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2023 CASEM Poster Presentations

(Clin J Sport Med 2023;33:e20–e37)

The Differences in Pain and Cardiovascular Responses Between Male and Female Athletes During a Cold Pressor Test

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Objective: In the general population, there is evidence that women experience more pain than men, but this has not been fully evaluated in athletes. Therefore, the purpose of our study was to measure the differences in pain and cardiovascular variables between male and female athletes during a painful cold pressor task.

Study Design: Two groups, pre–post test design.

Subjects: Sixty healthy male university athletes (age = 22.9 ± 2.2 years, height = 179.3 ± 9.6 cm, weight = 89.1 ± 12.2 kg) and 60 healthy female university athletes (age = 22.5 ± 2.5 years, height = 164.8 ± 6.7 cm, weight = 64.9 ± 9.2 kg) participated in the study.

Intervention: We used the cold pressor task, which requires the participant to immerse their hand in cold water for 3 minutes to induce pain and to increase blood pressure.

Outcome measures: We measured pressure pain thresholds (PPT) at the upper extremity and lower extremity before and after the cold pressor task. We used the numeric pain rating scale to assess pain, and we measured heart rate, systolic blood pressure, and diastolic blood pressure before, during, and after the cold pressor task.

Results: All participants experienced a significant amount of pain during the cold pressor task. There was no difference in pain during the cold pressor task between the male and female athletes (male = 5.56 ± 2.36 , female = 5.7 ± 1.69 , $P = 0.723$). Female athletes had significantly lower upper extremity PPT scores compared with male athletes (females = 70.2 ± 24.7 N and 74.7 ± 24.3 N and males = 97.9 ± 31.6 N and 107.9 ± 35.5 N; all $P < 0.001$). A similar result was observed for the PPT at the lower extremity. Although there were no significant differences in heart rate before and during the cold pressor task between male athletes (68.6 ± 10.2 bpm and 70.9 ± 10.2 bpm) and female athletes (70.2 ± 8.8 bpm and 72.8 ± 9.8 bpm, $P = 0.361$ and $P = 0.299$), there were significant differences in systolic blood pressure before and during the cold pressor task (males = 129.0 ± 11.8 and 143.5 ± 11.6 , females = 111.9 ± 9.4 and 129.3 ± 12.4 , $P < 0.001$ for both).

Conclusions: Although male and female athletes experienced a similar amount of pain during the cold pressor task, pain thresholds were significantly lower in female athletes compared with male athletes, which is a separate pain construct. The differences in PPT and systolic blood pressure

could indicate that female athletes have a different conditioned pain modulation compared with male athletes.

Acknowledgements: This study was partially funded by the Canadian Athletic Therapists Association.

Follow-up After ACL Reconstruction: How Long is Long Enough?

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Objective: To assess the differences in patient-reported outcome measures (PROMs) at 1 year and 2 years after anterior cruciate ligament reconstruction (ACLR) and evaluate the need for follow-up 1 year after the surgery.

Study Design: A retrospective comparison of prospectively collected PROMs.

Subjects: All patients who underwent an ACLR by a single surgeon between 2016 and 2020.

Intervention: Primary ACLR with or without associated meniscal surgery by a single surgeon between 2016 and 2020. Demographics include age, sex, side, and ethnicity.

Outcome Measures: Six externally validated PROMs were collected preoperatively and at 6, standardized, postoperative times. A repeated-measures analysis of PROMs at 1 year and 2 years after the surgery and subgroup analyses based on sex, age, and associated meniscal injury were completed. Differences in PROMs were compared with previously published or calculated minimal clinically important differences for each score.

Results: One-hundred forty-five participants were included in the final analysis. All PROMs except the Veteran's Rand-12 Mental Component showed a statistical improvement at 2 years compared with 1 year after ACLR. However, only the Quality of Life and Sport and Recreation domains of the Knee Injury and Osteoarthritis Outcome Score showed a clinically significant difference at 2 years postoperatively. No major differences were found in the subgroup analyses compared with the entire included sample.

Conclusion: Overall, PROMs exhibit little to no clinically meaningful difference at 2 years compared with 1 year after ACLR. As reinjury generally triggers rereferral, a 2-year follow-up visit has low clinical utility and increases financial and opportunity costs for the patient, physician, and health care system.

Acknowledgements: None.

The impact of 2-hour exertional heat stress on exercise-induced gastrointestinal syndrome and exercise-associated gastrointestinal symptoms in masters versus young adult endurance athletes

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Objective: To determine if the impact of exertional heat stress on the gastrointestinal tract varies between masters (≥ 40 years) and young adult (< 30 years) endurance athletes.

Study Design: Cross sectional.

Subjects: Sixteen (male $n = 12$ and female $n = 4$) masters [mean (SD): age 43.9 (3.2) years, height 176 (8) cm, body mass (BM) 74.2 (11.6) kg, fat mass 19.2 (6.3)%, $\dot{V}O_{2\max}$ 56.3 (6.9) mL/kgBM/min, and weekly training volume 291 (287) min], and 21 (male $n = 14$ and female $n = 7$) young adult [age 25.9 (2.3) years, height 177 (7) cm, BM 69.5 (8.4) kg, fat mass 14.6 (4.9)%, $\dot{V}O_{2\max}$ 61.0 (7.8) mL/kgBM/min, and weekly training volume 230 (294) min] recreationally trained, non-acclimatized, endurance athletes volunteered to participate.

Intervention: Two hours running at 60% $\dot{V}O_{2\max}$ in 35°C ambient conditions and 29% relative humidity.

Outcome Measures: Whole-blood samples were collected before, immediately after, 1 hour after, and 2 hours after exercise and analyzed for markers of exercise-induced gastrointestinal syndrome (EIGS) (plasma concentrations of I-FABP, sCD14, LBP, IgM, and systemic inflammatory cytokines). Thermoregulatory measures (rectal temperature and thermal comfort rating), heart rate (HR), rating of perceived exertion (RPE), and gastrointestinal symptoms (GIS) were recorded every 10 to 20 minutes during exertional heat stress.

Results: Preexercise to postexercise peak magnitude of change in intestinal epithelial integrity markers did not significantly differ ($P > 0.05$) between masters [mean (95% CI): I-FABP 1632 (959-2304) pg/mL, sCD14 -0.17 (-1.75 to 1.42) μ g/mL, LBP -0.68 (-3.54 to 2.19) μ g/mL, and IgM -3.71 (-31.1 to 23.7) MMU/mL] and young adult [I-FABP 1378 (815-1940) pg/mL, sCD14 0.59 (0.05 - 1.13) μ g/mL, LBP 1.17 (0.02 - 2.31) μ g/mL, and IgM 38.9 (-2.31 to 80) MMU/mL] endurance athletes. Peak postexercise plasma concentrations of proinflammatory cytokine IL-1 β was higher in young adult [3.04 (0.34 - 5.75) pg/mL, $P = 0.030$] vs masters [-1.08 (-3.55 to 1.39) pg/mL] endurance athletes. No difference between other systemic inflammatory cytokines was observed ($P > 0.05$). Severity of GIS during exercise was not different between masters [sum (range): 329 (0-69)] and young adult [608 (0-219)] endurance athletes ($P > 0.05$), nor were measures of thermoregulatory strain. Young adult endurance athletes presented significantly higher HR ($P = 0.019$) and RPE ($P = 0.030$) (165 bpm and 14, respectively) compared with masters (150 bpm and 12, respectively) endurance athletes along the exertional-heat stress.

Conclusions: Pathophysiology of EIGS in response to 2 hours of exertional heat stress is not substantially different in older active adults, with masters endurance athletes responding comparably to young adult endurance athletes. Despite a significant difference in some biomarkers of EIGS, levels remained within reference range and are of no clinical relevance.

Infrared Thermography: A Novel Tool for Monitoring the Healing Process of Fractures—A Systematic Review

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Canada; and 2CRIR-Lethbridge-Layton-Mackay Rehabilitation Centre, Montreal, QC, Canada.

Objective: This systematic review examined the current evidence using infrared thermography for measuring the change in tissue temperature during the healing process of fractures. The quality of the evidence was evaluated with the purpose of providing recommendations for clinicians when using infrared thermography.

Data Source: We searched 3 databases (Clarivance—Web of Science, Google Scholar and PubMed.gov) for studies comparing medical imaging and infrared thermography during the follow-up period of fractures in the extremities. One researcher conducted the full-text review, and 2 researchers completed the quality assessment of the eligible studies.

Main Results: We identified 3 research studies that met our inclusion criteria. One inclusion criterion that was necessary was evaluating fractures over a follow-up period of minimum 6 weeks using both infrared thermography and another form of imaging. In all 3 studies, researchers used infrared thermography to compare the temperature of the injured limb with the uninjured limb. A total of 61 participants with either forearm or lower-leg fractures were examined. The conclusion of all 3 studies indicated that during the inflammation phase, a 1°C temperature asymmetry is statistically and clinically significant. As the fracture healed during the repair and maturation phase, a decrease in temperature asymmetry was observed in all participants. Resuming training or sport was considered safe when the temperature of the fractured limb was equal to the uninjured side. Finally, all studies were also able to correlate the temperature changes to the healing phases of the fractures.

Conclusions: According to the grading criteria used to evaluate the research articles, the body of evidence supported the use of infrared thermography once a patient was diagnosed with a fracture by traditional medical imaging. Infrared thermography can safely be used to monitor the evolution of a stress fracture. The use of infrared thermography could be useful to determine the state of healing and for a safe return to sport. Infrared thermography is a new technology, and clinicians should understand that more research is needed and that infrared thermography cannot replace traditional diagnostic imaging tools.

Acknowledgements: This systematic review was partially funded by the Canadian Athletic Therapists Association (CATA).

Ask Teachers How—A Decade of Concussion Management Community Collaboration

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Objective: To share the experiences of one Ontario community's decade long collaboration among educators and health care professionals to optimize students' return to school after a concussion.

Study Design: The key organizers of a secondary school professional development workshop on the optimal return to school after a concussion were interviewed a decade later in a qualitative manner.

Subjects: Ninety-four educators and school support personnel attended the original 2012 concussion management educational workshop.

Intervention: Presurveys and postsurveys were completed by the 2012 participants. Educators were asked for input on how best to accommodate students returning to school after concussion. With the support of a local health professional, the educators' committee then developed the Green Folder tool, which was approved by the school board and implemented within their school in 2015. The Green Folder was taken by the postconcussion student to guidance appointments, to each class, and to medical appointments to facilitate communication, expectations, and accommodations.

