically sound outcomes. Coaches will benefit from the ability to monitor pre- and post-intervention changes, receiving objective data that can guide personalized training plans and minimize injury risks.

By partnering with MLSE's Sport Performance Lab, this project will contribute to the development of an advanced data analytics pipeline that integrates motion capture and movement similarity analysis into in-game and post-game player monitoring systems. These innovations will not only enhance team strategy but also promote player health and performance sustainability. Although this pipeline will initially be developed for basketball, the approach can be modified for many other sports. Thus, the project's broader significance lies in its potential to introduce new technologies and methods for motion analysis that can be applied across sports disciplines, advancing both research and practice. Finally, the outcomes of this project will serve as a basis for pursuing further funding opportunities, such as the NSERC Alliance Grant of CIHR Project Grant, to continue developing the pipeline, expand its real-world applications, and amplify its impact for performance and injury prevention across sports and training contexts.

T12

“Imagine Me and You, and You and Me”: A Partner's Assumed Motor Abilities Influence Our Own Imagined Movements in an Imaginary Joint Action Task

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Research Area: Motor Behaviour

Research Question: Are people aware of how a partner's assumed movement abilities influence their own imagined movements? How much control do people have over their own imagined movements in an imaginary joint action task?

Background Rationale: Imagining joint actions involves simulating both one's own movements and the movements of a partner. Previous research shows that people are able to adjust their imagination of a partner's movements based on the assumed motor abilities of the partner. Interestingly, adjusting imagination of the partner's movements also affects imagination of their own movements. Specifically, when an individual imagines coordinating movements with a high-performing (or low-performing) partner, the imagined movements of both the partner and the individual's own imagined movements are sped-up (or slowed-down). However, it is unclear whether or not individuals are aware of these changes, whether or not they are intentional, and whether or not they can consciously control these movements if explicitly instructed to do so.

Proposed Approach: Across two experiments, participants physically performed and imagined performing a serial disc transfer task alone and with an imagined partner. Physical and imagined movement time were measured to assess participants' imagination of their own movements and their partner's movements. Across different conditions, participants were told to imagine partners of varying abilities (high vs low). In Experiment 1, a post-experiment questionnaire assessed participants awareness of, and intention behind, any potential in their own movement speed when paired with the different imaginary partners. In Experiment 2, participants were explicitly instructed to keep their own imagined movement speed consistent, regardless of the partner's ability, in order to assess how well they can control their own imagined movements.

Potential Impact: This research contributes to a deeper understanding of how social factors influence motor imagery of joint action by showing that people have difficulty dissociating the imagination of their own movements from those of their partner in a joint task. The findings have important implications for sport contexts where athletes mentally rehearse coordinated movements or team-based strategies, because they highlight that the imagined performance of teammates may unintentionally shape one's own simulation. Recognizing this social influence is important for designing effective motor imagery interventions in sport.

T13

Assessing the Prognostic Ability of the Multimodal Exertional Test for Sport-Related Concussion

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Research Area: Sport-Related Concussion

Research Question: For athletes with concussion assessed at 1-week post-injury on the multimodal exertional test (MET), could performance on the MET predict length of recovery and how does it compare to symptom severity scores in prognostic utility?

Background Rationale: The uncertainty in the length of recovery following concussion still remains a great challenge for both clinicians and patients. We developed a widely accessible, multimodal exertional test (MET), which has been shown to be potentially useful for concussion, and are assessing its prognostic ability.

Proposed Approach: Methods: Interuniversity athletes (n = 41 [female = 29, male = 12]) completed a four-stage, twelve-task MET within 10 days of concussion (median = 7, IQR = 6 – 7). Week 1 performance in terms of pass or fail on the MET was obtained (i.e., pass: completed all 12 tasks of the MET, or failure can occur in 3 situations: 1) >10 symptom difference from initial symptom score, 2) athlete stops the MET, or 3) examiner stops the MET due to visible signs). Additionally, symptom severity scores, which was treated as a ordinal variable with three categories (low [<9], medium [>9 and <29], and high [>29] symptom severity scores) was obtained. Length of recovery was calculated as days between concussion date and clinical medical clearance date. Negative binomial survival analyses were performed using the Hamiltonian Monte Carlo Engine Stan via R. Results: In the first prognosis model using week 1 MET pass and fail, the modelled recovery time was an estimated 30.8 days (90% Credible Interval [CrI] = 20.4 – 41.5 days) for athletes who passed the MET at week 1, compared to 51.4 days (90% CrI = 39.9 – 62.6 days) for those who failed. The estimated mean difference in recovery times between groups was 20.6 days (90% CrI = 4.9 – 36.8 days) with a 97.7% posterior probability that recovery was longer in the MET fail group. Posterior cumulative recovery curves revealed no differences in predictive performance between the prognosis model with MET performance and the prognosis model with symptom severity scores.

Potential Impact: The MET appears to be a useful prognostic tool by providing insight into which individuals may experience a longer recovery following concussion. Additionally, these findings showcase a benefit of implementing the MET in clinical settings as it is comparable to symptom severity scores - the current 'gold standard tool' in concussion management - however allows clinicians to watch how athletes recovering from concussion respond to physical and mental stressors during the duration of a medical appointment.

T14

A Qualitative Assessment of the Perception of Wrist Guard Use for Gymnast Wrist Injury Prevention

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Introduction: Gymnast wrist (GW) is a stress injury of the distal radius physis in skeletally immature athletes, caused by repetitive high-impact wrist loading during growth. Despite evidence supporting

the efficacy of wrist guards in preventing GW, uptake remains limited. Understanding both gymnast and coach perspectives is key to developing effective prevention strategies. This study explores these attitudes to inform an evidence-based Gymnast Wrist Injury Prevention Program (G-WIPP).

Methods: A grounded theory mixed-methods approach was utilized. Competitive women's artistic gymnasts (ages 11–16) and coaches from Ontario clubs were recruited through purposive sampling. Participants completed a pre-interview questionnaire and virtual semi-structured interviews via Microsoft Teams. Inductive analysis of transcripts was conducted using NVivo 14. Open and axial coding with a constant comparative method identified emerging categories and themes. Data saturation was reached after 8 gymnast and 8 coach interviews.

Results: Four key themes emerged: physical, psychological, educational, and authority-based factors. Physical factors included beliefs about strengthening for injury prevention, and concerns about dependence, appearance, and convenience. Psychological factors reflected psychological dependence on wrist guards, and the normalization or fear of their use. Educational factors centered on limited awareness of GW and the impact of education from trusted sources. Authority figures (coaches, role models, and healthcare professionals) were noted to significantly shape perceptions and behaviours.

Discussion/Conclusion: The findings highlight multifactorial influences on wrist guard perceptions among adolescent female gymnasts and their coaches. By leveraging coach and healthcare provider influence, addressing knowledge gaps, and tailoring interventions to lived experiences of gymnasts, this study will inform the development of the Gymnast Wrist Injury Prevention Program (G-WIPP) and contribute to the advancement of safer sport practices.

T15

Prehab to Prepare Living Liver Donors for Enhanced Recovery (PROPELLER): A Feasibility Randomized Controlled Trial

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Research Area: Prehabilitation

Research Question: Is a Phase III RCT of prehabilitation in living liver donors feasible?

Background Rationale: Living donor liver transplantation is a critical treatment for people with end-stage liver disease. Preserving health and quality of life are paramount priorities of care for living liver donors (LLDs) as they receive no direct medical benefit from their donation. Prehabilitation has emerged as a feasible, safe, and efficacious strategy to improve preoperative health and contribute to improvements in physical and mental health, as well as reductions in adverse surgical outcomes. However, no trial has evaluated the feasibility of prehabilitation in LLDs.

Proposed Approach: This is a single-centre, multi-methods, feasibility RCT comparing multimodal prehabilitation versus usual care. Thirty LLDs were randomized 2:1 (intervention:usual care). The prehabilitation arm received a multimodal intervention comprising exercise, nutrition, stress reduction, and peer support to optimize health before surgery. Feasibility outcomes included eligibility rate, attrition, and adherence. Exploratory physical and psychosocial outcomes were measured. Qualitative

interviews were used to explore participant satisfaction.

Potential Impact: This study demonstrated a Phase III RCT of prehabilitation versus usual care may be feasible. Findings also demonstrated the safety and potential efficacy of prehabilitation to reduce commonly experienced adverse physical and psychosocial outcomes before and after surgery for LLDs.

Supporting Information: This trial is registered with ClinicalTrials.gov, identifier: NCT05431361

T16

A Multi-Stage Framework for Predictive and Patient-Specific Preoperative Planning in High Tibial Osteotomy

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Research Area: Biomechanics

Research Question: How can patient-specific biomechanical modeling, including ligament contributions, and clinical data be integrated to improve high tibial osteotomy (HTO) planning and outcome prediction—specifically by identifying reliable, ligament-informed thresholds for joint line obliquity (JLO) and establishing a biomechanical definition of surgical success through the concept of Minimum Effective Biomechanical Correction (MEBC)?

Background Rationale: Knee osteoarthritis (OA) affects over 6 million Canadians and is a major cause of pain and disability. Among patients with unicompartmental OA, malalignment is common—often due to either progressive joint degeneration or congenital deformities—and frequently leads to altered load distribution, joint instability, and the need for surgical intervention. High Tibial Osteotomy (HTO) is a well-established joint-preserving option in younger, active patients, designed to correct malalignment and shift loading away from the degenerated compartment. However, current planning tools often rely on radiographic landmarks and population-based norms, with limited ability to personalize the procedure to the biomechanics of individual patients.

One major shortcoming is the oversimplification—or total omission—of ligament behavior in most preoperative models. Ligaments play a central role in modulating joint mechanics post-HTO, particularly in how loads are redistributed across the tibiofemoral compartment. Yet, their contributions are often reduced to generic or linear representations in finite element models. This presents a critical knowledge gap: Do subject-specific ligament properties significantly alter the biomechanical outcomes of HTO? Without answering this, the clinical value of detailed imaging (MRI/CT) for soft tissue modeling remains unclear, and surgical planning risks overlooking key sources of variability.

A second important gap involves joint line obliquity (JLO)—a geometrically measurable consequence of correction that has strong biomechanical implications. Excessive JLO is linked to shear stress, instability, and suboptimal outcomes, but remains underutilized in planning due to poor predictability. Existing literature has not clearly defined how preoperative alignment influences post-op JLO, nor has it established thresholds beyond which correction becomes mechanically unsafe. Additionally, previous

studies tend to be retrospective, small-scale, and fail to leverage predictive modeling or patient-specific finite element simulations.

Lastly, while clinical improvement is typically measured through subjective tools such as the Minimal Clinically Important Difference (MCID), these do not always align with biomechanical improvements. A more mechanistic concept, Minimum Effective Biomechanical Correction (MEBC), has been proposed but not yet validated. There is currently no consensus on which of these better correlates with meaningful surgical success. Therefore, a systematic comparison between MEBC and MCID is urgently needed to refine targets for correction and optimize outcomes based on both mechanical performance and patient-perceived benefit.

Proposed Approach: Study 1: Role of Ligaments in Load Redistribution Following HTO – Modeling and Experimental Validation

This foundational study aims to evaluate how individual ligament anatomy and stiffness affect post-operative tibiofemoral load redistribution. Subject-specific finite element (FE) models will be developed using CT and MRI data, incorporating key ligaments (e.g., ACL, PCL, MCL, LCL) with nonlinear material properties. Simulated load-bearing scenarios—both pre- and post-HTO—will be conducted to assess the influence of ligamentous constraints on stress distribution across the joint.

To validate the computational models, cadaveric experiments will be performed using instrumented loading setups. These experiments will involve simulated osteotomies and pressure sensor measurements to provide empirical data for comparison with FE-predicted contact forces and alignment outcomes. This validation will help establish confidence in the use of ligament-integrated FE models for surgical planning.

Study 2: Thresholds of Post-Operative Joint Line Obliquity (JLO) – Prediction and Finite Element Analysis

This study is divided into two phases to systematically investigate the mechanical implications of surgical correction magnitude, particularly joint line obliquity.

Phase 1: Predicting Post-Operative JLO Using Pre-Operative Imaging and Surgical Planning Data

A retrospective cohort of patients with available pre- and post-op imaging will be used to build statistical or machine learning models that predict post-operative joint line obliquity based on planned correction angles, baseline alignment, and anatomical parameters. This phase will generate a spectrum of likely JLO configurations across patients with varying corrections.

Phase 2: Finite Element Modeling to Assess Biomechanical Consequences of JLO Variations

Using the predicted JLO configurations from Phase 1, subject-specific FE models will be constructed to simulate the resulting cartilage stress distributions and ligament strain patterns. The goal is to identify thresholds of excessive JLO where post-op mechanics may be compromised, providing actionable limits for surgical decision-making.

Study 3: This study aims to compare measurable changes in limb alignment and function to patient-reported and objective outcomes.