Outcome Measures: Key organizers were queried regarding barriers, facilitators, and overall impressions on the development and implementation of the Green Folder.

Results: Some of the biggest challenges included a lack of awareness and stigma regarding concussions among students, teachers, and parents. With ongoing education and teamwork, the tool was very well received and was enabled by open communication among all members of the student's circle of care. They also reflected upon how this collaboration ultimately led to a much larger resource for "return-to-school" postconcussion education and management. This larger resource was developed and released in 2019, and it is known as "SCHOOLFirst" (<https://schoolfirstconcussion.ca/>).

Conclusions: Concussion advocacy can become richer when key community stakeholders are empowered and engaged by concussion researchers in the health care professions. Our example can be heralded by many other communities in the development of similar programs.

Assessing the Importance of Past Physical Activity in Predicting Current Injury Risk Using Weighted Cumulative Exposure Methods

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Objective: Physical activity-related injury risk among children is affected by current and past activities. Past activity may predispose to injury through tissue damage and insufficient recovery or protect against injury by strengthening tissue with sufficient recovery. It is unclear what the relevant time window and relative importance of past activity are in predicting time to injury. The objectives of this study are to (1) determine the relative importance of activity done in past weeks in predicting current injury risk conditional on activity in the current week in children and (2) identify the time window over which past activity is relevant for predicting current injury risk.

Study Design: Prospective cohort study with weekly follow-up for 5.5 years.

Subjects: One thousand six hundred sixty Danish school children aged 6 to 15 years.

Observation Technique: Parents reported on the number of times their child participated in recreational activity (activity sessions) and whether they experienced pain each week. Participants with pain were followed up by a clinician who diagnosed any injuries.

Outcome Measures: The outcome was time to first clinician-diagnosed injury. Weighted cumulative exposure (WCE) functions were estimated for the association between the number of weekly activity sessions and time to first injury in each school year, conditional on activity in the current week. WCE functions were estimated using different time windows (10, 15, 20, 25 weeks), and the best fitting function was determined using the Akaike Information Criterion. We generated 95% confidence intervals accounting for repeated measures by bootstrap resampling.

Results: The best fitting WCE function included 20 weeks of past activity. Higher levels of activity recorded in the previous 2 to 9 weeks were predictive of increased risk of injury. However, given the same recent activity history, activity done more than 9 weeks earlier appeared protective.

Conclusions: WCE methods provide insight into time-specific associations between activity history and injury. Although higher levels of physical activity done recently may predict injury caused by increased fatigue and tissue damage, those who remain uninjured during this time may be less likely to be injured later on due to beneficial long-term effects of activity such as tissue strengthening.

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The Impact of Amino Acid Based Beverage Interventions on Gastrointestinal Status in Response to Exertional-Heat Stress

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Objective: To determine the effects of 2 differing amino acid (AA) beverage composition interventions on biomarkers of gastrointestinal status in response to exertional heat stress.

Study Design: Counterbalanced, crossover double-blinded RCT.

Subjects: After ethical approval and informed consent, 20, healthy, endurance running-trained nonheat acclimatized or acclimated male participants [mean (SD): age 32 (8) years, height 1.81 (0.05) m, body mass 77.7 (7.4) kg, fat mass 15.1 (5.1)%, and $\dot{V}O_{2\max}$ 59.6 (8.1) mL/kg/min] volunteered to participate.

Intervention: One week after the initial assessment, participants were randomly allocated to complete 2 exertional heat stress trials, with at least 1-week washout. Trials included a water control trial (CON) and 1 of the 2 AA beverages developed using EBS HydroActive Technology. On VS001 (4.5 g/L AA) and VS006 (6.4 g/L AA), participants were asked to consume a 237 mL prefabricated beverage with breakfast

and dinner for 7 days before the exertional heat stress trial, and every 20 minutes (from 0 minute to 120 minutes) during 2 hours running at 60% $\dot{V}O_2$ max in 35°C ambient conditions. CON received water volume equivalent.

Outcome Measures: Whole-blood samples were collected before, immediately after, 1 hour after, and 2 hours after exercise and analyzed for biomarkers of exercise-induced gastrointestinal syndrome (EIGS), including plasma concentrations of I-FABP, sCD14, LBP, IgM by ELISA, and systemic inflammatory cytokines by multiplex techniques. Physiological and thermoregulatory strain markers [i.e., physiological strain index (PSI)] and gastrointestinal symptoms (GIS) were recorded every 20 minutes during exercise.

Results: Overall, average PSI [mean (95% CI): 5.9 (5.0-6.7)] did not differ between the trials ($P > 0.05$). Preexercise resting biomarker concentrations of gastrointestinal status did not significantly differ between the trials ($P > 0.05$). Lower preexercise to peak postexercise I-FABP [Δ 249 (60-437) pg/mL, 900 (464-1336) pg/mL, 1485 (1050-1920) pg/mL], sCD14 [Δ -93 (-458 to 272) ng/mL, 12 (-174 to 197) ng/mL, 854 (527-1180) ng/mL], IgM (Δ -6.5 (-23.0 to 9.9) MMU/mL, -10.4 (-16.2 to 4.7) MMU/mL, 8.8 (3.1-14.5) MMU/mL), and systemic inflammatory profile [69 (52-86) arb.units, 62 (51-74) arb.units, 99 (59-139) arb.units] responses, but not LBP [Δ 9.0 (6.9-11.2) μ g/mL, 9.2 (7.2-11.3) μ g/mL; 9.8 (8.4-11.2) μ g/mL], were observed on V0001 and V006 compared with CON ($P < 0.05$), respectively. GIS did not significantly differ between the trials [% incidence and severity [mean (range)]: V0001 90% at 25 [0-93], V006 90% at 23 [0-62], CON 80% at 19 [0-65]].

Conclusions: The consumption of beverages containing AA, ranging 4.5 to 6.4 g/L, twice daily for 7 days, before and during exertional heat stress ameliorated the gastrointestinal integrity and systemic inflammatory responses associated with EIGS but without exacerbating GIS.

Nonsurgical Management of the Medial Collateral Ligament of the Knee: Understanding Adherence to Bracing Treatment

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Objective: To understand the facilitators and barriers to wearing a brace for the nonsurgical management of the medial collateral ligament of the knee.

Study Design: A qualitative study guided by patient-oriented research (POR) principles and interpretivist grounded theory (IGT).

Subjects: Sixteen patients (6 male and 10 female, age range: 32-64 years) from a randomized clinical trial (RCT) comparing the effectiveness of 2 different 6-week knee bracing protocols. The patients were recruited within a day of completing the bracing treatment.

Observation Technique: Subjects were interviewed using a semistructured guide to understand the patient's experience of wearing the brace as prescribed.

Outcome Measures: IGT was used to develop an understanding of the facilitators and barriers to MCL knee bracing adherence. The final model was coconstructed with 2 patient researchers recruited from the RCT.

Results: Five core categories were identified to classify the diverse facilitators and barriers to brace wearing: patient factors, clinical context, treatment factors, injury factors, and external factors. The resulting patient-centered model demonstrates how the complex balance between the facilitators affected patients' decision to wear the brace. Patient-specific facilitators were crucial to increasing brace wearing, especially having a strong desire to heal, experience with similar treatments, a good understanding of the purpose of the treatment, being of older age, and using positive coping mechanisms. Other facilitators of brace adherence were identified as positive social support, frequent clinical follow-ups, building effective relationships with clinicians, and higher brace satisfaction (i.e., ease of use and efficiency). Key contributors to reduced brace-wearing adherence were recognized as low treatment satisfaction (i.e., treatment duration and brace discomfort), certain sleeping habits, symptom improvement, and interpersonal hindrances (e.g., negative affect, low resilience, depression, anxiety).

Conclusions: Understanding the impact of treatment on clinical and patient-reported outcomes requires a thorough consideration of treatment adherence. This qualitative patient-oriented study provides a greater understanding of the complex nature of adherence to bracing MCL injuries. Recommendations for key knowledge users include improving bracing technology and comfort, implementing regular follow-up appointments with consistent clinicians, providing patients with high-quality information (i.e., injury and treatment pamphlet), and aiding patients in developing effective coping mechanisms and positive social support.

An Investigation of Active Force in Skeletal Muscle Fibers from Children With Cerebral Palsy

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Objective: To investigate the ability of single muscle fibers isolated from children with cerebral palsy (CP) to produce active force.

Study Design: Experimental study.

Subjects: Twenty-four muscle fibers from 6 adductor longus muscle biopsies isolated from children with CP.

Intervention: Adductor longus biopsies were obtained from children with CP ($n = 6$, 2-12 years) who underwent tendon release surgery. Muscle biopsies were permeabilized using 1% triton X-100 for 3 hours on ice. Fibers ($N = 24$) were isolated and then activated using a solution containing calcium and ATP. The active force-length (F-L) relationship of the fibers was determined using maximal activation at sarcomere lengths ranging from 2.4 μm to 3.4 μm . Sarcomere lengths were determined using laser diffraction. Force was normalized to fiber cross-sectional area to obtain stress. Due to the absence of samples from typically developing children, the maximal active stress of fibers from children with CP was compared with that produced by fibers from 1-month-old mice (equivalent human age of 12-years) and adult rats, which are known to produce active stresses similar to those produced by human fibers.

Outcome Measures: The outcome measures were the active F-L relationship of fibers from children with CP, and the maximal active stress of fibers from children with CP and mouse and rat muscles.

Results: We observed a leftward shift in the F-L relationship of the fibers from children with CP compared with a theoretical human F-L relationship, that is, peak stress occurred at a sarcomere length (2.4 μm), placing it on the ascending limb of the theoretical human F-L relationship. Furthermore, the maximal active stress of the fibers from children with CP was reduced ($P < 0.05$) compared with young mouse and adult rat fibers (82 ± 34 kPa vs 115 ± 39 kPa, 139 ± 44 kPa, and 143 ± 27 kPa, respectively).

Conclusions: We conclude that the contractile ability of fibers from children with CP is likely compromised. Further research is needed to investigate the origin of this contractile deficiency and how active force loss could be prevented. Based on findings from previous research, we speculate that the decrease in isometric force capacity is related to a reduction in titin quantity in muscles from children with CP.

Height, Weight, Strength, and Speed Depend More on the Status of Biological Maturation than on Chronological Age

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Background: Over the past years, a number of studies involving young elite soccer players have shown that parameters such as strength, speed, height, and weight are closely related to the status of biological maturity. However, there are currently no data comparing the effects of chronological age, birth quartile, and biological maturity on these parameters.