Patients undergoing HTO will be assessed pre- and post-operatively using:

Objective measures: joint angles (e.g., extension/flexion, varus/valgus), range of motion (ROM), and

alignment metrics (e.g., weight-bearing axis from CT or long-leg X-rays).

Subjective measures: validated patient-reported outcome measures (PROMs) including KOOS, WOMAC, and the Pain Catastrophizing Scale (PCS), along with global anchor questions.

The goal is to define the Minimum Effective Biomechanical Correction (MEBC)—the smallest measurable change in alignment and function associated with a clinically meaningful improvement, as defined by the Minimal Clinically Important Difference (MCID) in PROMs. By comparing MEBC and MCID, the study will support evidence-based surgical decision-making rooted in both biomechanics and patient experience.

Potential Impact: This research will significantly improve high tibial osteotomy (HTO) planning by integrating patient-specific biomechanics and clinical outcome measures. By linking ligament mechanics, joint line orientation, and patient-reported improvements, it offers a more personalized, evidence-based approach to optimize surgical success. Ultimately, the findings will enhance surgeons' ability to predict and prevent poor outcomes, bridging the gap between computational modeling and practical clinical decision-making.

T17

Daily Whole-Body and Muscle-Specific Protein Requirements in Resistance Trained Females and Males

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Research Area: Protein Metabolism, Sports Nutrition, Exercise, Sex Differences

Research Question: Purpose: To determine the daily recommended protein intake to maximize whole-body protein synthesis (WBPS) and myofibrillar protein synthesis (MyoPS) in resistance-trained female athletes during the mid-luteal phase (i.e., 5-9 days post-ovulation) compared to males following resistance exercise (RE).

Hypothesis: It is hypothesized that the protein requirement needed to maximize MyoPS will be lower than that which maximizes WBPS, and comparable between sexes.

Background Rationale: Current daily protein recommendations suggest ~1.6 g/kg/day to maximize training-induced gains in fat-free mass (FFM), though FFM may be a poor surrogate for muscle mass, which is the primary tissue for training-induced improvements in hypertrophy and strength. No study to date has determined muscle-specific protein requirements, and there is a dearth of studies in strength-trained females to support muscle remodeling and growth.

Proposed Approach: Leading up to each metabolic trial, and following two days of a controlled diet (1.2 g/kg/day protein), resistance-trained males and females in the luteal phase (n=10, each) will complete a standardized full-body RE protocol, eliciting MyoPS rates predictive of hypertrophy. Subsequently, in a randomized, crossover, counterbalanced design, participants will consume 16 half-hourly isocaloric

and isonitrogenous liquid meals (providing 0.2, 1.2, or 2.2 g/kg/day protein as crystalline amino acids). Using the L-[1-13C]-Phenylalanine (Phe) stable isotope tracer, whole-body phenylalanine flux and phenylalanine oxidation (PheOx, i.e., the reciprocal of WBPS) will be assessed through repeated breath and urine samples. In parallel, the [D5]Phe tracer will be used to quantify MyoPS rates through repeated blood sampling and muscle biopsies. A modified biphasic linear regression will estimate the breakpoint in PheOx and MyoPS, thereby identifying daily protein intakes that optimize protein synthesis at the whole-body and muscle levels, respectively.

Potential Impact: This study will shed light on female protein requirements, ultimately supporting lean mass accretion, exercise performance, and recovery for female athletes. These findings will inform the Sports Nutrition community, athletes, and coaches on nutritional requirements for female athletes, who have been historically under-represented, especially in exercise sciences.

T18

Quantifying the Physiological Demands of Athlete Training Sessions – a Feasibility Study Using Advanced Wearable Technology

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Research Area: Exercise Physiology

Research Question: To assess the feasibility of utilizing wearable technologies to optimize in-field exercise training intensities and examine the relationship between team-prescribed conditioning sessions and the time athletes spent at or above physiological thresholds.

Background Rationale: For success in high-performance sport, it is imperative that exercise training sessions deliver an optimal stimulus for cardiovascular adaptation and improvements in cardiorespiratory fitness. While heart monitors are readily available, recent evidence suggests that training programs based on an individual's physiological thresholds (i.e., ventilation and lactate thresholds) yield enhanced cardiovascular adaptation. Recent advancements in wearable technology now allow for real-time monitoring and more precise control over an individual's training stimulus. This provides an opportunity to examine the relationship between team-prescribed conditioning sessions and the time athletes spent at or above physiological thresholds, as well as the feasibility of applying wearable technology for monitoring and intervention in typical training settings.

Proposed Approach: Fifteen varsity athletes (21±2 years; 47% female) completed five sessions over 2 weeks. In week 1, athletes completed 3, 1-hour laboratory sessions separated by 24-hours. Assessment 1 (progressive exercise to volitional exhaustion with finger-tip blood lactate sampling) determined peak rate of oxygen consumption (VO₂peak), lactate threshold and ventilation thresholds (VT1/VT2). Assessment 2 (Wingate test) assessed anaerobic capacity. Assessment 3 (critical power test) assessed the aerobic power-duration relationship. During week 2, athletes completed two, team-prescribed conditioning sessions. During all sessions, oxygen consumption (VO₂ Master Pro), heart

rate (HR; Frontier X2), and skeletal muscle oxygenation (SmO₂; Moxy Monitor) were measured. Upon study completion, athletes completed a feasibility assessment questionnaire to explore acceptability, implementation, practicality, and integration of the wearable technologies used. For in-field training analyses, time spent at, or above physiological thresholds were assessed, with data presented as mean±SD and range (min-max percent time).

Potential Impact: This study is the first to assess the feasibility of applying advanced wearable technologies to optimize athletes' cardiorespiratory training stimulus during in-field, sport-specific training. Preliminary findings demonstrate wide interindividual variability in training intensities during team-prescribed conditioning sessions, with the range in percent time spent above physiological thresholds as follows: VT1 (2-75%); VT2 (0-40%); CP/CS (0-25%/2-14%). Duration and time exercising were highly correlated between sessions (both $r > 0.93$), and during exercise, HR was 149 ± 11 bpm and SmO₂ was $-29 \pm 16\%$. This suggests that personalized training unique to an individual's physiological thresholds may be warranted to provide athletes with a more appropriate and targeted stimulus for cardiorespiratory adaptation. In doing so, this can importantly enhance exertional capacity and increase competitive sport performance by tailoring training interventions to the unique abilities of an athlete and requirements of their sport.

T19

The Effects of Online vs. Offline Applications of Transcranial Direct Current Stimulation in an Endurance Context

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Research Area: Kinesiology

Research Question: determine a tDCS application protocol that results in reliable improvements in time to fatigue by testing the timing of when tDCS is applied and if a personalized tDCS montage can result in further improvements in time to fatigue.

Background Rationale: Athletes and coaches are always looking for new ways to improve their performance. Recently, non-invasive brain stimulation has been a tactic of interest for motor performance enhancement. Specifically, Transcranial Direct Current Stimulation (tDCS) has been investigated for its ability to induce neuronal excitability changes through the application of weak subthreshold direct current to the brain. The ability of tDCS to enhance cortical excitability has the potential to mitigate the effects of central fatigue. Central fatigue occurs due to decreased voluntary activation in the motor cortex (M1) resulting in suboptimal output of motor neurons caused by either a decrease in excitatory output or an increase in their inhibitory output. Through the application of tDCS output from M1 can remain elevated, which may prolong one's time to fatigue. The current literature that has investigated this phenomenon has yielded inclusive results, attributing this variability to the time-dependent effects of tDCS and inter-individual differences in electric fields generated by tDCS. Thus, this study aims to determine a tDCS application protocol that results in reliable improvements in time to

fatigue by testing the timing of when tDCS is applied and if a personalized tDCS montage can result in further improvements in time to fatigue.

Proposed Approach: A group of strength trained men and women will be recruited. During the first session participants will receive an MRI scan that will later be used for current flow modelling to construct the individualized electrode montage. Afterwards, each session will begin with 3-4 leg extension maximal voluntary isometric contractions. Participants will receive each of the following 4 conditions: 1) sham tDCS, (2) priming (offline) anodal tDCS, (3) online anodal tDCS, and (4) individualized online anodal tDCS. Offline tDCS will consist of 10 minutes of stimulation at 2mA prior to a time to fatigue (TTF) leg extension at 20% of peak torque. Online tDCS will be the same but occur during the TTF task.

Potential Impact: This research could help to inform future studies on the optimal tDCS application protocol to improve endurance performance. Additionally, this research could help to establish tDCS as a potential ergogenic aid that can be used in training and high performance sport.

T20

The Effectiveness of Wrist Bracing for Reducing Biomechanical Risk Factors Associated with Gymnast Wrist

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Introduction: Gymnasts often feel pressured to conceal pain and injury to support their likelihood for success, leading to long term health consequences. As such, preventative measures that safeguard gymnasts against common biomechanical injuries are critical. Distal radius physeal stress reaction, or Gymnast Wrist (GW), is prevalent in adolescent gymnasts due to repeated high force loading at the wrist growth plates. Wrist braces have shown to attenuate such forces. However, their efficacy for reducing GW risk in young female gymnasts is unknown. Therefore, this research aims to establish the effectiveness of anti-hyperextension wrist braces for reducing biomechanical GW risk factors in young female gymnasts.

Methods: Data collection is ongoing to quantify wrist biomechanics in 25 adolescent female artistic gymnasts (age 10-19 years; level 6-10) with and without bilateral anti-hyperextension wrist braces. Gymnasts' hand impact forces and extension angles are measured during three floor tasks (front handspring, round-off, back handspring). Extension angles are compared over the force-time profile. Exit surveys are administered to obtain feedback on brace use.

Results: Preliminary results show, during all tasks, wrist braces reduce the magnitude of wrist extension at initial contact of the hand with the floor and peak impact force (mean reduction across all tasks = 7.5 and 9.6 degrees, respectively). During each bracing condition, round-offs elicit greater (i.e., riskier) wrist

extension angles. To date, all gymnasts perceived braces as comfortable and to cause no performance detriments. All expressed interest in continuing to wear braces due to their perceived efficacy for decreasing wrist pain and/or increasing wrist support.

Discussion/Conclusion: This research is foundational as it provides preliminary supporting evidence for wrist bracing as a strategy to reduce GW risk in young female gymnasts, an athlete population largely underrepresented within current literature. Focused research efforts on GW are not only imperative for protecting the growing gymnast, but also for safeguarding these vulnerable athletes.

T21

Supporting the Developing Athlete: Psychological Safety and the Coaching of Adolescent Girls in Gymnastics

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Research Area: Kinesiology - Behavioural Stream (Sport Psychology)

Research Question: How do Women's Artistic Gymnastics coaches foster psychologically safe environments for adolescent girls (ages 11–15)?

1. What are the strategies and behaviours that coaches use to foster elements of psychological safety for their athletes?
2. How do developmental/gendered considerations influence these coaching practices?
3. What are some challenges coaches face in creating psychologically safe environments?

Background Rationale: Women's Artistic Gymnastics is characterized by a demanding culture where fear is often present and harsh coaching practices have historically been normalized (Martin et al., 2008; McLaren, 2023). At the same time, the sport includes a high proportion of adolescent girls who are navigating critical developmental transitions related to self-esteem, identity, and social belonging (Perry & Pauletti, 2011). These overlapping factors make the quality of the coaching environment especially significant. Although psychological safety has been studied in organizational and some sport contexts, it has not been examined in depth within WAG or among adolescent girls. This study aims to address that gap.

Proposed Approach: This study will use a qualitative design to explore the everyday coaching behaviours, relational strategies, and organizational influences that shape how coaches foster psychologically safe environments for adolescent girls aged 11–15. Data will be collected through semi-structured interviews, incorporating a vignette based on Cooke et al.'s (2024) framework of psychological safety in sport to prompt reflection on specific coaching scenarios. An inductive and reflexive thematic analysis (Braun & Clarke, 2006) will be conducted to identify patterns in how coaches describe and enact supportive behaviours.

Potential Impact: This study will provide new insight into how coaches foster psychological safety

in adolescent girls' gymnastics, a population where supportive environments are especially critical. Findings may inform coach education by identifying practical strategies that promote athlete voice, learning, and well-being. Furthermore, as psychological safety has not yet been widely examined within adolescent girls' gymnastics, this study helps open an important line of inquiry that requires further applied exploration with this specific group.

T22

Leg Press Strength Is More Strongly Associated With Extracellular Matrix Than Myofiber Hypertrophy After 8 Weeks of Resistance Training in Males and Females

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Research Area: Muscle Physiology

Research Question: Introduction: The collagen-rich muscle extracellular matrix (ECM) is essential for transmitting mechanical force produced by myofiber shortening. Given myofiber hypertrophy and increased force generation are compensatory adaptations to chronic mechanical overload (e.g., resistance training), we sought to determine the congruence between myofiber and ECM hypertrophy along with strength changes after training in both sexes.