Materials and Methods: Six hundred seventy-eight male youth soccer players from 8 elite soccer academies aged

between 12 and 18 years were tested. Testing has always been conducted by the same team of testers using the same equipment (Smart Jump and Smart Speed PRO systems) on standard-sized soccer fields with artificial turf. Testing was always performed in a strictly defined order and included measurement of standing height and body weight, horizontal jump, countermovement jump, 20-m sprint with 5-m and 10-m split, dribbling, juggling, and short and long passes. To determine the degree of biological maturation, growth from the predicted growth of parents, determined by the Khamis-Roche formula, was used. The dates of birth of all the players who took part in the study were also analyzed.

Results: In total, the study involved 678 soccer players aged 12.1 to 17.9 years (average age 14.0 ± 1.4 years, height $174 \text{ cm} \pm 10.3 \text{ cm}$, weight $64.0 \text{ kg} \pm 11.0$, and body mass index 20.9 ± 2.4). When studying the relationship between age in years and months, quartile of birth, degree of biological maturation, and analyzed parameters, significant and moderate relationships were found between maturity status and height ($R = 0.78$, $P < 0.001$), weight ($R = 0.77$, $P < 0.001$), horizontal jump ($R = 0.72$, $P < 0.001$), and 5-m ($R = -0.53$, $P < 0.001$), 10-m ($R = -0.66$, $P < 0.001$), and 20-m sprints ($R = -0.75$, $P < 0.001$), and this relationship for these parameters was stronger than that with chronological age.

Conclusion: The status of biological maturity has a more significant effect on the speed, strength, and anthropometry of young elite soccer players than chronological age.

Category: Sport Injury Prevention

Exploring the Relationship Between Cumulative Internal Load and Injury Risk in Women's Soccer

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Objective: This study aimed to investigate the relationship between cumulative internal load and injury rate among National Collegiate Athletic Association (NCAA) Division 1 women's soccer athletes.

Study Design: Prospective cohort.

Subjects: Twenty-seven women's soccer athletes (mean age = 19.5 years, standard deviation = 1.14).

Observation Technique: Athletes reported rate of perceived exertion (RPE) values to team athletic trainers within 10 minutes of the end of each practice and game session over the course of 1 competitive season of 14 weeks. RPE values were multiplied by session duration (minutes) to calculate session RPE, expressed in arbitrary units (AUs), as our measure of internal load.

Outcome Measures: The study outcome was all-complaint knee and ankle injury incidence throughout the competitive season. All-complaint knee and ankle injuries were collected postseason using a modified version of the Oslo Sports Trauma Research Center-Patella Tendinopathy Questionnaire through self-report.

Results: The team median cumulative load for all 27 female soccer athletes was 21 159 (range: 3255-26 491) AUs across the 14-week season. Trends in the team's weekly median cumulative internal load per week revealed a voltage drop following a high load in week 1 to week 2 and dips during midseason and the last 2 weeks of the season. A total of 15

knee and ankle injuries (7 time-loss and 8 non-time-loss) occurred during the observation period. The overall injury incidence was 14.14 injuries per 1000 hours of exposure, equivalent to 56 injuries per 100 athletes per season. Athletes who experienced an injury had a median cumulative load of 21 347 (range: 20 751–25 470) AUs throughout the season, compared with 18 777 (range: 15 365–22 691) AUs in non-injured athletes.

Conclusions: Results of this study suggest a potential association between cumulative internal load and injury risk among collegiate women's soccer athletes. Internal load monitoring and external load regulations could help maximize performance and reduce lower limb injury risk.

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The Impact of a 48-Hour High-Carbohydrate Diet, With High or Low FODMAP Content, Before Endurance Exercise on Gastrointestinal Motility and Symptoms, and Exercise Performance

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Objective: To determine the effects of a 48-hour, high-carbohydrate, high-fermentable oligosaccharide, disaccharide, monosaccharide, and polyol (FODMAP) (HCHF) or high-carbohydrate low-FODMAP (HCLF) diet on gastrointestinal motility and symptoms in response to endurance exercise, and subsequent exercise performance.

Study Design: Randomized, double-blind, crossover trial.

Subjects: Twelve (n = 10 male and n = 2 female) recreationally competitive endurance runners [mean (SD): age 42 (5) years, height 1.74 (0.08) m, body mass 72.1 (13.7) kg, fat mass 20 (8)%, and $\dot{V}O_2\text{max}$ 53.2 (8.6) mL/kg/min] with preexisting, recurrent, exercise-associated gastrointestinal symptoms (GIS) volunteered to participate.

Intervention: Participants were randomly assigned to a 48-hour high-carbohydrate (10–12 g/kg/d) high-FODMAP (50–60 g/d) (HCHF) and a high-carbohydrate low-FODMAP (2–3 g/d) (LCLF) intervention, with a 7-day washout between the trials. After the dietary intervention, participants completed 2-hour steady-state running at 60% $\dot{V}O_2\text{max}$, followed by a 1-hour distance test, in temperate ambient conditions (23°C, 49% RH). Maltodextrin (10 g at 10% wt/vol) was provided every 20 minutes during steady state, plus water provided ad libitum during the entire 3 hours. A 150-mL solution containing 20 g of lactulose was provided 30 minutes into the distance test to determine orocecal transit time (OCTT).

Outcome Measures: Preexercise and postexercise breath samples breath hydrogen (H_2) were collected, and Ex-GIS and rectal temperature (T_{re}), were measured. Every 15 minutes during steady-state exercise, HR, RPE, and Ex-GIS were recorded. During the distance test, the distance completed was recorded every 5 minutes, plus HR and RPE every 15 minutes. Breath samples were collected every 15 minutes during the

3-hour recovery. Breath samples were analyzed for hydrogen (H_2) to determine OCTT.

Results: OCTT did not significantly differ between HCHF 83 (58) minutes and HCLF 95 (55) minutes ($P = 0.59$). Greater total-GIS were reported preexercise ($P = 0.04$) and during ($p = 0.02$) steady state on HCHF; however, greater total-GIS were reported at the 1-hour to 2-hour recovery period on HCLF ($P = 0.04$). There was no difference in measured HR, RPE, or T_{re} between the trials. Distance completed was 9.9 (1.7) km and 10.0 (1.6) km on HCHF and HCLF ($P = 0.33$), respectively.

Conclusions: A 48-hour HCHF diet before endurance running leads to greater GIS before and during exercise; however, this does not impact exercise strain, gastrointestinal motility, or exercise performance. Greater GIS in the 1-hour to 2-hour recovery period with the HCLF trial requires further investigation.

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CAESM Research Abstract Submission

Contraception Choice for Female Endurance Athletes: What's Sport Got to Do With It?

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Objectives: (1) To better understand which contraceptives female endurance athletes are currently using or have previously used, and how these contraceptives are perceived to have impacted their health and performance. (2) To characterize the contraception selection process for female endurance athletes, including common concerns, satisfaction with physician encounters, and resources consulted.

Study Design: Exploratory survey study delivered anonymously on Qualtrics. The study was open from August 2021 to March 2022. Participant recruitment through social media and emails sent to university and club coaches, and endurance sport organizations.

Subjects: Three hundred twenty-three participants met the following eligibility criteria: (1) Is a female endurance athlete ≥ 18 years old? (2) Has used or considered using contraceptives that require consultation with a health care professional? (3) Has thought about how contraceptives could impact athletic performance?

Results: Of the participants currently using contraception (n = 182), 50.5% use the hormonal intrauterine device (IUD), 28.6% use an oral contraceptive pill (OCP), and 13.2% use the nonhormonal IUD; 90% of hormonal IUD users reported being happy with their selection; less than 5% experienced a negative impact on training, and nearly 40% thought that it had a positive training impact likely from decreased menstrual bleeding and symptom management. In comparison, the OCP and nonhormonal IUD users were not as satisfied with their selected contraceptive methods; 73.9% of nonhormonal IUD users experience heavier and more irregular bleeding, which was consistently cited as having a major negative impact on training; 30.6% of individuals on the OCP reported adverse body composition outcomes and negative mood changes. In addition, of the athletes who received contraceptive counseling from their physician (n = 84), 38.6% did not feel that

athletic performance was adequately factored into the discussion.

Conclusion: Our data suggest that the hormonal IUD is perceived to be the superior contraceptive regarding the impact on endurance performance. These results can help inform female endurance athletes inquiring about contraception, as well as the physicians advising them. This is particularly important as a significant percentage of female endurance athletes were frustrated and do not feel understood by their physicians during contraceptive counseling.

Effect of Amphetamines, Opioids, Androgenic Anabolic Steroids, and Cannabis on the Development of Chronic Traumatic Encephalopathy Features in Individuals Exposed to Mild Head Trauma: A Scoping Review and Proposed Nomenclature Change

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Objective: To determine the effects of amphetamines, opioids, and androgenic anabolic steroids (AAS), and cannabis on the development of chronic traumatic encephalopathy (CTE).

Data sources: A scoping review was conducted in the PubMed, Embase, Cochrane Library, Scopus, CINAHL, and SPORTDiscus electronic databases. Reference lists of included studies were also screened.

Main Results: Two thousand three hundred ninety-seven records were identified with an initial search. Seven studies met the following eligibility criteria: quantitative primary literature investigating amphetamines, opioids, AAS, or cannabis among humans with history of mild traumatic brain injury or concussion, with exploration of clinical and/or neuropathological features of CTE. Of these, 4 addressed cannabis use and 3 addressed endogenous AAS. Cannabis use and endogenous AAS deficiencies in individuals exposed to mild head trauma were associated with mostly adverse or neutral changes related to CTE features. Cannabis use may affect postconcussion suicidality and exacerbate postconcussive symptoms even several years after injury. Post-mild head injury AAS deficiencies were associated with cognitive, behavioral, mood, and motor changes consistent with CTE. Postinjury AAS deficiencies were also associated with brain changes suggestive of neuropathological features supporting a CTE diagnosis. No studies investigating amphetamines, opioids, or exogenous AAS met eligibility criteria.

Conclusions: The literature on the effects of amphetamines, opioids, AAS, and cannabis on CTE features in patients with mild head trauma is very limited. Knowledge gaps and opportunities for future research were identified. We proposed a nomenclature change from CTE to idiopathic degenerative encephalopathy of athletes (IDEA) to more accurately reflect the literature surrounding this condition.