Background Rationale: Methods: Recreationally active, young adult (18-30y) participants (10M;10F) completed three whole-body resistance training sessions for 8 weeks. Vastus lateralis muscle biopsies as well as leg press and extension one-repetition maximum (1RM) testing were conducted before and after resistance training. Picrosirius red staining was used to quantify muscle collagen (i.e., ECM) area as well as myofiber cross sectional area (fCSA).

Proposed Approach: Results: Leg press and extension 1RM strength increased $90\pm 52\%$ and $114\pm 72\%$ with training, respectively (both $p < 0.01$). Vastus lateralis fCSA increased from $5098\pm 1016\mu\text{m}^2$ to $6020\pm 1771\mu\text{m}^2$ following training ($p < 0.01$) with $\sim 19.8\%$ larger fibers in males regardless of training status ($p < 0.05$). Collagen content relative to muscle area remained constant with training at $6.9\pm 1.1\%$ in females and $7.7\pm 1.2\%$ in males ($p = 0.96$) with no effect of sex ($p = 0.09$). Consistent with differences in fCSA, absolute muscle collagen area per myofiber increased from $398\pm 111\mu\text{m}^2$ to $473\pm 166\mu\text{m}^2$ following training ($p < 0.05$) and was 43% lower in females compared to males regardless of training status ($p < 0.01$). Change in leg press 1RM, the movement more reliant on vastus lateralis function, was

more strongly correlated with change in collagen ($r=0.69$; $p<0.01$) than myofiber area ($r=0.50$; $p<0.05$). In contrast, change in leg extension 1RM was unrelated to either change in collagen ($r=0.24$; $p=0.33$) or myofiber area ($r=0.0053$; $p=0.98$).

Potential Impact: Conclusion: We demonstrate concomitant myofiber and ECM hypertrophy following chronic resistance training in humans, the latter of which better-reflects changes in muscle force generating capacity. Future research should look to assess training-induced changes in ECM quality (e.g., collagen cross-linking) alongside quantity.

T23

A Preliminary Investigation Exploring the Relationship Between Alexithymia and Affective Style in Canadian Athletes

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Katherine Tamminen, University of Toronto

Introduction: Alexithymia is characterized as a difficulty identifying feelings, difficulty describing feelings, and externally oriented thinking (Bagby et al., 1994). Alexithymia has been linked with poor emotion regulation ability (Preece & Gross, 2023), although there is limited exploration of how athletes with alexithymia regulate their emotions in sport. One approach to examining emotion regulation is to explore individuals' affective style, which refers to one's emotion regulation tendencies (Hofmann & Kashden, 2010). The purpose of the present study was to explore alexithymia among Canadian athletes, and associations between alexithymia and affective style.

Methods: Athletes ($n = 100$, 67% female) completed an online survey measuring alexithymia and affective style.

Results: A one-way ANOVA found statistically significant differences in alexithymia scores across competition levels, $F(3.96) = 3.272$, $p = 0.024$. Post-hoc analyses revealed high performance athletes scored higher on alexithymia compared to recreational athletes ($p = 0.018$). An independent t-test found no significant differences between men's and women's scores of alexithymia. Alexithymia was significantly positively correlated with concealing ($r = 0.261$, $p = 0.009$) and significantly negatively correlated with adjusting ($r = -.0372$, $p < 0.001$) and tolerating ($r = 0.474$, $p < 0.001$) affective styles.

Discussion/Conclusion: These results suggest athletes higher in alexithymia report lower abilities in tolerating and accepting emotions; while simultaneously they are more likely to engage in emotion regulation strategies to conceal emotions. These analyses are an important first step to addressing existing gaps in the literature, demonstrating the need to continue investigating the experiences of athletes who score high on alexithymia.

T24

The Use of Dual-energy X-ray Absorptiometry (DEXA) in Evaluating Recovery following Musculoskeletal Injuries in Athletes - A Scoping Review

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Research Area: Return to Play, Medical Imaging

Research Question: How can DEXA imaging be used to guide rehabilitation in both recreational and competitive athletes by monitoring changes in BMD and body composition after musculoskeletal injuries?

Background Rationale: Dual-energy X-ray absorptiometry (DEXA) is a widely used imaging modality in sports medicine and orthopaedics due to its accuracy in assessing bone mineral density (BMD) and body composition. Tracking these parameters provides valuable insights into the recovery process following musculoskeletal injuries, which are prevalent among athletes.

Proposed Approach: A comprehensive literature search was conducted in Ovid MEDLINE, EMBASE, Cochrane Central, and SportDISCUS databases (2000–2024). Studies were included if they used DEXA to measure BMD or body composition changes in athletes following musculoskeletal injuries. Titles, abstracts, and full texts were screened independently by two reviewers, with discrepancies resolved through discussion. Data were synthesized qualitatively and we reported and identified major trends.

Potential Impact: This study highlights the utility of DEXA imaging for monitoring recovery in athletes and emphasizes the need for sport-specific rehabilitation protocols that incorporate objective data from DEXA scans to optimize outcomes.

T25

Recombinant Human Growth Hormone for Knee Osteoarthritis (the KORR Study)

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David Wasserstein, University of Toronto

Research Area: Sports medicine

Research Question: Does recombinant human growth hormone have the potential to improve symptoms and function for patients with moderate knee osteoarthritis?

Background Rationale: Knee osteoarthritis (KnOA) is the most prevalent form of arthritis and a leading cause of pain and disability among adults. Primary KnOA typically affects older patients, with a prevalence of 40% in those over 70 years of age. For those patients who fail nonoperative treatment, total knee arthroplasty is the “gold standard” of treatment.

In younger and more active individuals, KnOA can be particularly debilitating, disrupting employment, physical activity, and long-term joint health. Patients below 60 years of age with mild-to-moderate KnOA (Kellgen Lawrence grade II–III) are not suitable candidates for joint replacement, having higher post-operative dissatisfaction rates and implant wear. A “treatment gap” is well documented for these patients, who are too young for definitive arthroplasty, but unable to make significant improvements in their disease course with current therapies. 84% of orthopaedic surgeons feel there is a need for better treatment options in these patients.

Current treatment paradigms prioritize conservative measures designed to limit symptoms, rather than modify or prevent disease progression. First line therapy includes activity modification, analgesia (oral NSAIDs), weight loss, lifestyle changes, braces, and physical therapy. Second-line pharmacological therapy includes intra-articular injections (e.g.: cortisone, platelet-rich plasma, hyaluronic acid derivatives) which can provide temporary pain relief. Surgical options include arthroscopic knee surgery for debridement or microfracture, which is currently advised against by the Arthroscopy Association of Canada. Patients with isolated unicompartmental disease may be candidates for realignment osteotomy or partial knee replacement. Both procedures have specific inclusion criteria and are highly invasive, functioning at best to delay total knee replacement.

The underlying pathophysiology for these patients is complex. For some, participation in sport or athletics can increase loading and damage to cartilage, which results in a pro-inflammatory state causing joint degeneration. In others, anatomical, genetic, and biochemical factors can trigger this cycle. Quadriceps muscle weakness and dysfunction results in increased stress on the joint. Previous studies have shown that increasing quadriceps strength can reduce the progression of cartilage loss in knee compartments. Patients with greater quadriceps strength report better function and lower pain levels.

Therefore, the recommended first line treatment for KnOA is physical therapy to improve muscle strength, flexibility and joint stability. However, many trials report non-compliance over 50%, leading to limited effectiveness. Høglund et al found that a six-week program of hip and core muscle strengthening resulted in initial improvements in pain; however, six-month follow-up showed that benefits were not maintained in the medium and long-term. It is hypothesized that the disease state creates a self-limiting cycle, by which pain and weakness inhibit and discourage patients from successfully engaging in exercise therapy. Additionally, the slow progress and small effect size of benefits may reduce motivation and compliance. Thus, a disconnect develops between evidence-based guidelines, clinician recommendations, patient behaviours and clinical response. Therefore, a new strategy targeting the underlying muscular atrophy associated with knee pain and dysfunction is critically needed.

Growth hormone is released from the pituitary gland in pulsatile fashion. It is responsible for the growth and development of most musculoskeletal tissues in the body, such as cartilage and bone, through upregulation of insulin-like growth factor-1 (IGF-1). Recombinant human growth hormone (rHGH) is a synthetic form of the hormone which is approved for use in conditions such as HIV-associated muscle wasting and pediatric growth disorders.

Preclinical studies have demonstrated anabolic effects of rHGH on skeletal muscle in both animal models and humans with disuse atrophy. Animal studies have also shown improvements of cartilage

appearance from intra-articular knee and temporomandibular joint injections. Dunn et al replicated this finding with intra-articular ankle injections, finding that 93% of patients ankles showed halted cartilage degeneration after treatment. Laboratory studies found that rHGH therapy improved muscle strength and hypertrophy in young adult males compared to placebo when accompanied by a training regimen, and increased muscle mass in men aged 40-70 years old. A pivotal study by Mendias et al. (2020) showed that rHGH increased quadriceps strength and volume in patients following ACL reconstruction, compared to placebo. The rHGH group also had lower serum matrix metalloproteinase-3 (MMP-3), which is a biomarker for cartilage degradation. Despite this promise, rHGH has never been studied in the context of idiopathic or degenerative osteoarthritis.

To better understand the feasibility and potential utility of rHGH in musculoskeletal rehabilitation, we have conducted a systematic review and meta-analysis of clinical trials involving rHGH use in humans. Despite heterogeneous populations and outcomes, studies consistently showed a dose-dependent relationship between rHGH dose and serological insulin-like growth factor-1 levels (IGF-1). Participants treated with rHGH displayed improved lean body mass and muscle strength (measured by isokinetic leg extension) in meta-analysis but were also more prone to adverse events such as peripheral edema, arthralgia, and carpal tunnel symptoms. rHGH therapy was most effective when administered to young, active adults; it is hypothesized that these patients have more anabolic reserve for muscle growth, and for pathologies driven primarily by an underlying muscle dysfunction.

To understand more from the patient and provider perspectives, we conducted a prospective mixed-methods study on perceptions and barriers to rHGH treatment. 300 patients were recruited from an orthopaedic sports and fracture clinic. Quantitative analysis of Likert-style questionnaires revealed that 72% of participants would use rHGH for injury recovery if prescribed by a physician. Regression analysis showed that males, younger subjects, and more educated subjects were most likely to be willing to try rHGH treatment. Common themes from both patients and surgeons included a desire to learn more about indications, therapeutic doses, and adverse events of rHGH therapy.

Therefore, our central hypothesis is that targeted rHGH supplementation, combined with structured physical therapy may improve quadriceps strength and functional outcomes in patients with symptomatic KnOA. Before proving clinical efficacy, however, we must provide that it is safe and feasible to conduct a large randomized trial with this methodology. Given that no major adverse events have ever been reported, we hypothesize that rHGH treatment will be proven safe.

Primary Aim

To evaluate the feasibility of conducting a large-scale randomized controlled trial (RCT) assessing the efficacy of rHGH in patients with mild-to-moderate KnOA, with feasibility defined by: Medication adherence, Recruitment/retention capacity, Tolerability and safety.

Secondary Aims

To gather preliminary data on efficacy by comparing clinical and functional outcomes (quadriceps strength, PROMs, imaging, motion capture analysis) between intervention and placebo groups.

Proposed Approach: Study Design

This is a single-centre, randomized, double-blind, placebo-controlled pilot RCT. A total of 34 participants (1:1 allocation) will be enrolled at Sunnybrook Health Sciences Centre. The intervention duration is 6 weeks, with a follow-up of 24 months. Sequential screening of all patients visiting the Orthopaedic

clinics of the co-investigators will be carried out by trained research personnel. Any patient meeting the inclusion criteria will be approached for possible enrollment by trained research personnel. Research personnel will allocate eligible participants in a 1:1 fashion to rHGH or placebo through a central computerized randomization system (random number generator; 1-34, allocation via even and odd numbers). No block randomization or stratification will occur. Randomization will be performed by a trained researcher.

Inclusion Criteria

Adults aged 18–60 years with isolated knee OA >6 months with radiographic evidence (Kellgren-Lawrence II-III) and knee pain worsened with loading (stairs, squatting, etc.) or physical examination (palpation, range of motion) will be recruited into the study. Patients with bilateral disease will be included, as will patients who have a remote (>12 months) history of meniscal or ligamentous injury.

Exclusion Criteria

Prior surgery or major trauma to the affected limb, BMI <20 or >35, diabetes, cancer, endocrine, or rheumatologic disease, active pregnancy or lactation, and inability to self-administer subcutaneous injections. Women of child-bearing potential will have a pregnancy test before enrollment.

Interventions

Participants will receive either: rHGH (Saizen) at 0.5 mg/m²/day subcutaneously, divided into twice-daily injections, or Placebo (0.9% saline), administered identically for six weeks.

This dosage and pulsatile regimen were validated to be safe and effective in increasing serological IGF-1 by >100% from baseline. All participants will receive a standardized physiotherapy protocol, focusing on quadriceps and hip strengthening over three sessions per week for 12 weeks.

Feasibility Outcomes (Primary)

Adherence to the injection regimen will be measured through subjective patient-reported diaries, percentage of unused syringes, and serial serum measurements of IGF-1 levels. Results will be measured as both continuous and dichotomized (e.g.: self-reported adherence >80%) variables. The proportion of patients with successful IGF-1 response (>100% of baseline) will also be measured.

Recruitment (proportion of eligible patients who meet screening and inclusion criteria who agree to participate) and retention (proportion of patients who attend the 12-week follow-up) are categorical variables. Safety outcomes include the presence and frequency of minor and major adverse events, rHGH dose reductions, and study withdrawals. The primary endpoint for these outcomes is the 12-week follow-up visit.

Clinical Outcomes (Secondary)

Patient-reported outcome measures will include the Knee injury and Osteoarthritis Outcome Score (KOOS), the Short Form 20 (SF-20), and the Tegner activity scale.

Isokinetic knee extension strength (peak isokinetic torque at 90°) will be measured using a Biodex extremity machine. Other measurements will include hip flexion, hip abduction, and knee flexion.

Functional outcomes, such as knee range-of-motion, and thigh, calf, and abdomen circumference will be measured. Markerless motion capture of walking gait, squat, jump, and stair climb will be carried out to

assess knee varus/valgus and flexion/extension angles.

Radiologic measurements will include X-ray analysis of arthritis progression at 12 and 24 months, and MRI assessments of cartilage thickness, lesion size and depth, and thigh musculature volume.

Compliance with the physical therapy regimen will be via a self-reported diary and fitness tracker (ActiGraph GT3X-BT). Adverse events will be recorded using an adverse events reporting form. All outcomes measured in this study have been externally validated.

Schedule of Assessments

Patients interested in participating in the study will be assessed for eligibility. Eligibility assessments (abstracted from standard care testing or done as part of study screening as necessary) include vital signs, and medical history. Standard laboratory testing will be carried out, and subjects with normal values (or minor deviations after review by our

study endocrinologist) will be permitted to enroll. Fully informed participant consent will be obtained prior to performing any study mandated activities. Once enrolled, patients will attend a baseline visit for measurements, instruction on drug administration, and to receive their medications. Subsequent measurements will occur at 2 weeks, 6 weeks, 3 months, 6 months, 12 months and 24 months.

Statistical Analysis

The study uses an intention-to-treat (ITT) approach. Primary outcomes will be analyzed using unpaired t-tests (adherence), and chi-squared tests (serological response, retention, safety). Descriptive statistics will summarize feasibility outcomes.

As this study is a pilot, there is no formal sample size calculation. However, we set a threshold for successful feasibility (self-reported compliance of 100% or serum IGF-1 levels increasing by 100% in the experimental arm) at 80% of the entire sample. We plan to recruit 34 patients (17 in each arm) based on our current funding. Using the Power Analysis and Sample Size Software (PASS 2024) NCSS, LLC. (Kaysville, Utah, USA, ncss.com/software/pass), for an observed feasibility rate of 80% and alpha of .05, the 95% confidence interval for feasibility is 62.8% to 91.7%

Potential Impact: If successful, we could have a brand-new way to help people with arthritis build muscle and reduce pain. This study will show whether it's safe and possible to give growth hormone to people with arthritis and if it helps them feel and move better.

In the short term, it will give doctors and researchers a new idea to test in a larger study. In the long term, it could lead to a new treatment option for younger people with knee arthritis—one that helps them avoid surgery and stay active longer.

This work is also important because it focuses on a group often left out of arthritis research: younger adults with early-stage disease. If successful, this could change how we treat arthritis and improve quality of life for thousands of Canadians.

T26

Sleep Apnea in Paralympic Ontario-Resident aThletes With Spinal Cord Injury (SPORTS) Study

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Research Area: Sleep disorders in para-athletes living with spinal cord injury.

Research Question: Does use of continuous positive airway pressure (CPAP) for four months to treat high-performance athletes with spinal cord injury (SCI) who have moderate-to-severe sleep-related breathing disorders (SRBDs) significantly reduce their levels of fatigue, depressive symptoms, anxiety, and cognitive impairment, and thereby improve their work and social participation, and quality of life, as well as significantly improve their performance and perceived risk of injuries?

Background Rationale: Restorative sleep is essential for a person's health and wellbeing; it helps restore the immune, nervous, skeletal, and muscular systems, and is a vital process to help us maintain mood, memory, and cognitive and physical performance. Untreated moderate-to-severe sleep-related breathing disorders (SRBDs), which include central and obstructive sleep apnea, can lead to excessive daytime sleepiness, stroke, myocardial infarction, metabolic dysfunction, kidney dysfunction, and death. SRBDs have also been linked with several psychosocial, neurocognitive and behavioral consequences affecting quality of life, interpersonal relationships, and physical and occupational well-being in the general population. More specifically, SRBDs have been associated with fatigue, depression, anxiety, stress, chronic dysphoria, somatic complaints, reduced activity level, and emotional apathy that can negatively affect sports performance. SRBDs can also cause cognitive impairment including a decline in attention, concentration, memory, and ability to learn new tasks, which can also have a negative impact on person's sports performance, work performance and productivity, occupational health and safety, and are linked with workplace stress, burnout, and job dissatisfaction. Moreover, there is a growing body of evidence that suggests untreated moderate-to-severe SRBDs adversely affects the individuals' performance in sports-related activities, especially among those high-performance athletes.

SRBDs is a very common problem after spinal cord injury (SCI), with instances being reported in up to 50% of those with paraplegia, and up to 91% of those with tetraplegia. Despite the fact that the frequency of SRBDs after SCI are considerably greater than in non-disabled persons, this condition is still largely understudied, under-recognized, undertreated in the SCI population.

With this, we hypothesize that:

- a. use of CPAP to treat high-performance athletes with SCI who have moderate-to-severe SRBDs will significantly reduce levels of fatigue, depressive symptoms, anxiety, and cognitive impairment, and thereby improve their work and social participation, and quality of life; and
- b. use of CPAP to treat athletes with SCI who have moderate-to-severe SRBDs will significantly improve their performance and perceived risk of injuries.

Proposed Approach: This mixed methods research project will include:

1. A single-arm clinical trial to evaluate the effectiveness of CPAP in improving fatigue, mood, anxiety, cognition, quality of life, social and work participation, and sports performance among adults with any level and severity of SCI, who are diagnosed with moderate to severe SRBDs; and
2. A qualitative study that will include semi-structured interviews to identify the perspectives of athletes with SCI who undergo CPAP therapy, and their perceptions about the risk of sports-related injuries.

Potential Impact: The proposed research will address an important knowledge gap with regards to the neurocognitive and psychosocial implications, and the negative impact on sports performance of untreated SRBDs in the para-athletes living with SCI, and how CPAP therapy can improve their participation and performance in sports with additional benefits to their mental health, well-being, and quality of life. Altogether, this research project aligns with the mission of the Tanenbaum Institute in respect to:

- a. “enhancing and sustaining athlete performance, health, wellness, and safety”;
- b. “reducing risk of injuries and maltreatment”; and
- c. “advancing high-performance sport in a manner that is safe, welcoming, inclusive and accessible to all.”

T27

Progressive Cyclical Loading as a Cadaveric Model for Chronic ACL Deficient Knee Pathology

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Research Area: Sports Medicine, Orthopaedic Surgery, Biomechanics, Rehabilitation Science

Research Question: Can a progressive cyclical loading protocol applied to ACL-deficient cadaveric knees reliably reproduce the anatomical and biomechanical features of chronic ACL deficiency (CAD)?

Background Rationale: An acute ACL rupture is one of the most common athletic injuries affecting athletes from all levels from recreation to professional levels. However, a large subset of athletes either delay surgery, undergo failed ACLR, or are never diagnosed in the acute phase. These individuals develop a Chronic ACL Deficient (CAD) knee, characterized by higher rates of concurrent meniscal and cartilage damage, altered biomechanics, and poorer outcomes after late reconstruction. Despite this substantial population, no cadaveric model exists that replicates these chronic changes. This limits experimental study and innovation in treatment approaches for this patient population.

Proposed Approach: We will employ 11 fresh-frozen cadaveric knee specimens in a within-specimen experimental design. Each specimen will undergo:

1. Baseline Testing (ACL-intact)
2. ACL Transection (acute ACL-deficient state)
3. Progressive Cyclical Loading – three phases (900N, 1200N, 1500N at 1 Hz for 1000 cycles each) with tibial translations of 10mm, 13mm, and 16mm at 22° knee flexion.

Kinematic (anterior tibial translation), pressure mapping (TekScan), and meniscal integrity outcomes will be measured. A specimen will be deemed “CAD knee” if $\geq 30\%$ increase in anterior tibial translation is observed compared to the transected baseline. Data will be analyzed via repeated-measures ANOVA (continuous variables) and Friedman test (ordinal variables).

Potential Impact:

- Provide the first cadaveric model to replicate CAD knee pathology for bench-to-bedside research.
- Inform surgical decision-making and rehabilitation strategies by testing alternative treatments beyond isolated ACLR.
- Ultimately, improve care, outcomes, and return-to-sport rates for athletes affected by chronic ACL deficiency.

T28

Athlete Concussion Surveillance in Special Olympics Sports

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Research Area: disability sport

Research Question: What is the prevalence of concussion in Special Olympics athletes in Canada? How can concussion incidence and post-game management be tracked for Special Olympics athletes at competitive events in Canada?

Background Rationale: This TISS-funded project brings together leaders in the Special Olympics Canada

community and concussion and disability research to co-create a feasible solution to the current lack of standardized assessment and surveillance of concussion in Special Olympics sports. The project aims to (a) develop and pilot a Special Olympic athlete concussion surveillance tool that can enable coaches and medical staff to capture concussion injury, demographic, and sport characteristics (Phase 1), and (b) surveil Canadian Special Olympics competitive athlete concussion incidence and history (Phase 2).

Proposed Approach: Over the past 12-months, we conducted a nominal group technique with six participants (1 medical staff and 5 coaches), along with consultation with a Special Olympics Concussion Advisory Board, that resulted in the co-creation of a 23-item surveillance tool (Phase 1). This tool has been piloted by medical staff at two, multi-day SO competitions (Ontario and Nova Scotia Provincial Games). We also surveyed 251 athletes and 13 caregivers in July 2025 at the British Columbia and New Brunswick Provincial Games (Phase 2). These surveys are in addition to the 186 surveys completed in May 2024 to July 2024. Across the 450 survey respondents in Phase 2, athletes identified as a man (n=291, 65%), woman (n=152, 34%), and non-binary (n=2, 0.4%) with a mean age of 35.8 years (SD=15.8 years). Seventy-eight percent (n=353) of athletes played high-risk sports (e.g., alpine skiing, floor hockey, basketball) and 70% (n=313) of athletes played low-risk sports (e.g., bocce, swimming, weightlifting). 145 of the 450 survey respondents (32%) reported an athlete diagnosed and/or suspected concussion in their lifetime. In response to a concussion, athletes told a trusted adult (n=91, 63%), sought medical attention (n=92, 63%), followed a return-to-sport protocol (n=43, 30%), and followed a return-to-school/work protocol (n=35, 24%).

Potential Impact: Our team has systematically created and piloted a concussion surveillance tool and generated the largest concussion history dataset that is specific to Special Olympic athletes in Canada. These outputs have the potential to improve concussion management post-event and identify gaps where concussion education and prevention can be prioritized.

T29

Building Capacity for the Delivery of Mental Health Care among Elite Youth Athletes: A Youth and Family Engaged Approach

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Jo Henderson, University of Toronto

Jordan Sutcliffe, Royal Military College of Canada

Rosemary Purcell, University of Melbourne

Research Area: Sport Psychology

Research Question: Three key research areas/priorities explored in this project are: 1) how do athletes and parents engage in conversations about seeking mental health support and how to parents and athletes navigate conversations that include disclosures of mental health concerns? 2) what is the

prevalence of mental health concerns among elite youth athletes? and 3) how can sport clubs and organizations provide better access to information, resources, and tools for parents and elite youth athletes concerning mental health in sport?

Background Rationale: While the mental health of elite adult athletes has received increasing research attention (Poucher et al., 2021), the mental health of elite youth athletes is under-studied (Purcell et al., 2023). In Canada, young people are more likely to experience mental disorders than any other age group (Pearson et al., 2013), and the peak age of onset of mental disorders occurs during the mid-teen years (Solmi et al., 2022). At the same time, the prevalence of mental disorders among elite adult athletes is comparable, and in some cases higher, than the general population (Purcell et al., 2020). Despite being considered a well-resourced population with various outlets of support, elite athletes are exposed to unique stressors that require careful consideration. Elite youth athletes, in contrast, often experience similar personal and environmental risk factors, yet they may lack access to equal resources and support as adult athletes. Elite youth athletes include individuals between the ages of 12-17 who are engaged in sport contexts that have a primary focus on performance outcomes and involvement in sport with an explicit or implicit underlying goal of progression to adult elite, collegiate, or professional sports. While they may face similar training and competitive pressures as elite adult athletes, elite youth athletes are developmentally different from adult elite athletes, marked by various biopsychosocial changes that warrant a developmental approach to understanding mental disorders and access to mental health care. However, there is a lack of research that focuses on mental health among elite youth athletes, with no research exploring the delivery of mental health care among this population or the roles of parents in seeking support for their child athlete's mental health concerns. The current research will address this important gap in the literature and establish a foundation for future research and initiatives to support the mental health of elite youth athletes.