Acknowledgements: The authors thank Dr. Oliver Leslie for his work on a concept paper that helped lay the groundwork for this present study. The authors thank University of Manitoba librarians Carol Cooke and Caroline Monnin, for their advice regarding methodological considerations. They also thank Dr. Brian Postl, former Dean of the Max Rady College of Medicine, who

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ORIGINAL RESEARCH ABSTRACT

Prevalence of Depression in Retired Professional Baseball and Hockey Players

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Objective: To compare the prevalence of depression in a matched sample of retired professional baseball and hockey players.

Study Design: Cross-sectional Survey.

Subjects: Seventy-eight retired professional baseball players (major and minor league baseball) and 22 retired professional hockey players (national hockey league)

Observation Technique: (1) Professional Baseball Players Alumni Facebook Group through Qualtrics Online Survey Platform and (2) Data gathered by Esopenko, Carrie, et al. "Cognitive and psychosocial function in retired professional hockey players." *Journal of Neurology, Neurosurgery & Psychiatry* 88.6 (2017):512–519.

Outcome Measures: (1) The prevalence of depression using the Patient Health Questionnaire-9 (PHQ-9) (threshold of >9) in baseball players and Beck Depression Inventory (BDI) (threshold of >8) in hockey players. (2) Prevalence of reported lifetime history of concussion.

Results: Prevalence of depression in baseball players (PHQ-9) was 19.23% and 40.91% in hockey players (BDI). History of concussion events in baseball and hockey players was mean = 0.99, SD = 1.37 and mean = 4.8, SD = 2.7, respectively.

Conclusion: There was a significant difference in the prevalence of depression between retired baseball players and hockey players. Given the differences in the prevalence of sports-related concussion between the 2 sports and in this sample, these data support the negative psychological impacts of concussion in professional athletes after they retire. The depression scores in retired baseball players suggest that there are contributing factors in addition to sport-related concussion that negatively impact the psychological well-being of athletes after they retire.

The Impact of Time from Injury to Surgery on Bucket-Handle Meniscus Tear Repair Rates: A Retrospective Cohort Study

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Objective: To assess the association between time from injury to surgery on meniscus repair rates in a cohort of patients with bucket-handle meniscus tears.

Study Design: Retrospective cohort study.

Subjects: Forty-nine patients (16 females and 33 males) with confirmed bucket-handle meniscus tears presenting to an orthopedic surgeon and receiving surgery between January 2020 and December 2020.

Intervention/Observation Technique: Retrospective chart review.

Outcome Measures: The primary outcome was the impact of time from injury to surgery (in weeks) on meniscal repair (binary outcome: yes or no) at the time of surgery. Data were analyzed using logistic regression. Statistical significance was set at $\alpha = 0.05$.

Results: Mean patient age was 34.6 years (SD = 10.9). Twenty-nine (59%) patients presented with concomitant anterior cruciate ligament tears. Median time to surgery was 21 weeks (interquartile range [IQR] = 7.5, 51 weeks). Thirty-eight patients (78%) underwent meniscus repair, whereas 11 (22%) received a meniscectomy. The meniscus repair group demonstrated a significantly shorter time to surgery when compared with the meniscectomy group (14 weeks [IQR = 5.6, 34.1 weeks] vs 41.7 weeks [IQR = 21.6, 106.7 weeks], respectively; $P = 0.01$). Patients with a time to surgery of less than 21 weeks had a 6.9-fold increase in the likelihood of meniscus repair (95% CI, 1.3–36.5, $P = 0.02$). Patient age, sex, and concomitant anterior cruciate ligament status were not found to influence whether a repair was performed.

Conclusions: Patients with bucket-handle meniscus tears who underwent surgical treatment within 21 weeks from the time of injury demonstrated a significantly higher likelihood for repair as compared with those experiencing a longer time to surgery. Longer-term follow-up is needed to determine the rates of successful repair including the need for revision surgeries in this cohort; this question will be addressed in future work. As meniscal resection accelerates knee osteoarthritis thereby resulting in worse patient outcomes, study findings highlight the importance of accurate and time-sensitive diagnosis and surgeon referral to improve the odds of performing meniscus-sparing procedures at the time of surgery. These results can be used to better inform benchmarks/standards for timely treatment of bucket-handle meniscus tears in the Canadian setting.

CASEM—Informing Return to School Practices for Students After Concussion

Educator Perspectives on Supporting Students to Return to School Following a Concussion

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Objectives: The primary objective was to describe the feasibility of providing academic accommodations to students following a concussion. The secondary objective was to describe school resources available to support students returning to school following a concussion.

Study Design: Additional coverage mixed-methods design.

Subjects: Canadian grades 7 to 12 teachers and school administrators.

Observation Technique: Survey administered online through Research Electronic Data Capture and qualitative semistructured interviews (guided by interpretivism) conducted through Zoom.

Outcome Measures: Descriptive statistics were used to examine the (1) feasibility of providing academic accommodations to students in grades 7 to 12 and (2) prevalence of school resources to support grades 7 to 12 students returning to school following a concussion. Reflexive thematic analysis was used to inductively analyze the semistructured interviews.

Results: One hundred eighty teachers ($n = 138$) and school administrators ($n = 41$) who teach grades 7 to 12 participated in the survey and 18 participants ($n = 13$ teachers, $n = 5$ school administrators) completed an interview. Based on the survey, 96% (172 of 179) of participants agreed that students should have access to academic accommodations following a concussion. Participants indicated that some accommodations were more feasible to provide, such as breaks (96.5%, 161 of 167) or extra time (89%, 154 of 173), than other accommodations, such as restricting learning to review material only (49%, 82 of 168) or limiting bright light in the classroom (67%, 112 of 167). Qualitative interviews expanded upon survey findings and indicated that limited resources, including school facility, personnel, and time, contributed to the feasibility of providing academic accommodations to students following a concussion.

Conclusions: Teachers and school administrators (grades 7–12) confirmed the importance of providing accommodations to students following a concussion. Academic accommodations that are the most feasible for teachers and school administrators to implement should be prioritized, ensuring that students are supported with the resources available within the school. Clinicians should be mindful of school resources and of the accommodations that may be more feasible for educators to provide to students following a concussion.

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Surgical Outcomes for Long Head of the Biceps Surgery: An Updated Chart Review

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Objectives: To better understand which technique provides the best surgical outcomes based on improved function and minimizing reoperation. To better inform surgeons in decision making and surgical management of pathology of the long head of the biceps tendon (LHBT).

Study Design: Retrospective chart review followed by prospective telephone interviews.

Subjects: Three hundred twenty-five subjects (167 tenotomy and 158 tenodesis) who underwent 1 of 4 tenotomy-based or 1 of 3 tenodesis-based surgical techniques for the management of LHBT pathology.

Intervention: Tenotomy-based surgical techniques include (1) arthroscopic tenotomy; (2) arthroscopic shortening and tenotomy; (3) arthroscopic tenotomy with mini open shortening; and (4) arthroscopic tenotomy with mini open shortening and debridement of bicipital groove. Tenodesis-based surgical techniques include (5) arthroscopic tenotomy with mini open tenodesis, drawn in; (6) arthroscopic tenotomy with mini open tenodesis, pushed in; and (7) arthroscopic tenotomy with mini open tenodesis, pushed in with bicep groove debridement.

Outcome Measures: The primary outcome measure was the requirement for further intervention following the LHBT surgery (cortisone injection or another surgery) assessed by chart review. The secondary outcome measures were the patient's personal satisfaction with the procedure [Single Assessment Numeric Evaluation (SANE) score] and the patient's subjective restriction in function following the surgery (assessed using a single ranking question with 5 possible answers).

Results: Patients who underwent tenotomy with tenodesis (12%) were significantly more likely to require subsequent intervention than those who underwent tenotomy alone (4.2%) ($\chi^2 = 6.687, P = 0.010$). Patients who indicated that they were able to do everything as they could before their problems started, nearly two-thirds (62.1%) had undergone tenotomy as opposed to tenodesis ($\chi^2 = 9.970, P = 0.041$). Patients who underwent tenotomy and tenodesis overwhelmingly reported being glad (90.4% vs 93%, respectively) that the surgery was performed and that they would have the surgery again (88.6% vs 90.4%, respectively). Median SANE scores were high in both tenotomy (median = 85, IQR = 73.75-95) and tenodesis (median = 85, IQR = 75-90) patients.

Conclusions: It seems that biceps tenotomy alone is superior to tenotomy, with tenodesis in decreasing the rate

of reoperation and improving functional outcomes, although both tenotomy and tenodesis procedures seem to produce high patient satisfaction.

Influence of Age, Sex, Sport-Participation, and Concussion History on Brain-Derived Neurotrophic Factor (BDNF) in Healthy Adolescent Athletes

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Objective: Brain-derived neurotrophic factor (BDNF) is a protein that encourages growth and differentiation of neurons and synapses in the brain and holds promise as a biomarker for the detection and management of sport-related concussion (SRC). This study aims to characterize the relationship between plasma BDNF in healthy adolescent athletes regarding concussion history, age, sex, and sport participation.

Study Design: Cross-sectional study.

Subjects: Healthy adolescent athletes (n = 149; age 15.69 ± 1.51 years; female = 72).

Observation Technique: Substudy within the Pan-Canadian SHRED Concussions (Surveillance in High Schools to Reduce the Risk of Concussions and their Consequences) study. Blood samples were collected from athletes before their sport season.

Outcome Measures: Plasma BDNF was measured through enzyme-linked immunosorbent assay (ELISA, EnVision plate reader) in duplicates. Multilevel multivariable linear regression investigated the associations between plasma BDNF (natural log-transformation) and sex, sport participation (collision/contact/noncontact), age, and concussion history.

Results: Plasma BDNF in male athletes was significantly higher compared with female athletes ($\beta = 0.218, 95\% \text{ CI: } 0.056, 0.380, P = 0.008$). Furthermore, youth engaged in collision ($\beta = 0.371, 95\% \text{ CI: } 0.077, 0.665, P = 0.013$) and noncontact sports ($\beta = 0.537, 95\% \text{ CI: } 0.198, 0.876, P = 0.002$) had significantly higher plasma BDNF compared with youth participating in contact sports. No association was found between plasma BDNF and age ($\beta = 0.032, 95\% \text{ CI: } -0.026, 0.091, P = 0.28$) or concussion history ($\beta = -0.109, 95\% \text{ CI: } -0.277, 0.06, P = 0.206$). When considering effect modification by sex, we found that age was associated with female plasma BDNF ($\beta = 0.092, 95\% \text{ CI: } 0.029, 0.155, P = 0.004$) but not with male plasma BDNF ($\beta = -0.07, 95\% \text{ CI: } -0.173, 0.033, p = 0.186$).