Proposed Approach: This research adopts a youth- and family-engaged approach across three studies to explore issues related to the delivery of mental health care among elite youth athletes. Study 1: The purpose of the first study is to examine the experiences of help-seeking for mental health concerns among elite youth athletes and their parents. The data collection methods for Study 1 will include qualitative individual semi-structured interviews with elite youth athletes and their parents to ask participants about their experiences and familiarity with issues related to mental health in elite youth sport contexts, previous experiences receiving information about mental health or seeking support for mental health concerns, and challenges or issues related to help-seeking for mental health support. Study 2: The purpose of the second study is to examine the prevalence of mental health concerns and unmet needs for psychological support in a representative sample of competitive adolescent athletes (at local, provincial, national, and international levels). Study 3: The third study developed from consultations with advisory group members aims to address some of the key barriers to accessing mental health care for their elite youth athletes. Study 3 will be a feasibility study to assess the implementation of mental health champions in a low-cost manner by upskilling laypersons within sport organizations and providing them with resources and information about mental health in sport.

Potential Impact: The proposed research is among the first of its kind in Canada and internationally to examine the issue of mental health among elite youth athletes and to specifically engage youth and parents to understand the issues and obstacles in help-seeking for mental health concerns among this population. The current research will address important gaps in the literature and establish a foundation for future research and initiatives to support the mental health of elite youth athletes, as well as supporting sustained participation and performance excellence in high-performance sport. Additional outcomes from this project include the development of partnerships, knowledge translation and mobilization, and community engagement with high performance sport organizations. The project also contributes to ongoing training and education, and supporting the development of research and professional skills related to consultation and community engagement, workshops and conferences, interdisciplinary research, and knowledge mobilization and communication.

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P01

Exploring Priority Areas for Addressing Student-Athlete Mental Health Issues: Perspectives from Canadian University Athletic Directors

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Introduction: Introduction: Over 14,000 student-athletes compete in sports across 120 Canadian universities. There are significant differences in how mental health resources are funded and accessed across these institutions. The distinct cultural and structural features of Canadian sport require made-in-Canada solutions. However, little is known about the extent and capacity of university athletics departments to prioritise student-athlete mental health issues. Therefore, the purpose of this study was to explore differences in the prioritisation and impact of student mental health strategies across university contexts.

Methods: Methods: This study used a bilingual purpose-built survey to capture institutional priorities regarding mental health programming and resources for student-athletes. A total of 32 university athletics directors representing universities from all Canadian provinces and approximately 25% of all Canadian post-secondary institutions. Data were analysed descriptively and non-parametrically.

Results: Results: Analyses revealed no significant differences in the prioritisation or perceived impact of student-athlete mental health strategies across university contexts, including program size and geographical region. Notable descriptive findings indicated that athletics directors believed the sporting environment within their institutions had a greater influence on the mental health of student-athletes than the broader university sport system, underscoring the importance of institution-specific strategies.

Discussion/Conclusion: Discussion/Conclusion: These findings suggest Canadian universities have adopted a homogenous approach to addressing athlete mental health, which may serve as a strong foundation for the development and implementation of nationally scalable programs. However, the lack of significant differences may also indicate that universities are converging around shared understandings (e.g., national-level guidelines such as USport) regarding student-athlete mental health, which fall short in responding to context-specific demands. Qualitative responses suggest this is reflective of limited institutional innovation, insufficient funding, and the early-stage development of athlete mental health strategies. As such, there remains an opportunity to design mental health programming that builds on shared priorities while responding to unique institutional needs.

P02

A Bilateral Comparison of Lower Limb Strength and Pirouette Performance in Elite Female Dancers

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Introduction: Traditional dance training is designed to develop a well-balanced dancer, yet laterality has the ability to impair bilateral strength and functional symmetry. The aim of this study was to investigate the effects of lateral preference on elite level dancers by conducting a bilateral comparison of lower limb strength and pirouette performance. A pirouette is an essential turning skill in dance technique, wherein multiple revolutions are completed on a single supporting leg along the longitudinal axis.

Methods: Using 3D motion capture and force plates for analysis, eight highly trained dancers performed three maximal effort single leg countermovement jumps (SCMJ) bilaterally, as well as ten single pirouette en dehors in both the preferred and non-preferred direction.

Results: A lateral preference questionnaire indicated a rightward bias was prevalent amongst this group of dancers for both footedness and preferred turning direction. Significantly more successful pirouettes were performed in the preferred (73%) compared to the non-preferred condition (50%). The SCMJ data demonstrated no significant differences in jump height and vertical ground reaction force (vGRF) at take-off, suggesting no bilateral strength asymmetry between the lower limbs. There were also no significant differences in any of the discrete biomechanical pirouette performance variables: displacement of the center of mass over center of pressure (COM-COP), trunk angle, knee flexion and external hip rotation of the gesture leg in retiré position, as well as GRF production and peak pelvic rotational angular velocity at push-off. However, non-significant trends toward greater COM-COP displacement at retiré ($0.08\text{m} \pm 0.03$ vs $0.06\text{m} \pm 0.04$) and peak pelvic angular velocity at push-off ($1.04\text{ revs/s} \pm 0.20$ vs $0.99\text{ revs/s} \pm 0.22$) were observed in the non-preferred compared to the preferred direction, respectively.

Discussion/Conclusion: Therefore, the lower success rate of non-preferred pirouettes may be a result of postural instability or the use of a less efficient weight transfer strategy.

P03

Examining the Determinants of Skating Speed in Ice Hockey Athletes: A Systematic Review

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Introduction: The sport of ice hockey is a physically demanding sport, in which skaters perform repeat bouts of sprint-like activities creating a reliance on the anaerobic glycolytic system and aerobic

metabolism for recovery (6). The most important characteristic of highly skilled ice hockey athletes is the ability to skate at high rates of speed, which is why an athlete's skating speed capacity is arguably the most important factor that separates highly skilled players from less skilled players (5,15). The acceleration speed of ice hockey players has the potential to influence success in performance because of the ability the athletes will possess to cover distances faster than their opponent (21).

The purpose of this review is to identify the current available and best suited methods used to predict the on-ice skating ability of an ice hockey athlete through the various means available to sport coaches, sport scientists, and allied team staff.

Methods: In finding the articles to review, the research team used 3 search engines—Pubmed, SPORTDiscus, and Google Scholar. Three search engines were used to limit the number of duplicates and nonrelevant articles extracted. On all 3 search engines, the following search terms were used—ice hockey AND skating speed, determining skating speed, hockey skating, hockey speed, hockey skating AND speed, and predicting skating speed AND hockey. The search terms were decided by the lead author, based on common themes arising in the literature within this specific domain. The original date of the search was December 20, 2022, with a subsequent search done in April of 2024. In addition, the reference lists of the included studies meeting the inclusion criteria after title and abstract screening were examined for additional relevant sources.

Results: A summary of subject characteristics is given in Table 2. Data from the included studies were extracted onto a custom-made Excel document, which included study design, intervention details, subject characteristics, statistical measures, performance variables, and results. Through the 19 studies analyzed, a total of 1,386 subjects are included, with an average age of 19.5 years. Among the studies, 9 studies had male subjects only (2,4,6,8,10,11,18–20). Two studies had female subjects only (3,17). Four studies combined both male and female subjects (9,12,14,21). The level of play across all studies varied. A total of 5 studies looked at junior level or high school level athletes (1,2,10,13,18). Nine studies had collegiate level athletes (3,8,9,11,14,18–21). Four studies used professional level athletes (4,6,7,16). One study used national team level athletes (17).

Among the 19 studies analyzed for the review, the off-ice assessments can be categorized into 4 areas: sprinting, jumping, body composition, and anaerobic power.

Discussion/Conclusion: The act of sprinting is similar to the act of skating in ice hockey, given the relationship that exists between both acts of locomotion in generating horizontal force and horizontal power, which can explain the reason in which many forms of sprinting have been shown to be predictors of on-ice skating speed (18). One of the most well-known sprinting-based test, the 40-yard dash, requires the athlete to sprint 40 yards in which a time is recorded for how fast the athlete achieves this desired distance.

In a cohort of 18 male ice hockey players at the university level, significant relationship was shown to exist between off-ice pro-agility testing and on-ice pro-agility testing speed (11). This study was able to exemplify the importance of change of direction within the sport of ice hockey, and the ability to predict how well an ice hockey athlete can change direction on the ice through the testing of change of direction off of the ice.

An interesting and novel finding that presented itself within the literature came from the Thompson et al. group, in which resisted sprinting was examined in relation to predicting on-ice skating speed. The group used 30 kg of resistance for males and 15 kg of resistance for females, attached behind the athlete, in which the athlete was then asked to sprint for a 15-m distance(22).

Off-ice testing for lower body anaerobic power and strength, through the use of lower limb power-based exercises such as jumping-based tests, can be shown to correlate with many on-ice skating metrics. Jumping-based tests can be broken down into activities that resemble a vertical jump, horizontal jump, counter movement jump, or even a depth drop jump, all of which will be further explained in relation to on-ice skating mechanisms. If an off ice mechanism of testing can be shown to represent lower body power production, the given test will have the highest affinity in predicting on-ice skating speed and performance-based tests (14).

A wide variety of plyometric-based jumping tests have been correlated with many aspects of on-ice skating ability (13). The depth drop jump has been shown to correlate well with skating speeds in both forward and backward skating, maximum skating speeds, and backward average skating speeds (13).

In reviewing the available literature, it is evident that there are off-ice tests that can show a relationship with on-ice skating speed, such as linear sprinting, resisted sprinting, vertical jumping, body fat percentage, and anaerobic power, which all can be used as a valuable tool for sport coaches, strength and conditioning coaches, sport scientists, and scouting teams. Off-ice sprinting, jumping and plyometrics, body composition, and anaerobic power testing, all in their unique ways, have shown relationships with on-ice speed-based testing metrics. However, it is important to note the unique physical and biomechanical demands of the sport that do require special attention. The current literature does support a means to test and predict on-ice skating speed with off-ice testing mechanisms; however, the research team believes further investigation should be done to conclude on a best suited practice for determining skating speed through off-ice measures.

Supporting Information: Link to full text - https://journals.lww.com/nsca-jscr/abstract/2023/10000/femoroacetabular_impingement_in_ice_hockey.26.aspx

P04

Assessing Your Own Skills; Subjective Cognition Versus Objective Cognitive Motor Functioning in a Healthy Athlete Population

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Introduction: The majority of research on athlete cognition has examined subjective cognition and objective cognition independently. To our knowledge, there are currently no studies examining the relationship between subjective cognition and objective cognitive-motor functioning in a healthy athlete population. The present study aims to examine the relationship between subjective cognition and objective cognitive-motor functioning in a healthy athlete population to gain a better understanding of whether these facets of cognition measure unique constructs.

Methods: Ninety-five varsity and intramural athletes (Mage = 20.1, 50% female) from York University, Toronto, Canada, were recruited between August 2024 and October 2024. Subjective cognition was measured using the Patient Reported Outcomes Measurement Information System (PROMIS) Cognitive Function Short Form 8-item, which evaluates how often cognitive challenges were encountered over the past seven days. Cognitive-motor functioning was assessed using the TRAZER Sports Stimulator, which is a computerized interactive program that tests a series of cognitive-motor functions by tracking participants' movements in response to visual targets. Specifically, reaction time and speed were assessed for three cognitive-motor functions: response inhibition, cognitive flexibility, and mental arithmetic. Pearson correlations evaluated the relationships between PROMIS scores and reaction time and speed measures for each of the cognitive-motor functions.

Results: Accordingly, there were no significant correlations between subjective cognition and any of the cognitive-motor scores (r 's range from $-.002$ to $-.20$, p 's $> .05$). These results suggest that measures of subjective cognition and objective cognitive-motor functioning may provide us with unique information about athlete functioning.

Discussion/Conclusion: Therefore, subjective measures may not provide an adequate assessment of athletes' cognitive abilities and may relate more to overall well-being than cognition, specifically. While the PROMIS is important for evaluating subjective assessments of one's cognitive functioning, evaluating objective cognitive motor functioning may better capture an athlete's cognitive ability in the context of sport.

P05

Preseason Multiplanar Hip Kinematics and In-Season Primary Non-Contact ACL Injury Risk: A Systematic Review

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Introduction: Anterior cruciate ligament (ACL) injuries are among the most common sport-related injuries to the lower extremity, with approximately 250,000 occurring annually in North America [2]. These injuries are debilitating, often resulting in extended time away from sport, increased risk of subsequent knee injuries, and reduced performance and career length [1,4]. Roughly 70% of ACL injuries occur through a non-contact mechanism, typically involving dynamic knee valgus, internal tibial rotation, and anterior tibial translation during deceleration or directional change [3].

Given the synchronicity of the lower limb kinetic chain, aberrant hip, knee, and ankle biomechanics have been implicated in ACL loading [5, 8]. However, the influence of three-dimensional hip kinematics remains unclear. This systematic review examined whether preseason hip kinematics are associated with in-season non-contact ACL injuries in athletes.

Methods: Ovid MEDLINE, Embase, CINAHL, SPORTDiscus, and Scopus were searched. Included studies assessed hip kinematics in adult athletes (18-35 years) before the competitive season and reported non-contact ACL injuries during the season. Two reviewers independently screened studies for inclusion, extracted data, and assessed risk of bias using the Quality Assessment Tool for Observational Cohort Studies. Meta-analysis was not performed due to methodological heterogeneity.

Results: Three studies (n=122 female athletes; 13 ACL injuries) were included. Two assessed cutting tasks; one assessed both cutting and deceleration. One study reported no significant group differences in hip flexion during side cutting [9]. Another used 3D statistical parametric mapping during 90° cutting and found lower hip flexion in injured athletes between 73–90% of stance ($p=0.042$) and greater hip external rotation between 65–82% of stance ($p=0.003$) [6]. No differences were observed for ab/adduction [6]. The third study found no significant group differences in MANOVAs; however, greater hip adduction was seen in injured athletes during both tasks when analyzed individually ($p=0.02-0.03$) [7]. Hip internal rotation did not differ between groups [7].

Discussion/Conclusion: Differences in hip flexion, external rotation, and adduction during preseason tasks may be associated with future ACL injury. Inconsistent findings and methodological variability limit interpretation. Preseason hip kinematics and in-season ACL injury should be further studied. This will allow for identification of at-risk athletes and improved design and implementation of training and injury prevention programs.

P06

Preoperative Activity and Risk of Postoperative Complications Following Lower Limb Arthroplasty: A Retrospective Analysis from the All of Us Research Program

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Introduction: Postoperative complications after total joint arthroplasty (TJA) pose significant challenges to recovery. With increased adoption of wearable devices, changes in physical activity levels before and after surgery may offer insights into patient outcomes. This study examined whether changes in step count and activity-related calories around the time of surgery are associated with early postoperative complications.

Methods: A retrospective cohort study was conducted using data from the All of Us Research Program. Adults who underwent hip or knee arthroplasty with available Fitbit and demographic data were included. Mean daily steps and activity calories were calculated 30 days preoperatively and compared to the 90-day postoperative period. Percent change was computed and standardized. Multivariable logistic regression assessed associations with 90-day postoperative complications, adjusting for age, gender, race (White vs. Non-White), ethnicity (Hispanic vs. Non-Hispanic), and BMI. Model discrimination was evaluated using the area under the receiver operating characteristic curve (AUC).

Results: A total of 807 individuals were included (mean age 65.1 ± 7.6 years; 75% female), with 19% experiencing at least one postoperative complication following lower limb arthroplasty. The model revealed that greater deviations in physical activity between the pre- and postoperative periods were associated with increased odds of complications. In particular, larger reductions in activity-related calories postoperatively were associated with a higher complication risk (OR = 0.686 per standard deviation increase; 95% CI: 0.292–1.080; $p = 0.061$). Though not statistically significant, this association approached conventional thresholds. Similarly, greater increases in postoperative step counts relative to preoperative levels were also associated with higher complication odds (OR = 1.256; 95% CI: 0.969–1.544; $p = 0.12$), however, this was also not statistically significant. Higher BMI was significantly associated with an increased risk of complications (OR = 1.531; 95% CI: 1.344–1.718; $p < 0.001$). The model demonstrated moderate discriminative ability (AUC = 0.693; 95% CI: 0.641–0.746).

Discussion/Conclusion: Postoperative complications were more common among patients who demonstrated greater deviations in physical activity levels following surgery. Although these associations did not reach conventional thresholds for statistical significance, the observed trends suggest that maintaining consistent activity patterns pre- and post-operatively may be associated with lower complication risk. These findings highlight the potential use of wearable device data in identifying early indicators of postoperative risk in lower limb arthroplasty, warranting further prospective validation.

P07

Redefining Success: Translating Safe Sport Research into the Quality Coaching Toolkit

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Introduction: In response to increasing recognition of maltreatment in Canadian sport, calls have been made to promote environments that foster holistic well-being and performance. While Safe Sport initiatives have often focused on preventing harm, less attention has been paid to enabling positive coaching practices. This project aimed to bridge that gap by translating research on positive sport environments into a practical, accessible, and evidence-based resource for sport practitioners.

Methods: Qualitative, semi-structured interviews were conducted with Olympic and Paralympic athletes ($n=13$) and coaches ($n=11$), all of whom had achieved international podium success within positive environments. Interviews were analyzed using reflexive thematic analysis (Braun & Clarke, 2019).

Results: Key characteristics of high-quality coaching and sport environments were identified, including holistic development, individualized coaching, respectful coach-athlete relationships, and empowering coaching styles. Findings were translated into a Quality Coaching Toolkit in partnership with the Coaching Association of Canada. The Toolkit offers a strengths-based, trauma-informed framework (the HIGHER method) for coaches working in high-performance and competitive contexts along with strategies such as reflection prompts and planning tools to help coaches assess and adapt their own practices. A redefinition of success, incorporating enjoyment, well-being, personal growth, and sustainability, was central to both the research and Toolkit.

Discussion/Conclusion: This initiative demonstrates the potential for athlete and coach-informed research to drive systems-level change through knowledge mobilization. Findings challenge the assumption that performance and athlete welfare are a 'balancing act', instead offering evidence that high performance can be achieved in environments that are safe, supportive, and empowering. The collaborative process also highlights how partnerships between researchers and national sport organizations can support meaningful, values-aligned cultural shifts in coaching practice.

P08

Development of a Concussion Surveillance Tool for Special Olympics Canada Using the Nominal Group Technique

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Introduction: Concussions are a significant public health concern. Athletes with intellectual disability are often underrepresented in concussion research, education, and care. Special Olympics Canada (SOC) understands concussion risks however concussion rates are unknown. With SOC, this study aimed to co-create a Concussion Surveillance Tool relevant to athletes with intellectual disability to be used to collect concussion information at SOC events and competitions.

Methods: A consensus method, the nominal group technique (NGT), was used to inform the Concussion Surveillance Tool. Two concepts were considered during the NGT: 1) concussion-related information to collect relevant to athletes with intellectual disability, and 2) supports needed to ensure better adherence to concussion protocols. After the NGTs, all participants ranked the final ideas (1=not important to 5=very important). Items that reached 75% consensus or greater (i.e., median scores ≥ 3.75) were included in the surveillance tool.

Results: Six participants (four men, two women; 41-80 years old) completed the NGT across three meetings. Concept 1 (surveillance items) generated 38 ideas, where top scored ideas included whether the athlete returned to play (median score=5) and whether treatment was initiated (median score=5). Concept 2 (supports) generated 36 ideas, where the top scored ideas included verbal communication about the injury (median score=5) and follow-up between medical professionals, athletes, and coaches (median score=5). A content analysis collated the ideas in four categories representing sections within the tool: 1) Athlete demographics information (e.g., concussion history), 2) Concussion incident description (e.g., how did the injury occur?), 3) Injured athlete description (e.g., symptom checklist), and 4) follow-up recommendations (e.g., athlete supports at home).

Discussion/Conclusion: Based on study findings, the Concussion Surveillance Tool was developed. Use of the tool at Special Olympic events and competitions across Canada will improve concussion management post-event and identify gaps where concussion education and prevention can be prioritized.

P09

Lower Extremity Kinematics During Common Ice Hockey Goaltender Stances

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Introduction: Goaltending has evolved significantly over the years, introducing techniques such as the butterfly and reverse vertical horizontal (RVH) post-play, which involve dropping to the knees to cover the lower part of the net. These stances are suggested to place considerable stress on the hip, knee, and ankle joints compared to traditional stances (e.g., standing, vertical horizontal (VH) post-play). However, the kinematic differences between these techniques and potential implications for injury risk has not been fully explored. Therefore, the purpose of this study was to quantify three-dimensional lower extremity joint kinematics during key goaltending stances.

Methods: The kinematics of twenty-six goaltenders (mean (SD) age = 19.5 (2.3) years) were measured during key goaltending stances (i.e., butterfly, standing ready, RVH, and VH) using Theia3D markerless technology. Three-dimensional hip, knee, and ankle angles were quantified in these positions.

Results: The butterfly and RVH compared to the standing ready and VH demonstrated higher mean hip internal rotation (16.6 – 22.2 degrees vs. 5.2 – 11.4 degrees) and ankle abduction (11.7 – 15.9 degrees of abduction vs. 1.6 – 10.8 degrees of adduction). Compared to the standing ready, the kneeling stances also involved higher mean knee abduction (12.4 – 15.1 degrees vs. 5.6 degrees) and external rotation (13.0 – 21.3 degrees vs. 0.7 degrees).

Discussion/Conclusion: The butterfly and RVH stances showed riskier kinematics for common hip, knee, and ankle injuries in goaltenders. These injuries may result from the high hip internal rotation - femoroacetabular impingement syndrome and labral tears, knee abduction and external rotation - medial collateral ligament injuries and meniscal tears, and ankle abduction - high ankle sprains. This study highlights the need for more biomechanics research to understand the demands of goaltending stances and how interventions such as muscle strengthening or load management strategies that limit the volume of specific movements during training could reduce injury risk.

P10

“Hockey First-Education Second”: Canadian Hockey Players’ Experiences with Education

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Introduction: The Canadian Hockey League (CHL) promotes itself as the premier developmental league for players aged 16-20 (CHL, 2025). While the CHL states in policy that it supports both the athletic and academic development of these youth, anecdotal evidence suggests that the training and game schedules of these athletes may impinge on their educational experiences. The 2022 Child Labour in Sport report also highlights concerns about the educational experiences of athletes in high-performance and professional sport. Given the lack of information on developmental hockey, this study explored the educational experiences of former CHL players.

Methods: Eight former CHL players (aged 25-28) participated in one semi-structured interview. Interviews were analyzed using Braun and Clarke’s (2016) thematic analysis.

Results: Findings suggest that players experienced a “hockey first, education second” culture, reinforced by systemic pressures including the CHL’s prestige, demanding schedules, commercial interests, and an anti-education culture perpetuated by team personnel, academic advisors, and tutors.

Discussion/Conclusion: The findings are interpreted through the lens of educational neglect referring to the failure to integrate academic needs into training schedules, often due to excessive training, travel, or the normalization of sport being more important than school (Kerr, 2023). This study highlights the need for structural changes within the CHL to enhance the educational experiences of youth hockey players. Recommendations for addressing the educational neglect faced by CHL players are discussed.

P11

Sleep-Related Breathing Disorders in Athletes and Para-Athletes: A Systematic Review

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Mitsue Aibe

Introduction: Sleep-related breathing disorders (SRBDs), characterized by repeated interruptions in breathing during sleep, are frequent in athletes yet remain understudied and underdiagnosed. This systematic review aimed to comprehensively review on the frequency, consequences, and treatment outcomes of SRBDs among athletes and para-athletes. Also, to synthesize current evidence and recognize key knowledge gaps.

Methods: This systematic review was registered in PROSPERO (CRD42024556899) and following PRISMA guidelines, a comprehensive literature search was conducted across seven databases from inception through July 2024.

Results: Of 3,120 publications captured, there were 19 publications on SRBDs in non-disabled athletes and 1 publication on SRBDs in para-athletes with SCI. The frequency of SRBDs varied from 7% to 68% and according to sport modality: (a) 24%–86.5% in rugby players (n = 4 studies); (b) 8%–62.5% in active football players (n = 4); (c) 22%–41% in retired football players (n = 4); (d) 8% in basketball players (n = 1); (e) 30% in elite swimmers (n = 1); (f) 61% in ice hockey players (n = 1); and (g) 68% in judo athletes (n = 1). In the only study on para-athletes with SCI, 22% of participants had SRBDs. Reported consequences (n=9 studies) included reduced cardiac function, depression, cognitive impairment, and excessive daytime sleepiness. Identified risk factors (n=12 studies) included older age, male sex, high body mass index, large neck circumference, and playing lineman position. Treatment outcomes (n=4 studies) showed continuous positive airway pressure therapy improved sleep quality, reduced daytime sleepiness, and enhanced athletic performance among golfers and judo athletes, while mandibular advancement device reduced apnea severity and snoring among rugby players.