Conclusions: Plasma BDNF in healthy youth athletes is influenced by sex and sport participation but not by history of concussion. In female athletes, plasma BDNF was higher with increasing age. These factors should be considered when

evaluating plasma BDNF as a biomarker following sport-related concussion in adolescent athletes.

Acknowledgements: National football league funding for the SHRED concussion study (PI Dr. Carolyn Emery). Funding by the Hotchkiss brain institute (Dr. Debert start-up grant).

Finding Pragmatic Measures for Student-Athlete Load and Capacity: An Evaluation of Postseason Internal Load, Injury Risk, and Strength Asymmetry

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Objective: To (1) determine whether internal load is associated with knee and ankle injuries in collegiate soccer and basketball players; (2) determine whether substantial (<0.7) dominant leg hamstring/quadriceps strength asymmetry is associated with internal load in participants.

Study Design: A subcohort study within a larger cohort study.

Subjects: Eighty-five Tier 1 college soccer and basketball players.

Observation Technique: Using a handheld dynamometer and standard protocols, we performed isometric hamstring and quadricep strength tests and administered a baseline questionnaire at a preseason session (2021-2022) to collect demographic, injury history, and medical history. Strength values for were normalized by body weight.

Outcome Measures: At postseason, we collected a 1-time rating of perceived exertion (RPE) data to measure “chronic” internal load through the season (modified Borg scale of 1-10, using a questionnaire) and all-complaint knee and ankle injuries (yes vs no) using a modified version of a previously validated Oslo Sports Trauma Research Center-Patella Tendinopathy Questionnaire. Chronic internal load was rated on a 10-point scale (1 being easy and 10 being extremely exhausting). Using 95% CI and controlling for team clusters, we conducted logistic and ordinal logistic regression analyses to address objective 1 and objective 2, respectively. Covariates for each model included sex, sport, previous injury, inadequate sleep (<7 hours), and school-related exhaustion (scale of 1-10).

Results: Based on a final model, chronic load had a significant independent relationship with knee and ankle injury risk (OR: 1.46, 95% CI 1.17, 1.84). For the second objective, there was a significant relationship between dominant limb strength ratio and internal load (β : -2.50, 95% CI -4.77, -0.225); however, this was dependent on school-related exhaustion (β : 1.10, 95% CI -0.830, 3.03).

Conclusions: A 1-time postseason subjective measure of internal load predicted injury risk in collegiate players. A 1-time postseason self-report measure of RPE is a convenient tool that may be useful to coaches and sports medicine professionals in making informed decisions regarding load modification among collegiate soccer and basketball players in a subsequent season.

Acknowledgement: This study was funded by the Applied Health Sciences Research Program at the Saint Louis University.

Suspected Injury and Concussion Rates in Canadian High-School 7's Rugby

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Objective: To examine the suspected injury and concussion rates at a single-day, spring, high-school 7s rugby tournament in Calgary, Alberta (2022).

Study Design: Cross-sectional video analysis.

Subjects: Male and female rugby players (ages 15-18 years) participating in a high school 7s tournament in Calgary, Alberta. Twenty-nine games (15 male and 14 female) were analyzed.

Observation Technique: Games were recorded and analyzed using video-analysis software (Nacsport Scout Plus).

Outcome Measures: Suspected injuries and concussions were evaluated based on previously validated methods (West et al., 2021). Suspected injury rates (IR) and injury rate ratios (IRR) (using female rate as reference value) were compared between male and female leagues.

Results: Twenty-two suspected injuries (male = 12, female = 10) were recorded (male IR = 223.60/1000 player-hours 95% CIs; 115.54-390.59, female IR = 205.06/1000 player-hours 95% CIs; 98.33-377.11) and overall suspected IRs did not differ by sex (IRR = 1.09 95% CIs; 0.43-2.82). Eight suspected concussions (male = 5, female = 3) were identified (male IR = 93.17/1000 player-hours 95% CIs; 30.25-217.42, female IR = 61.51/1000 player-hours 95% CIs; 12.69-179.78), accounting for a large portion of injuries (male = 42%, female = 33%) with no significant difference by sex (IRR = 1.51 95% CIs; 0.29-9.75). The tackle was the most common event leading to injury (90%; male = 92%, female = 90%).

Conclusions: Suspected IRs are high in high school rugby 7s, with no significant sex differences for suspected injuries or concussions. The tackle accounts for a large proportion of injuries, an area for targeting future 7s rugby-specific injury prevention interventions.

Acknowledgements: The Sport Injury Prevention Research Centre is one of the International Olympic Committee Research Centers for the Prevention of Injury and Protection of Athlete Health. This study is a subcohort of a larger Surveillance in High Schools to Reduce Concussion and its Consequences (SHRED Concussions) cohort study across multiple sports and sites in Canada (SHRED Concussions REB 18-2107). This study

was conducted with support from Rugby Alberta, the Calgary Rugby Union, and Rugby Canada.

Reference: West S, Shill I, Patricios J, et al, 461 Narrowing the gender gap in rugby injury epidemiology: a novel video-analysis study in the women's game. *British Journal of Sports Medicine* 2021;55:A176.

Does Ultrasound-Guided Shoulder Joint Hydrodilatation Followed by Immediate Physical Therapy (SHIP) Improve Outcomes in Patients With Adhesive Capsulitis of the Shoulder? A PILOT Randomized Control trial

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Study Design: Clinician-blinded, randomized, control trial pilot.

Subjects: Twenty adult patients with adhesive capsulitis (frozen shoulder).

Objective: To determine whether physiotherapy initiated immediately (within 30 minutes) after a shoulder hydrodilatation injection will improve adhesive capsulitis symptoms of pain, limited ROM, patient function, and patient well-being more when compared with usual care physiotherapy after hydrodilatation (physiotherapy 7-14 days post injection).

Intervention: Patients with adhesive capsulitis of the shoulder were randomized to SHIP or Shoulder Hydrodilatation followed by usual care in the control (SHUC). In both groups, the hydrodilatation procedure was provided by medical doctor (MD) 1 who was blinded to the patient group. The procedure was an ultrasound-guided injection of a standard volume of triamcinolone, local anesthetic, and sterile normal saline into the affected glenohumeral joint. In the SHIP group, patients immediately proceeded to physical therapy within 30 minutes of the injection. In the SHUC group, the patient received the hydrodilatation, then attended physical therapy a week later. All study patients had an additional physical therapy at 2 and 3 weeks and a follow-up by MD 2 (blinded) at 30 days.

Outcome Measures: Standardized active and passive range-of-motion (ROM) measurements at preprocedure, immediately post procedure, and physical therapy visit 1, 2, and 3 using a goniometer. Patient surveys at 0-day and 30-day follow-up included the Upper Extremity Functional Index (UEFI), pain visual analogue scale (VAS), Shoulder Pain and Disability Index (SPADI), and the Shortened Disabilities of the Arm, Shoulder, and Hand (QuickDASH).

Preliminary Results: In the SHIP group, the average age was 52.56 ± 8.5 years, and there were 4 female and 5 male patients. In the control group, there were 6 female and 2 male patients, with an average age of 52.75 ± 7.3 years. In terms of pain reported on VAS, in the SHIP group, preinjection pain was on average 4.7/10 and pain with activities of daily living (ADL) was 6.09/10. For the control group, average pain VAS was 6.84/10 and pain with ADL was on average 6.39/10. At 30-day follow-up, the SHIP VAS pain was 2.2/10, and with ADLS, it was 1.89/10, whereas in the control group, it was 2.14/10 and 2.07/10, respectively.

Increased Symptom Scores and Prolonged Course of Recovery for Female Patients With Concussion Injuries Seen at a University Sport Medicine Clinic

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Objective: To characterize patients with concussion injuries seen at a university sport medicine clinic, comparing presentation at first visit and recovery between female and male patients, and to identify potential sex-related differences.

Study Design: Retrospective chart review of patients with concussions seen by a sport and exercise medicine (SEM) physician from January 1, 2015, to May 31, 2021, at a university-based sport medicine clinic in Edmonton, Alberta, Canada.

Subjects: Five hundred fifty-two patients with 621 unique injuries (263 female and 358 male patients; mean age 20 ± 9 years) seen over 1607 visits.

Observation Technique: Patients with concussions were subdivided by sex into female (F) or male (M).

Outcome Measures: Demographics; method of injury (MOI); concussion severity, as measured by the Standardized Concussion Assessment Tool (SCAT 3/5): total symptoms (n/22), total symptom score (n/132); and recovery timelines.

Results: In total, of 621 concussions, most resulted from organized sports (n = 477), followed by recreational sports (n = 82), then activities of daily living (ADL) (n = 60), with 2 not specified. In terms of MOI, the most common sports for concussion injury for female patients were hockey (12%), soccer (11%), and rugby (9%), whereas the most common sports for concussion injury for male patients were hockey (39%), football (16%), and soccer (8%). In female patients, ringette, volleyball, and wrestling each accounted for 6% of the concussion injuries. Female patients were older ($F 21.5 \pm 10.7$ years, $M 18.5 \pm 7.6$ years, $P < 0.0001$) and presented with greater initial concussion severity, as measured by SCAT 3/5 total symptoms and total symptom scores (mean number of symptoms: $F 14.2 \pm 6.5$, $M 10.0 \pm 6.8$, $P < 0.00001$; mean total symptom scores (TSS): $F 40 \pm 28.1$, $M 24 \pm 23.7$, $P < 0.00001$). For each of the 22 symptoms on the SCAT 3/5 form, female patients had higher severity on average than did male patients. Female patients took longer to return to sport/activity (RTS) ($F 81.7 \pm 164.9$ days, $M 39.3 \pm 63.1$ days; $P = 0.003$) but not to return-to-learn (RTL) ($F 14.2 \pm 17.7$ days, $M 11.6 \pm 14.1$ days; $P = 0.31$).

Conclusions: In this cohort of patients, female patients reported greater concussion severity, with more symptoms at the initial visit than did male patients. Female patients also took longer to return to sport/activity. Underlying mechanisms of injury and implications for therapy remain to be explored.