Discussion/Conclusion: SRBDs occur frequently in athletic populations and pose significant health and sports performance implications if unmanaged. Notably, limited research on para-athletes with SCI highlights a major knowledge gap requiring targeted investigation and tailored management strategies.

P12

Systematic Observation and Analysis of Taekwondo Coaching Behaviour in Competition

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Introduction: Since access to an expert coach is critical for athletic excellence (Horton et al., 2005), understanding expert coaching qualities during competition warrants investigation. This study aimed to assess the frequency and duration of different Taekwondo coaching behaviours across Cadet (12–14), Junior (15–17), and Senior (17+) levels.

Methods: Five current or former Taekwondo Canada national team coaches were audio and video recorded during the 2025 National Championships. Recordings were analyzed using Behavioural Observation Research Interactive Software (BORIS) and coded via a modified version of the Coach Analysis and Intervention System (CAIS; Cushion et al., 2012).

Results: A one-way ANOVA examined behavioural frequency differences by age group. Only management behaviour showed a statistically significant difference ($F(2,52) = 7.10, p = .002, \eta^2 = .21$). Tukey's HSD revealed significantly more management behaviour in the senior group ($M = 16.88, SD = 13.37$) compared to cadet ($M = 4.50, SD = 2.93; p = .01$) and junior ($M = 7.00, SD = 7.98; p = .006$) groups. No significant differences were found between cadet and junior groups. Other behaviours were not statistically different, but several showed moderate effect sizes, suggesting there may be practical significance to the increased frequency of senior-level tactical instruction ($p = .31, \eta^2 = .05$), and reduced frequency of cadet-level hustle ($p = .22, \eta^2 = .06$), and psychological instruction ($p = .31, \eta^2 = .04$). A second ANOVA examined differences in performance-state silence. Results showed a significant difference across age groups ($F(2,51) = 7.64, p < .001, \eta^2 = .23$), with significantly longer silence in seniors ($M = 202.23, SD = 77.63$) compared to juniors ($M = 125.00, SD = 55.40; p < .001$). No significant difference emerged between these and the cadet group ($M = 139.66, SD = 73.90$).

Discussion/Conclusion: Results suggest that the frequency of some coaching behaviours differs across age/skill groups, and the amount of performance-state silence increases at the senior level. However, more research is needed to determine why these behaviours are used more frequently in some groups, and to determine the effect that these behaviours might have on performance outcomes.

P13

Evaluating the Stability of Cognition Among Elite Athletes Across Seasons.

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Introduction: The benefit of physical activity on cognitive functions is well-documented. For athletes, rigorous training towards achieving success in sport may also result in alterations in cognition. The purpose of this retrospective study was to explore how cognition among athletes changes across seasons.

Methods: The sample was 58 elite/international-level athletes (N female=44; mean age [SD] =21.58 years [3.91], 16.30-35.58 years) from five sports who trained at a Canadian national sport institute and completed pre-season baseline testing at two time points, 9-21 months apart. Analyses were also conducted in a subset of 24 athletes who had an additional third time point, 6-18 months following the second time point. Cognitive performance was measured by tests from the Vienna Test System, a computerized neuropsychological testing battery. Group-level cognitive stability was evaluated using paired-samples t-tests or Wilcoxon signed-rank tests for data across the two time points, and repeated measures ANOVAs or Friedman's tests for data across the three time points. Smallest worthwhile changes (SWCs) examined individual-level changes across time points.

Results: There were significant improvements on tests of cognitive flexibility and sustained attention across the two time points ($p < .05$). Athletes also had significantly faster reaction times (RTs) on tests of cognitive flexibility and working memory, but slower RTs on a test of selective attention ($p < .05$). Significant differences between the three time points were also observed on tests of cognitive flexibility, working memory, and planning ability ($p < .05$), specifically, between the first and second and/or first and third time points, but not between the second and third time points. Across cognitive tests, the percent of athletes who showed meaningful improvements based on SWCs ranged from 16.67 to 87.50%.

Discussion/Conclusion: The findings suggest that pre-season cognitive performance may change over time. Considering the importance of cognition in sport performance, these findings highlight the need to monitor cognitive functioning over time.

P14

Should You 'Just Walk It off'? The Impact of Daily Steps on the Recovery from Exercise-Induced Muscle Damage

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Introduction: Delayed-onset muscle soreness (DOMS) and temporary reductions in muscle strength are common after unaccustomed exercise and/or high force lengthening contractions (LC). Thus, practical, low-cost, accessible recovery strategies are important to restore exercise performance and/or reduce subsequent injury risk. As higher habitual physical activity is considered the evolutionary default for humans, we hypothesized that higher daily step count would promote muscle strength and DOMS recovery after EIMD.

Methods: In a randomized, crossover manner, nine participants (5M/4F, 22+3 yrs.) completed two 4-day conditions: high activity (HA; 14024+2008 steps/day) and moderate activity (MA; 4743+380 steps/day), separated by a 4-week washout. DOMS (visual analogue scale) and muscle strength (maximal voluntary isometric contraction) were assessed before and daily after a bout of unilateral eccentric exercise (150 maximal LC).

Results: DOMS increased after exercise ($p < 0.001$), peaked on Day 2, and remained elevated above baseline on Day 4. Although there was no effect of activity ($p = 0.213$) there was a large effect ($d = 0.88$) of DOMS reduction at Day 4 with HA. Muscle strength decreased after exercise ($p < 0.001$) and was lowest on Day 2. Although there was no effect of activity ($p = 0.16$) there was a moderate effect ($d = 0.75$) of muscle strength improvement at Day 2 with HA. DOMS and muscle strength were negatively associated ($p < 0.05$) in both the HA ($r = -0.60$) and MA ($r = -0.93$) phases.

Discussion/Conclusion: These findings suggest higher habitual activity may support improved recovery of the lower body following EIMD. This simple, highly accessible activity-based recovery strategy may be particularly relevant for recreational to elite-level athletes aiming to maintain physical performance across consecutive days of exercise.

P15

The Family Quality Participation Framework

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Introduction: Family members are key supporters and enablers of participation in physical activity and sports. The limited research on the adult family adaptive sports experience suggests that family members have their own journeys relating to adaptive sports participation which is tied to the competitor. Much research has been done to explore how to ensure competitors have quality participation experiences, but less is known about how to support the families. As such, the goal of this research project is to identify the elements which enable family quality participation.

Methods: Guided by Family Systems Theory and the Quality Participation Framework and following the adapted AGREE-II guidelines for physical activity messaging, three studies were conducted to

identify the elements of family quality participation. The first study was a scoping review, the second study a single instrumental case study, and the third a validation study. The results of these studies were analyzed according to Framework analysis and descriptive statistics to create the Family Quality Participation Framework.

Results: The analysis of these three studies led to the identification of three elements which enable family quality participation: belongingness, engagement, and recognition. At the centre of the elements of family quality participation is the family system, composed of the competitors and their loved ones, who have a mutually influential relationship. Furthermore, five different levels of family inclusion were identified for each element: 'no families', 'and families', 'families of', 'families matter', and 'families'. Examples of resources for each level and element are provided to support the implementation of families centred programs.

Discussion/Conclusion: The Family Quality Participation Framework provides research-based guidelines for how to incorporate a families focus into sports and physical activity. The identification of different elements and levels can facilitate family inclusion in an adaptive sports context.

P16

Game Changers: Empowering Women Coaches Through a Community Soccer Program

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Introduction: In response to the underrepresentation of women coaches in Canadian sport and persistent barriers to their participation, Guelph Soccer launched a targeted program to increase the representation of girls and women in coaching. The initiative included organization-funded coach training, a women's soccer league with childcare, a social support network, and monthly coach huddles to foster learning and connection.

Methods: Using the CIPP (Context-Input-Process-Product) Model of Program Evaluation, a three-year mixed-methods evaluation was conducted. This included quantitative pre- and post-participation surveys and qualitative focus groups. Across three cohorts, 72 participants completed pre-participation surveys, 30 participants participated in focus groups, and 24 participants completed post-participation surveys. Topics explored included perceived barriers and facilitators to coaching, program impact, feelings toward coaching, and future coaching intentions. A follow-up survey one year post-program assessed continued coaching involvement.

Results: Participants consistently highlighted the program's structure and intentional design, as well as its instrumental, informational, and emotional supports, as critical to their positive experiences. Many participants reported personal and professional growth, including increased confidence, improved preparation and knowledge, greater organizational skills, pride in coaching, and the enjoyment of connecting with like-minded individuals. One year after the program, 70% of participants had continued coaching, with the remainder intending to return to coaching in the future.

Discussion/Conclusion: These findings suggest that a women-led, intentionally designed program that directly addresses known barriers can effectively support women's entry and retention in coaching. What began as a grassroots initiative has since been scaled nationally by Canada Soccer. The evaluation offers important insights and recommendations for developing sustainable and inclusive support programs to advance gender equity in coaching.

P17

What Is Coachability in Sport? A Systematic Review

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Introduction: The term 'coachable' is often used by coaches to describe their athletes. Despite its common usage, the concept remains poorly defined, under-researched, and its value in assessing, developing, and predicting athletic performance is not well understood. This systematic review aims to examine the evidence on how the concept of coachability has been used in prior research and the value of this concept in athlete selection and development contexts.

Methods: The systematic review was completed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Results: Following the search procedure, 8270 articles were extracted from four databases (Scopus, Sport Discus, Ovid). 7070 articles were included in the screening process (n= 1200 duplicates removed). Generally, coachability was used in complex and nuanced ways and preliminary results suggest that the construct is regularly used by coaches to select and invest in athletes. More specifically, coaches perceive coachability to be linked with personality traits (such as cooperation, low immoderation, and anger). Moreover, a task-motivational climate (i.e., climates that focus on mastery of task elements rather than goal directed climates) can prompt athletes to become more coachable (e.g., by promoting mindfulness about their engagement in sport). Finally, where coachability was empirically assessed, the Athletic Coachability Scale (Giacobbi, 2000) was commonly used to measure the athletes' intensity of effort, ability to cope with criticism, reactions to coaching feedback, openness to learning, trust with the coach, and ability to work with teammates.

Discussion/Conclusion: This review contributes to the growing knowledge base on coachability by synthesizing existing research and highlighting its varied definitions and applications in sport. It underscores the importance of coachability in athlete selection and development, while pointing to the need for a more consistent conceptualization and measurement.

P18

“Is It a Bird? Is It a Plane?...”: Distilling Personal Identities Through Movement

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Introduction: Humans can recognize the identity of a person solely based on how they move, suggesting a “dynamic identity signature” embedded in a movement’s spatiotemporal variations. This signature may also reflect broader patterns of individual motor strategies, which are especially relevant in sports where subtle biomechanical differences can critically influence performance and injury risk. This study evaluated a pipeline developed to quantify spatiotemporal variations across diverse human actions.

Methods: An open-access multimodal human movement dataset with recordings of 90 adults (60 females and 30 males) performing a series of 21 actions (e.g., running, jumping jacks) was used. A series of dimensionality reduction and clustering techniques was used to process the high-dimensional movement data and extrapolate relevant dynamic signatures of the movements and identities of the actors.

Results: Principal component analysis (PCA) on angle-axis representations reduced the complex kinematic data into six principal components, capturing up to 96% of the variance. Kernel PCA revealed distinct action clusters and quantified significant between-actor variability (dispersion) across different movements. Movements with greater spatiotemporal dispersion were found to be more indicative of individual identity. Furthermore, actions were grouped into kinematically similar communities based on shared effector use and movement features.

Discussion/Conclusion: This study demonstrates that the dynamic identity signature varies considerably by action type and can be used to quantify individualized movement characteristics. In sports, these signatures may serve as higher-order variables to assess personal playing style, monitor biomechanical consistency, and design personalized training regimens. By linking movement individuality to performance-relevant outcomes, this framework has potential applications in athlete development, rehabilitation, and skill optimization.

P19

Biomechanical Assessment of a Two-Foot Vertical Jump Following Anterior Cruciate Ligament Reconstruction

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Introduction: A two-foot vertical jump is commonly used as a return-to-sport (RTS) assessment following ACL reconstruction (ACLR)¹. The conclusions drawn in a clinic (e.g. achieve 90% of range of motion or strength in the involved limb compared to the contralateral limb) may not reflect the underlying mechanisms to complete the jump by the athlete. Therefore, the purpose of this study was to compare kinematic and kinetic limb symmetry indexes between ACLR patients and healthy controls at the time of return to sport

Methods: Data were collected on 27 ACL patients (M:14; F:13; Age: 24.92 [5.14]) and 27 healthy controls (M:17; F:10; Age: 24.44 [3.27]). Isometric strength was measured bilaterally with a dynamometer with the knee positioned at 90° (Biodex System 4, Evome Medical Technologies, Shirley, NY). Marker data was collected using 17 Qualisys motion capture cameras (Qualisys, Göteborg, Sweden) and ground reaction force (GRF) data was collected synchronously using two force plates (BP600900; AMTI, Watertown, MA, USA). Wireless EMG electrodes (Delsys, Natick, MA) and (3M, Minnesota, USA) were positioned over the quadriceps, hamstrings, and calves. Data were collected while the participants performed a two-foot vertical jump and were analyzed at initial landing and 200ms post-landing. The Limb symmetry index (LSI) was also used to compare the involved limb and the uninvolved limb for ACLR patients and the non-dominant limb and the dominant limb for the healthy participants. A two-tailed, independent samples t-test was performed on each of the LSI values. Significance was set at $p < 0.05$.