We Can Do Better—An Evaluation of an Osteoarthritis Patient Education Program

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Objective: To evaluate the impact of an in-person physician-led Comprehensive Osteoarthritis Management Education and Treatment (COMET) program on knowledge translation and patient empowerment for self-managed care and treatment trends following a comprehensive education session.

Study Design: Preintervention and 1, 3, and 6 months after intervention patient self-report questionnaires.

Subjects: Twenty-five patients with hip and knee osteoarthritis referred to Sport and Exercise Medicine for consultation.

Intervention: Subjects participated in a 45-minute in-person physician-led osteoarthritis teaching session with focus on evidence-based nonsurgical osteoarthritis treatments.

Outcome Measures: Participants reported upon their osteoarthritis treatment history. Descriptive statistics were used to assess the percentage of patients at the time of enrollment and 1, 3, and 6 months after intervention using evidence-based treatment approaches to manage their osteoarthritis.

Results: The education session resulted in positive trends in the use of effective, evidence-based, treatment strategies to manage pain and function impacted by osteoarthritis. Weight loss (0-13%), exercise (42-50%), physical therapy (29-44%), and hyaluronic acid injection (0-22%) treatments increased over the 6 months of self-report. The use of intra-articular steroid (17-0%) and treatments without evidence of efficacy (38-20%) decreased over the study period. The mean number of minutes per day spent exercising increased from 25 at the time of enrollment to 44 minutes at 6 months after the intervention.

Conclusions: Patient education and knowledge translation improves compliance with treatment and self-efficacy with pain management strategies for patients with osteoarthritis.

There is a Reversal Effect of Relative Age in Elite Senior Athletics: Successful Young Men Are «Early-Born Athletes», While in Adults There Are More «Late-Born» Athletes

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Introduction: Previous studies have found that there is a wide range of the relative age effect (RAE) in young athletes, which is dependent on age and gender. However, there is currently scant data comparing the prevalence of the RAE in successful athletes across different age groups from the same sport during the same period. We aimed to compare the prevalence of the RAE in different age groups of successful athletes.

Materials and Methods: The date of birth of all youth (younger than 18 years) and senior (20 years and older) male

and female track and field athletes were analyzed. All athletes had entered the World Top 20 rankings in disciplines where performance rules were the same at youth and adult levels. Data were collected from the Web site www.tilostopaja.eu between 1999 and 2006. All dates of birth were divided into 4 quartiles according to the month of birth: January to March first quartile (Q1, early born), April to June second quartile (Q2), July to September third quartile (Q3), October to December fourth quartile (Q4, late-born).

Results: A significant prevalence of RAE in successful youth track and field athletes were reported. Early-born (61.1%) and late-born (38.9%) athletes were represented, respectively ($\chi^2 = 131.1$, $P < 0.001$, $\varpi = 0.24$). The RAE is not significant in successful senior track and field athletes. Athletes born in the first half of the year are only 0.4% more prevalent than those born in the second half of the year (50.2% and 49.8%, respectively). Olympic Games and World Championship medalists are more often late-born athletes (44.1% and 55.9%, respectively) ($P = 0.014$, $\chi^2 = 6.1$, $\varpi = 0.20$).

Conclusion: The RAE is only prevalent in successful young track and field athletes. The RAE was not observed in successful senior track and field athletes, regardless of gender, in any of the analyzed discipline groups. The RAE reverse was observed in successful senior track and field athletes.

Effects of Topical and Oral Analgesic Medication Compared with a Placebo in Injured Athletes: A Systematic Review With Meta-Analysis

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Objective: Athletes experience injuries often, and regularly take analgesic medication. Despite wide use, limited studies exist on the efficacy of nonsteroidal anti-inflammatory medication in injured athletes compared with a placebo. The purpose of this study was to determine the efficacy of topical and oral nonsteroidal anti-inflammatory drugs for reducing pain compared with a placebo in injured athletes.

Data Sources: An electronic search was conducted using Medline/Pubmed, Web of Science, Ovid, and SportDiscus for all literature relating to topical or oral medications in athletes for pain management after injury. Two reviewers screened the studies and performed a quality assessment of the studies using the Downs and Black scale. To determine efficacy, the Hedges g value was calculated. It was assumed that the studies were methodologically different, so an inverse variance with random-effects model was used, and the DerSimonian and Laird estimator was used to pool effect sizes and estimate between-study variance (τ^2).

Main Results: We identified 13 eligible studies that included 16 interventions. A total of 1304 participants, from which 1273 received an intervention, were analyzed. The meta-analysis was conducted using R 4.1.3 and the package meta 5.2-0. Bias-corrected, standardized, mean differences (Hedges g) of the change of pain scores were calculated with 95% CI. There was a significant pooled effect size reflecting a reduction in pain outcomes for the topical treatment versus placebo ($g = -0.64$; 95% CI $[-0.89, -0.39]$; $P < 0.001$). There was not a significant reduction in pain outcomes for the oral treatment versus placebo ($g = -0.26$; 95% CI $[-0.60, 0.17]$; $P = 0.272$).

The meta-analysis for the topical and oral treatment presented high heterogeneity ($I^2 = 71\%$) and moderate heterogeneity ($I^2 = 55\%$), respectively.

Conclusions: When compared with a placebo, topical medications were significantly better at reducing pain compared with oral medications in injured athletes. Our results are different when comparing to other studies that examined the effect of medication on experimentally induced pain versus musculoskeletal injuries. The results from this study suggest that athletes should use topical nonsteroidal anti-inflammatory medication for pain because it is more effective and has less reported adverse effects compared with oral medication.

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A Survey of Parents Regarding a “Return-to-Learn” Protocol Following Sport-Related Concussion

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Objective: To demonstrate that the Green Folder tool has a beneficial role in assisting parents to support their child's return to school following a sport-related concussion.

Study Design: Quantitative prospective study using a newly validated survey that we created.

Subjects: Twenty-one parents of secondary school student athletes with a sport-related concussion.

Intervention: This Green Folder tool is carried by students, containing a list of specific daily class-by-class accommodations and recommendations from physicians and guidance counsellors for use by the student, teachers, parents, and other members of the student's circle of care.

Outcome Measures: These included parental recognition of available school supports that were in place for their child and whether parents felt that there was improved communication between their child's health care provider and school. Rapidity of symptom resolution post concussion in their child, as reported by parents, was also included.

Results: The parents of students who used the Green Folder reported stronger positive opinions about student school supports compared with those who did not use the Green Folder ($P = 0.0066$). They also felt that school staff had a better understanding of the return-to-learn strategies compared with the group that did not use the Green Folder ($P = 0.0036$).

Conclusions: These results suggest efficacy and evidence for continued use of the Green Folder in the high school setting. Further research evaluating the effectiveness of this tool in other academic environments, as well as an assessment of the Green Folder's use on a more widespread scale may be warranted.

The TEAM Study: Physical Activity and Clinical Characteristics of Osteoarthritis Patients With or Without Lower Limb Injury, Trauma, or Surgery

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Objective: To compare physical activity levels and clinical characteristics between osteoarthritis (OA) patients with and without a previous history of lower limb injury, trauma, or surgery (ITS).

Study Design: Cross-sectional study.

Subjects: One hundred twenty-six subjects (69 female and 57 male subjects, 40-74 years of age) diagnosed with “mild to moderate knee OA” using clinical and radiographic criteria.

Comparison: Subjects were categorized into the following 2 groups: (1) having no history of lower limb ITS (NoITS group) or (2) having a history of lower limb ITS (ITS group).

Outcome Measures: The outcome measures were global physical activity questionnaire (GPAQ) score, body mass index (BMI), abdominal circumference, 40-m fast-paced walk speed, 30-second chair stand test score, age, and sex. They were assessed at the baseline visit of the Technology, Exercise Programming, and Activity Prescription for Enhanced Mobility (TEAM) Study.

Results: There were no significant differences in self-reported physical activity levels, BMI, abdominal circumference, and age between the groups. There were significant differences for both functional test scores, with the ITS group having faster, 40-m, fast-paced walk speeds ($P < 0.001$) and higher, 30-second, chair stand test scores ($P < 0.005$). The ITS group also had significantly more male subjects and fewer female subjects than the NoITS group ($P < 0.005$).

Conclusions: Physical activity levels and body composition are not related to individuals' history of lower limb ITS among older adults with mild-to-moderate knee OA. However, the superior functional test performances observed in the ITS group suggests that individuals' history of lower limb ITS may impact functional outcomes among those diagnosed with knee OA. Given the higher proportion of male subjects in the ITS group, the disparity in sex distribution between the groups may have played a role in the observed differences in functional outcomes. Ongoing investigation and mediation analyses will help us better understand this role.

The Use of Suture Anchors in Posterolateral Corner Reconstruction in the Setting of Multiligament Knee Injury: Clinical and Radiological Outcomes

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Objective: To describe clinical and radiological outcomes of posterolateral corner (PLC) reconstruction using suture anchors as fixation method of choice for fibular head docking and to describe a technique tip for biceps femoris tendon repair in case of concomitant rupture. The secondary objective was to compare outcomes between acute (<6 weeks) and chronic reconstructions.

Study Design: case series.

Subjects/Intervention: Demographic data, and clinical and radiological outcomes were collected from 60 patients who underwent 2-tailed PLC reconstruction in the setting of multiligament knee injury (MLKI) between 2017 and 2021.

Outcome Measures: Patients were assessed for range of motion (ROM) and functional outcomes, including Tegner, Lysholm and International Knee Documentation Committee (IKDC) scores. Complications and reoperations were also reported. Radiographic parameters focused on measurements

of the lateral femorotibial space in varus stress views to evaluate stability and determine failure rate. Subgroup analysis based on time from injury to reconstruction was additionally performed.

Results: With 2 (3.3%) loss to follow-up, 58 patients with a mean age of 33.8 years and a mean follow-up of 15.1 months (range: 4.2–44.8 months) were included. Sixty-five percent were men. Knee dislocation grades included KD 3-L, 4, and 5. No isolated PLC reconstructions were performed. Twenty-five patients (43.1%) underwent acute reconstruction and 14 (24.1%) presented with a neurovascular injury; 77.5% had concomitant meniscal tears requiring repair. The mean postoperative ROM was 1.7 to 133.2 degrees. Mean Tegner, Lysholm, and IKDC scores were 5.1 ± 2.3 , 84.6 ± 12.1 , and 73.4 ± 18.2 , respectively. The mean side-to-side difference of lateral femorotibial space on varus stress views was 0.3 ± 1.2 mm; 14 patients (24.1%) required revision surgery for hardware removal, stiffness, or clinical failure, and 9 (15.5%) had complications, including infection, arthrofibrosis, and implant failure. In addition, patients with acute reconstructions had better functional outcomes compared with those who presented with a chronic injury.