Results: There were a number of statistically significant differences in the LSI values, between the ACLR patients and the healthy controls, with respect to knee joint kinematics and ground reaction forces. There were no statistical differences in the EMG LSIs between groups (Table 1). There were a number of statistically significant differences in the LSI values, between the ACLR patients and the healthy controls, with respect to knee joint kinematics and ground reaction forces. There were no statistical differences in the EMG LSIs between groups (Table 1).

Discussion/Conclusion: Despite statistically similar EMG LSI values, the ACLR patients are exhibiting kinematic, kinetic, and strength deficits compared to the healthy controls. This is despite being cleared by a clinician to RTS. Most RTS protocols, only consider the jump height in RTS assessment and not the underlying mechanisms of how this is achieved.

Supporting Information:

Figure 1: Comparison of LSIs between the ACLR patients and the healthy controls (* $p < 0.05$).

	Flex/ Ext	Abd/Add	Int/Ext	GRF Med/Lat	GRF Ant/Post	GRF Sup/Inf	Ext. Moment	Flex. Moment
ACLR	0.8 [0.2]*	1.0 [0.3]	1.0 [0.5]*	0.8[0.3]*	0.8 [0.2]*	0.8 [0.3]*	0.7 [0.2]*	0.9 [0.2]
Healthy	1.0 [0.2]	1.1 [0.4]	1.3[0.5]	1.1[0.3]	1.2 [0.5]	1.1 [0.2]	1.0 [0.2]	1.0 [0.1]

P20

Keeping Your Head in the Game: Validation and Exploration of a Body Image Interference Measure Among Athletes

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Introduction: Body-related attention is distracting to athletes' ability to concentrate in competition and can lead to detriments in performance. Body surveillance, disordered eating, and body-related shame and guilt are established body-related distractors for athletes. Body image interference (BII) refers to attentional focus disruption due to preoccupation with the body resulting in body-related attention bias with implications for competitive performance.

Methods: This study explored the validity of a new BII measure among athletes. In this study, data from an initial sample of athletes (N = 209) was used to conduct exploratory factor analysis which yielded a two-factor structure. Confirmatory factor analysis demonstrated good model fit of the two factors reflecting negative and positive subscales. A second sample of athletes (N = 97; 60.8% cisgender women) completed the BII scale and measures of body surveillance, body-related authentic and hubristic pride, shame, guilt, and disordered eating.

Results: A path model tested body surveillance as a predictor of BII subscales with body-related emotions and disordered eating as mediators. The model yielded (1) direct effects of body surveillance on guilt, shame, and disordered eating, (2) direct effects of shame and disordered eating on negative BII, and (3) direct effects of guilt and authentic pride on positive BII.

Discussion/Conclusion: The results underscore the relevance of body surveillance, body image emotions, and body-related behaviours for how athletes experience body-related attention and performance in competition. The findings also suggest a possible adaptive role of body image on attention given associations of body-related authentic pride with positive BII.

P21

Beyond the Podium: Examining Performance Differences at the Paris 2024 Olympic Games

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Introduction: The Paris 2024 Olympic Games marked the first gender-parity Games, with equal numbers of male and female participants. While existing literature often focuses on sex-based physiological differences among elite performers (e.g., Joyner et al., 2025; Hunter et al., 2023), limited attention has been paid to how these differences shift across the full range of competition. This study examines whether performance gaps between male and female athletes remain constant, converge, or diverge from podium finishers to last-place competitors. Understanding these patterns may help

identify structural, psychological, and social barriers that influence female athletes' development and performance trajectories.

Methods: This study analyzed results from individual track and field events at Paris 2024 where direct male-female comparisons are valid: 100m, 200m, 400m, 800m, 1500m, 10,000m, marathon, racewalk, long jump, triple jump, high jump, and pole vault. Events with structural discrepancies (e.g., implement weight or hurdle height) were excluded. Rankings were normalized to enable performance comparisons across different field sizes. Descriptive statistical analyses were conducted to assess if performance differences change progressively across rankings.

Results: Preliminary analysis shows a consistent trend of divergence between male and female performances across most running events. At the podium level, sex-based differences were smallest (typically 10–15%), increasing to 12–30% among lower-ranked athletes. In field events, early results suggest greater variability, often due to the presence of outlier performances (e.g., in the men's pole vault). These findings suggest that physiological differences alone may not fully account for observed disparities. Instead, structural, psychological, and historical barriers may contribute to increased performance gaps as ranking declines.

Discussion/Conclusion: These findings point to the need for a broader understanding of gendered performance differences in elite sport. While physiological explanations remain important, the widening gaps beyond podium placements underscore the influence of systemic inequities, including differential access to coaching, competition, resources, and support systems. This work provides a foundation for more nuanced performance analysis and policy interventions aimed at fostering equitable pathways for athlete development and success.

P22

Examining the Associations Between Objective and Subjective Cognition and Mental Health Symptoms in a Sample of Healthy University Athletes

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Introduction: Cognitive assessments are used for baseline evaluations and post-injury monitoring in sport. These assessments involve objective cognitive testing and subjective reporting of cognition and mental health symptoms. Assessing an athlete's cognition requires an understanding of the associations between these variables. Thus, the present study examined the relationship between objective cognition, subjective cognition, and mental health symptoms in healthy athletes

Methods: Athletes from York University (N = 100, Mage = 20.2, 50% female) completed computerized cognitive tests (Creyos cognitive battery), a measure of subjective cognition (PROMIS), a measure of self-reported cognitive symptoms (SCAT5 Symptom Evaluation, select items), and measures of depression

(PHQ-9) and anxiety (GAD-7). Three objective cognitive domains were derived from performance on the cognitive battery (Short Term Memory; Reasoning; Verbal Processing). Scores on each measure were standardized using validated population-based norms. This allowed us to describe the level of objective cognition and rate of subjective cognitive complaints and mental health symptoms in our sample. Linear regressions were conducted to examine the association between subjective cognition, objective cognitive domains, and SCAT5 cognitive symptoms, while controlling for mental health, age, and sex.

Results: None of the objective cognitive domains were associated with subjective cognition, $p > .05$. Greater SCAT5 cognitive symptoms were associated with worse subjective cognition, $B = -1.26$, $p < .001$. Greater mental health symptoms were associated with worse subjective cognition, $B = -3.00$, $p < .001$.

Discussion/Conclusion: Objective cognition was not associated with subjective cognition or SCAT5 cognitive symptoms, suggesting that objective cognition may provide us with unique information about athletes' functioning. The association between SCAT5 cognitive symptoms and the PROMIS, a gold standard measure of subjective cognition, suggests that the SCAT5 can serve as a proxy for assessing subjective cognition. These results have implications for the measures we should include in the assessment of athletes' cognition.

P23

When Practice Pays Off: How Practice Schedule and Learning Context Shape Motor Performance in Golf Putting

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Introduction: Motor learning in social settings, such as during team practice, allows learners to potentially benefit from both the execution and observation of the to-be-learned skill. The present study investigated the outcomes of a specific type of social motor learning in which pairs of individuals (dyads) alternate between performing and observing the skill. The study focused on the impact of constant and variable practice schedules within dyadic practice of a golf-putting task.

Methods: Because previous research shows that variable practice conditions aid learning compared to constant practice, we investigated if dyadic learners practicing in a constant practice schedule (n=20; 1-distance) gained from observing their partner practicing in the variable schedule (n=20; 4-distance) compared to individuals practicing alone (i.e., no observation) in a constant schedule (n=20; 1-distance). Participants completed: pre-tests; acquisition sessions (50 physical practice trials [plus 50 observation trials for the dyad group]); immediate post-tests; and 24-hour retention and transfer tests.

Results: Preliminary analyses revealed that accuracy and consistency improved in all groups during acquisition and that these improvements were maintained in retention and transfer (all $p < .001$). There were no significant group differences in any experiment phase. These initial results did not replicate previous research on the practice variability effect.

Discussion/Conclusion: The lack of effects may be related to the variability associated with putting in novice participants or interference (rather than facilitation effects) from observing the partner's performance. Additional analyses will be conducted and reported on the patterns of performance changes across sessions as well as psychosocial outcomes such as motivation and self-efficacy.

P24

Whose Side Are You on? How Footedness Affects Temporal Encoding Processes of Soccer Passes

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Introduction: Athletes learn to predict sport-specific spatial aspects of projectile trajectories (e.g., Abernethy & Russell, 1987; Makris & Urgesi, 2015). Such predictive ability appears to be related to handedness or footedness, arguably exacerbated by the likelihood of interacting with right- versus left-sided kinematic information (re.: negative perceptual frequency hypothesis; Hagemann, 2009). Notably, asymmetries in such perceptual biases have not been examined from a temporal perspective, which is critical to study due to the spatiotemporal nature of many sport skills. It was hypothesized that implementing a sport-specific motor task would reveal reduced rightward bias in left-footed soccer players compared to previous studies, as both perceptual and motor experience would influence predictive ability.

Methods: Experienced left- and right-footed soccer players (n=30) completed a pass-return task, wherein they watched videoed passers (left- or right-footed) kicking a ball towards them at 3 different speeds. Participants then passed a soccer ball to one of three possible targets; they were asked to be accurate as possible in terms of the temporal onset and the endpoint spatial accuracy of their kick. Videos of the passer were occluded at ball contact to emphasize the encoding of kicking approach kinematics.

Results: A 3-way ANOVA revealed a significant interaction between passer footedness and pass speed, which indicated a larger change in response time across pass speeds when observing left- versus right-footed passers ($F(2,56)=13.2$, $p < .001$, $\eta_p^2=.32$). Critically, pre-planned contrasts showed that left-footed participants exhibited significantly larger response time differences across pass speeds when observing left-footed passers, as compared to those of right-footed participants.

Discussion/Conclusion: Such results provide evidence that asymmetries in soccer players' sensorimotor experience influence their projectile prediction capabilities and not just perceptual familiarity alone. As such, there are practical advantages to considering both lateralized perceptual experiences and motor processes for athlete development in practice and gameplay.

P25

Quantifying the Upper Limits of Skeletal Muscle Hypertrophy: Insights from a Longitudinal Study in University Athletes

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Introduction: Resistance exercise training (RET) has been well-documented to yield improvements in physical function through skeletal muscle adaptation. Primary adaptations often sought after are muscular size/mass (hypertrophy) and strength changes. Skeletal muscle mass (SMM) plays a valuable role in health, quality of life and physical function, and, in many cases, it is positively correlated with sports performance. However, it is understood that there is an upper limit to the amount of muscular hypertrophy attainable by an individual. For competitive contact-sport athletes, altering body composition to meet the physical demands of their position is common practice. Many athletes, prioritize the accretion of SMM through RET. Because of this, high-level athletes undertaking monitored, prescribed, and intense training represent a valuable population to observe potential upper limits of muscular hypertrophy and strength adaptation.

Methods: Gold-standard methods to track and assess body composition and strength changes over two years were used in a cohort of ~150 university-level varsity football athletes of varying positions. All athletes will be following a pre-set training design involving heavy RET four times per week and recording specific exercises and training loads. Each program is individualized to optimize body composition for the athlete's position and designed by a certified strength and conditioning specialist. Body fat percentage, weight, total fat mass, and total lean mass will be determined using dual x-ray absorptiometry and bioelectrical impedance analysis. All measures will be taken annually at three-time points for a total of six data collection points.

Results: DEXA derived total-body-less-head (TBLH) lean mass changed across the first competitive year of collections, with varying patterns observed across positional groups. When collapsed across all participants, mean TBLH lean mass decreased over the competitive season ($-299.8 \pm 2077.9\text{g}$, $n = 63$), but subsequently increased substantially during the off-season ($+1712.5 \pm 2203.3\text{g}$, $n = 66$). Positional sub-analysis revealed great variability in lean mass changes. Offensive linemen demonstrated the largest off-season gains in lean mass ($+2421.6 \pm 2128.9\text{g}$, $n = 8$), while also losing greater than average lean mass during the competitive season ($-451.4 \pm 2849.2\text{g}$, $n = 7$). In contrast, the quarterbacks/special position group gained lean mass across both the competitive ($+309.8 \pm 2665.3\text{g}$, $n = 5$) and off- ($+1032.3 \pm 1935.8\text{g}$, $n = 6$) seasons.

Discussion/Conclusion: These findings suggest that off-season resistance training plays a critical role in restoring and increasing lean mass following in-season declines. Notably, lean mass trajectories varied by positional group, with offensive linemen experiencing the greatest fluctuations.

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