Conclusions: The use of suture anchors as fixation method of choice for fibular head docking in 2-tailed PLC reconstruction can reliably restore varus stability and provide fair functional outcomes in patients with either acute or chronic MLKI with posterolateral instability, associated with a low rate of implant-specific complications.

Category: Sport Epidemiology

Machine Learning Classification of Brain Vital Signs Across the Spectrum of Healthy to Acute Concussion the Spectrum of Concussion

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Objective: The objective of this study was to determine whether brain vital sign assessments could classify the likelihood of any given individual to be healthy, concussed, or subconcussed.

Study Design: Secondary analysis.

Subjects: Brain vital signs data were aggregated from 4 independent studies in athlete populations (age range 12–21) across multiple sports. This included 33 healthy controls, 61 subconcussed individuals with repeated head-impact exposure, and 15 acute diagnosed concussions (<48 hours post injury), for a total sample size of 109.

Intervention/Observation Technique: Principle component analysis was conducted to separate brain vital signs features into linearly separable components. A gradient-boosted decision tree classification model was built using a leave-one-out cross-validation method to minimize overfitting and evaluate performance.

Outcome Measures: A leave-one-out cross-validation method was used to evaluate performance with a resulting sensitivity and specificity score (0–1) for each subject group and an overall classification accuracy score (0–1).

Results: Concussion ranked the highest (93.44% sensitivity, 91.75% specificity), followed by healthy (81.97% sensitivity, 84.96% specificity) and subconcussion (63.93% sensitivity, 89.92% specificity) for an overall classification accuracy of 79.78%.

Conclusions: Neurophysiological health related to head impact exposure can be evaluated and classified across multiple sports, age groups, and skill levels. The findings support the concept that objective neurophysiological evaluation of cognitive processing can significantly add to existing clinical assessment and monitoring capabilities in brain injury. This approach has potential to move toward specific diagnostic applications across the spectrum of concussion. Ongoing and future work is focused on expanding this model to include prognostic attributes using groups with longer-term chronic concussion.

The Impact of 2 Compositionally Different Amino Acid Based Beverage Interventions on the Prevention of Exercise-Associated Bacteremia in Response to Exertional Heat Stress

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Objective: To determine the impact that 2 hours of running at 60% $\dot{V}O_{2\max}$ in 35°C has on bacteremia and the magnitude of prevention that 2 differing amino acid (AA) beverage compositions may provide.

Study Design: Counterbalanced, crossover, double-blinded RCT.

Subjects: Twenty, healthy, endurance running-trained, non-heat acclimatized/acclimated, male participants [mean (SD): age 32 (8) years, height 1.81 (0.05) m, body mass 77.7 (7.4) kg, fat mass 15.1 (5.1)%, $\dot{V}O_{2\max}$ 59.6 (8.1) m/kg/min, and running training load 288 (131) min/week], absent of gastrointestinal health complications, had not consumed gastrointestinal modifying supplements and dietary regimen in the past 3 months, and had not consumed nonsteroidal anti-inflammatory and/or stool-altering medications within 1 month before the experimental trial.

Intervention: One-week after the initial assessment, participants were randomly allocated into 2 exertional heat stress trials, with minimum 1-week washout. Trials included a water control trial (CON) and 1 of 2 AA beverage interventions (VS001 or VS006) developed using EBS HydroActive Technology. Interventional trials required participants to consume 2×237 mL/day prefabricated doses for 7 days before the trial and during 2 hours of running at 60% $\dot{V}O_{2\max}$ in 35°C ambient conditions. Water volume equivalent was provided for CON.

Outcome Measures: Whole-blood samples were collected before and immediately after exercise into sterile pyrogen/DNAse/RNase-free blood processing consumables and processed to aliquots of plasma. Bacterial DNA (50- μ L elution) was extracted from plasma as per manufacturer's instructions (QIAamp UPC pathogen mini kit). Total DNA quantification was conducted using a Qubit fluorometer (ThermoFisher Scientific). Blank control samples, using pyrogen/DNAse/

RNAse-free water, were run simultaneously in duplicate, with no detectable DNA acknowledged.

Results: Significant increases in total DNA concentration before to immediately after exercise was observed on CON [mean (95% CI): preexercise 0.014 (0.012-0.016) ng/ μ L, postexercise 0.039 (0.029-0.049) ng/ μ L, $P < 0.001$] and VS006 [preexercise 0.013 (0.010-0.016) ng/ μ L, postexercise 0.033 (0.028-0.038) ng/ μ L, $P < 0.001$] but not VS001 [preexercise 0.018 (0.010-0.025) ng/ μ L, postexercise 0.031 (0.018-0.043) ng/ μ L, $P = 0.059$]. Regarding the participants' trial allocation, a trend for higher magnitude of change from preexercise to postexercise on CON versus VS001 ($P = 0.052$) was observed but not for CON versus VS006 ($P = 0.575$).

Conclusions: The potential for translocation of whole bacteria from the lumen into systemic circulation in response to exertional heat stress seems positive in all participants. AA beverage (VS001) may provide a mitigating affect for bacteremia in response to exertional heat stress.

How much do triathletes train? A systematic review

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Objective: The objective of this systematic review was to determine how much time triathletes spend training for race distances up to the full distance (also known as the Ironman distance) and how much time is spent on each discipline (swim/bike/run).

Data Sources: Five databases [PubMed, Medline (Ovid), CINAHL, EMBASE, and SportDiscus] were systematically searched for journal articles with the keyword triathlon. Two reviewers conducted a title, abstract, and full-text review of eligible studies. Articles that reported training volume for triathletes training for full-distance races or shorter were included. Triathlete characteristics, race information, total training volume, and volume for each discipline (when available) were extracted. The risk of bias was assessed for each included study.

Results: We identified 52 eligible studies. Twenty studies provided training volume data for the full distance, 8 for half distance, 13 for Olympic distance, and 1 for sprint distance. The mean weekly training volume was 16.2 hours/week for full distance ($n = 2498$), 13.4 hours/week for half distance ($n = 343$), and 11.9 hours/week for Olympic distance ($n = 280$). Only 1 study reported training volume for the sprint distance, with a median volume of 6.5 hours/week ($n = 77$). In addition, 16 studies reported combined training volume for triathletes training for different distances (e.g., Olympic and full distance) with a mean volume of 13.4 hours/week ($n = 1378$). Training volume for each discipline was reported in 18 studies (19%). Elite triathletes spent most time on cycling (full distance 52%, Olympic 41%), followed by swimming (full distance 28%, Olympic 36%) and running (full distance 20%, Olympic 23%). Nonelite triathletes similarly spent most time on cycling (full distance 53%, half distance 48%, Olympic

46%), followed by running in full distance (29%) and half distance (31%) but swimming in Olympic distance (29%). The remaining training time was spent swimming in full (18%) and half (21%) distances and running in Olympic distance training (25%).

Conclusions: This review demonstrates that weekly triathlon training volume increases when the race distance increases. Irrespective of race distance, triathletes spend the most time cycling. Elite triathletes spend more time swimming than running, but for nonelite triathletes, the volume for each discipline depends on the race distance.

Impact of a Spiral Learning Curriculum on Concussion Competency: A Quantitative and Qualitative Study

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Objective: The objective of this study is to evaluate the long-term impacts of a spiral concussion curriculum on residents' perceived competency acquisition.

Study Design: Prospective cohort comparison study.

Intervention: We developed a spiral concussion education curriculum that initially consisted of flipped classroom learning (tutor-directed half-day teaching session and self-directed learning from a study guide), workplace learning in concussion clinics, and self-reflection. A second cohort was later implemented with all the previous elements and additional near-peer teaching (NPT) to improve on learner engagement. Residents were asked to complete a preintervention and 6-month postintervention test assessing their knowledge and perceived confidence in competency.

Subjects: A total of 114 family medicine residents participated in the concussion curriculum and completed the preintervention test. Twelve residents (first cohort: $n = 5$, second cohort: $n = 7$) completed the 6-month postintervention test. Six residents (first cohort: $n = 5$, second cohort: $n = 1$) attended the 6-month postintervention, qualitative, semi-structured interviews.

Outcome Measures: The primary outcome measures were residents' knowledge and perceived confidence in competency.

Results: Quantitative analysis: Residents in the second cohort ($n = 7$) had a knowledge increment of 11.58% ($P > 0.05$) compared with the first cohort ($n = 5$) of minus 3.33% ($P > 0.05$) and confidence in competency increment of 62.79% ($P = 0.0014$) versus 30% ($P = 0.025$) at 6-month postintervention. Qualitative analysis: Residents exposed to the curriculum felt more prepared to manage concussions, to possess a stronger framework for working with concussion patients, and to have developed a stronger approach on physical examinations. They perceived frequent revisiting of

concepts through spiral learning aided in consolidation of learning and increase in competency. The resident exposed to NPT found it valuable for learner engagement, building confidence, and creating psychological safety.

Conclusions: Spiral learning with NPT showed a significant increase in confidence in concussion management competency and a nonsignificant but incremental increase in knowledge. Residents perceived the spiral learning curriculum to improve their clinical approach to assessing and managing concussion patients. This is the first study to assess the impact of spiral learning on concussion management and despite the small sample size, results support the use of spiral learning with NPT in residency education.

Case Report and Systematic Review of Pseudoaneurysm Following Ultrasound-Guided Corticosteroid Injection to Manage Hip Osteoarthritis in a Patient on Anticoagulation

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Objective: To present a case of circumflex femoral pseudoaneurysm following ultrasound-guided corticosteroid injection to the hip while on therapeutic anticoagulation and to review the literature for potential risk factors for vascular injury following intra-articular injection, given the high rate of osteoarthritis and comorbid use of anticoagulants in our aging population.

Case: A 71-year-old woman, anticoagulated with a DOAC for nonvalvular atrial fibrillation, underwent right hip ultrasound-guided corticosteroid injection without initial complication. She re-presented 48 hours later with significant ecchymosis and groin pain and was found to have a 1.2-cm pseudoaneurysm of a small branch femoral circumflex artery, managed with coil embolization the following day.

Study Design: Data were obtained and reported in accordance with the PRISMA (preferred reporting items for systematic reviews and meta-analyses) guidelines. Results were included if they were English language and contained information on vascular complications of percutaneous intra-articular interventions in humans. PubMed, EMBASE, and Google Scholar were searched from inception to October 2022. Due to limited results, reference lists were also reviewed for the relevant literature. Results were excluded if they reported on trauma, operative interventions, or if the vascular wall was intentionally breached.

Results: Four hundred twenty-two records screened; 36 articles were identified, and 4 met the inclusion criteria. There are no published cases of vascular complications following percutaneous, nonoperative interventions to the hip. One case described a circumflex humeral artery aneurysm, suspected to be related to a corticosteroid injection (Liberati et al, 2009). Limited evidence was found on the risk of anticoagulants for percutaneous articular intervention and pseudoaneurysm: a single case study (Damgaard et al, 2009) identified bilateral pseudoaneurysm and knee hemarthrosis secondary to needle aspiration with therapeutic warfarin. There is a body of literature supporting the risk of pseudoaneurysm in the lateral geniculate artery secondary to end-stage osteoarthritis (Son

et al, 2013 and Sasho et al, 2008). No similar results were found for the hip.

Conclusions: Despite the prevalence of hip osteoarthritis, and frequency of comorbid use of anticoagulants, there is limited evidence for understanding of the risk of pseudoaneurysm for percutaneous interventions for hip osteoarthritis.

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What factors do clinicians, athletes, and coaches perceive are associated with recovery from low back pain (LBP) in elite athletes? A Concept Mapping study

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Objective: Despite their peak physical fitness, 90% of Olympic athletes experience LBP during their career. Established risk factors for athlete LBP include training exposure, career duration, and older age. However, there is little evidence about the factors associated with athlete recovery from LBP. This study aimed to identify factors that experienced clinicians, athletes, and coaches associate with LBP recovery in elite athletes.

Study Design: Concept mapping is a mixed method participatory approach for qualitative data collection and quantitative data analysis. Participants brainstormed responses to the focus prompt “*what factors are associated with the recovery of an elite athlete from low back pain?*” The Concept Systems groupwisdom Web platform was used to collect and analyze data. We followed Kane and Trochim recommended processes to synthesize and edit the brainstormed statements before inviting participants to sort statements into related concepts and rate their relative importance.

Results: There were 56 brainstorming and 34 sorting and rating participants. Participants had gender parity and comprised 75% clinicians, 15% coaches, and 10% athletes. More than 60% had >15 years of elite sport experience, and participants represented 13 different countries, 5 continents, and 17 sports. We synthesized and edited the 234 participant brainstormed statements to 82 single-idea, unique statements. Following multidimensional scaling and hierarchical cluster

analysis, the research team agreed on 6 LBP recovery-related themes: (1) external support networks, (2) clinical team factors, (3) athlete psychological factors, (4) assessment, management, and rehabilitation, (5) athlete factors (non-physical, nonpsychological), and (6) athlete-specific physical factors. Participants identified athlete empowerment and psychology as important recovery factors, including coach athlete and athlete clinician relationships and care team communication. Within assessment, management, and rehabilitation factors, early identification of red flags was considered important. Return-to-sport plan considerations included a collaborative, athlete-centered, and well-communicated plan, with consistent messaging.

Conclusions: Factors identified in our study as important to recovery from LBP in elite athletes align with the biopsychosocial model of community LBP management. Our results highlight the need for further research into the impact of psychology, athlete relationships and care team communication on LBP recovery in elite athletes.

Effect of Ice Surface Size on Collision Rate and Type in National Collegiate Athletic Association Division 1 Men's and Women's Ice Hockey

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Objective: To determine whether rink size (international (200 × 100 ft), hybrid (200 × 90 ft or 200 × 95 ft), or NHL (200 × 85 ft)) affects collision rate and type in NCAA Division 1 men's and women's ice hockey.

Study Design: Cross-sectional study.

Subjects: Four NCAA Division 1 hockey teams, 2 women's (St. Cloud State, University of Minnesota) and 2 men's (University of Alaska-Anchorage, Minnesota State), from the 2018 to 2019 season.

Observation Technique: Full-game replays were streamed using the FloHockey platform. Eight games per team played on international, hybrid, and NHL-sized rinks were analyzed by 2 current or former (<2 years postgraduation) NCAA Division 1 hockey players using standardized collision tracking guidelines.

Outcome Measures: Collision type was broken down into the following main categories: player/player, player/boards, and player/ice. Collisions in each category were further classified as volitional, accidental or incidental, and all collisions involving direct or indirect head impact were subcategorized. Severe head impacts were identified according to the clinical signs of concussion for removal from play based on NHL guidelines. Statistical analyses used the nonparametric Mann-Whitney *U*-test; *P* values of less than 0.05 were considered significant.

Results: For both men's and women's teams, there were significantly fewer total and player/player collisions in games played on international and hybrid (200 × 90 or 200 × 95 ft) as compared with NHL rinks (all *P* ≤ 0.01). For men's hockey (volitional bodychecking permitted), there were also fewer collisions in games played on international as compared with hybrid rinks (*P* = 0.03) and significantly fewer total and direct head impacts in games played on international as compared with NHL rinks (*P* = 0.02). For women's teams, there was a

nonsignificant trend toward fewer total head impacts (direct and indirect) on larger ice surfaces.

Conclusions: An increase in rink dimensions from NHL size to either hybrid size or to international size in both men's and women's NCAA Division 1 hockey was associated with a decrease in total collisions, particularly player/player collisions, and head impacts, especially during men's games. These results highlight a potential primary preventative strategy to reduce hockey-related injuries and concussions irrespective of gender, and it could be used to advocate for organizations to elect to use larger rink sizes in NCAA or other elite-level hockey.

Confidence Levels in Concussion Diagnosis and Management: A Survey of General and Family Practice and Sport and Exercise Medicine physicians in Ontario

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Objective: To assess confidence levels in the diagnosis and management of concussion and to identify concussion-related learning preferences in physicians from the Ontario Medical Association (OMA) Sections of General & Family Practice (GFP) and Sport and Exercise Medicine (SEM).

Study Design: Cross-sectional online survey performed in 2022.

Subjects: Active physicians within the OMA Sections of GFP and SEM seeing patients with concussion. Response rate: GFP 216/15 674 (1.4%), SEM 35/696 (5.0%).

Observation Technique: Independent variables were Section (GFP vs SEM), guideline usage, and clinical concussion exposure.

Outcome Measures: Physician confidence in concussion diagnosis and/or management on a Likert scale of 1 (not comfortable) to 5 (very comfortable). Scores of 1, 2, or 3 were considered "less confident," and scores of 4 or 5 were considered "confident."

Results: For diagnosis, 62.8% of GFP and 85.7% of SEM physicians reported that they were confident. For management, 46.1% of GFP and 82.9% of SEM physicians reported that they were confident. Fisher exact testing showed significant differences in confidence between sections for both concussion diagnosis (*P* = 0.007) and management (*P* < 0.001) and was adjusted for in reported OR calculations. More than 15 years of practice experience did not predict confidence in either diagnosis (OR = 0.98, 95% CI: 0.56, 1.69) or management (OR = 1.44, 95% CI: 0.84, 2.47). Clinical exposure to concussion within the past year did predict confidence for both diagnosis (OR = 6.74, 95% CI: 2.87, 15.81) and management (OR = 2.63, 95% CI: 1.16, 5.96). Reliance on clinical guidelines predicted confidence in concussion management (OR = 1.94, 95% CI: 1.01, 3.74). Preferred resources for future learning were Web sites (46.2%) and continuing medical education (85.0%). Significantly more SEM physicians selected consultations with colleagues (GFP 11.4%, SEM 29.4%; *P* = 0.005), training in medical school/residency (GFP 30.3%, SEM 55.9%; *P* = 0.003), journals/

medical publications (GFP 26.1%, SEM 44.1%; $P = 0.031$), sports organizations (GFP 4.3%, SEM 23.5%; $P < 0.001$), and social media (GFP 1.4%, SEM 8.8%; $P = 0.037$).

Conclusions: Use of clinical concussion guidelines may increase physician confidence in managing concussion in practice. Knowledge translation efforts should target delivery methods based on the demographic of interest. Future work should examine how physician confidence levels might translate to their clinical behaviors and practice patterns.

Best Practices for Neuromuscular Training Warm-up Program Implementation in Youth Team Sport: A Systematic Review

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Objective: The primary objective was to evaluate best practices for neuromuscular training (NMT) warm-up dissemination and implementation (D&I) in youth team sports. The secondary objective was to describe NMT D&I outcomes, including strategies to reduce injury.

Data Sources: Eight databases (i.e., MEDLINE, EMBASE, CINAHL, EBSCO, SPORTDiscus, ProQuest

Dissertations and Theses Global, Cochrane) were searched. Search concepts included injury prevention (NMT), youth, sport, and implementation. Three sets of paired reviewers performed the title, abstract, and full-text screening, data extraction, and quality assessment (Downs & Black checklist) and came to consensus with a third reviewer resolving any disagreements.

Main Results: The literature search resulted in 61 articles included. Top sports included soccer (49%), basketball (11.5%), rugby (11.5%), and multisport (11.5%), ranging from U9 to U19 at various levels. Top study designs included 18 of 61 (29.5%) randomized controlled trials (RCT), cross-sectional (13 of 61; 21%), and quasiexperimental (9 of 61; 15%). Time restrictions ($n = 25$) and limited awareness of preventative effects of programs ($n = 8$) were commonly identified barriers for NMT implementation. Facilitators included comprehensive workshops ($n = 11$) and support ($n = 8$). Highlighted program characteristics included sport-specific and fun exercises. The most frequent D&I strategies evaluated were workshops with supplementary resources (WR), workshops with both resources and personnel support (WRP), and workshops only (W). The most frequently reported D&I outcomes were adherence or adherence related ($n = 37$). One study comparing WR and WRP implementation found no differences; however, it found a 56% reduction in injuries for high adherence groups. Another study comparing the same strategies with additional supervision found a 36% reduction in injuries. Studies using WR ($n = 21$) reported adherence ranging from 1.4 to 3.2x/week. Those evaluating WRP ($n = 11$) reported adherence to programs 1.5 to 2.4x/week. Three of 6 studies using WRP showed a 15 to 38% reduction in injury rates.

Conclusions: High-quality studies primarily focused on D&I strategies are limited. The use of comprehensive workshops and resources supports success in the implementation of NMT programs. Building on current knowledge, future research should consider implementation-effectiveness hybrid approaches to promote the real-world utilization and long-term maintenance of NMT warm-ups in youth team sport.

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