



UNIVERSITY OF CALGARY
FACULTY OF KINESIOLOGY



Human Performance Lab 2023 Annual Report

DIRECTOR'S MESSAGE



The Human Performance Lab (HPL) at the University of Calgary has undergone many upgrades. In 1981, it consisted of a single, long, and narrow room, with two force platforms embedded into a walkway, two 16 mm film, high-speed cameras, and a Cybex machine.



In preparation of the University campus hosting the athletes of the 1988 Winter Olympic Games, a two storey building, specifically designed for scientific research became the home for the "new" HPL in 1987. Multiple force platforms that could be arranged in different configurations, multiple high-speed video cameras, laboratories for exercise physiology and biochemistry, motor control, and biomechanics were developed and implemented with state-of-the-art equipment. Generous laboratory and office spaces were available for this multi-disciplinary, open-, and shared-access facility long before multi-disciplinarity in research became fashionable.

Through a generous grant from the Canada Foundation for Innovation (CFI), two floors were added to the existing HPL in 2002/03, introducing facilities for animal based, pre-clinical research, molecular and cellular biomechanics and physiology, genetics, and nutrition. A shift from descriptive human research to approaches aimed at understanding mechanisms of human mobility, health, well-being, and longevity was made possible through this visionary expansion.

Today, we are at the brink of another upgrade and modernization of the HPL, extending the existing footprint with a new building made possible through a \$ 20 million donation by the Taylor Family Foundation. And like the original idea more than 40 years ago, this HPL extension is based on the principles of multi-disciplinarity, open and shared spaces, and maximal flexibility. Scientists from the life-, clinical-, and psychosocial sciences will be working side by side to facilitate intra-disciplinary research in an incomparable environment.

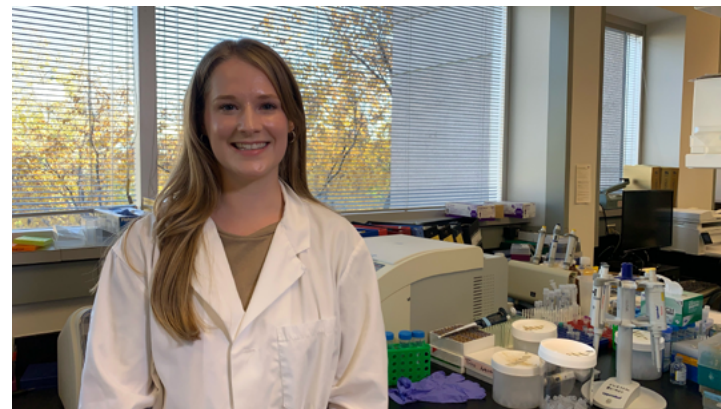
We would like to thank Don and Ruth Taylor for their generous donation which makes this extension of the HPL possible, their support of the Human Performance lab over decades, and their vision for the future of human mobility and longevity research. We would also like to thank the Faculty of Kinesiology and the University of Calgary for their enduring support, and all friends and supporters of our research, and our families for their understanding for our passion in our work. All your support has made it possible for us to be at the leading edge of human performance research for the past four decades.

W. Taylor *W. Ruth Edwards*

HIGHLIGHTS

Honour	Carolyn Emery — Fellow, Royal Society of Canada
Honour	Salvatore Federico — Inducted, Corresponding Member of the Accademia Peloritana dei Pericolanti
Honour	Leigh Gabel — University of Calgary Student Union Teaching Excellence Awards Honorable Mention
Honour	Walter Herzog — Cy Frank Legacy Award from the McCaig Institute for Bone and Joint Health for Career Contributions in Musculoskeletal Research and Osteoarthritis
Honour	Walter Herzog — The McKeith Basic Science Award from the American Academy of Cerebral Palsy and Developmental Medicine
Honour	Walter Herzog — The Ian Macnab (President's) Memorial Lecture at the Canadian Orthopaedic Research Society
Honour	Jonathan Smirl — Top Cited Article for the year published in Physiological Reports
Honour	Brian MacIntosh — President's Lecture at the Annual CSEP Conference for career contributions to exercise physiology research
Award	Cindy Barha — Canada Research Chair (Tier 2) in Neuroscience, Brain Health and Exercise
Award	Zachary Barrons — Supervised by Dr. Darren Stefanyshyn Footwear Biomechanics Applied Research Award
Award	Tyler Cluff — National New Investigator Award, Heart and Stroke Foundation of Canada
Award	Tyler Cluff — Faculty of Graduate Studies Excellence in Supervision Award, UCalgary
Award	Reyna Crawford — Supervised by Dr. Darren Stefanyshyn Nike Award in Footwear Science
Award	Brent Edwards — UCalgary Research Excellence Chair, UCalgary

HIGHLIGHTS



Award	Ash Kolstad — Co-supervised by Drs. Carolyn Emery and Brent Hagel Izaak Walton Killam Doctoral Scholarship
Award	Dana Lowry — Supervised by Dr. Raylene Reimer Izaak Walton Killam Doctoral Scholarship
Award	Benno Nigg — Top 7 Over 70 Award
Award	Benno Nigg — Lifetime Achievement Award, Footwear Science
Award	Isla Shill — Co-supervised by Drs. Carolyn Emery and Brent Hagel Vanier Scholarship
Appointed	Carolyn Emery — Global Chair, UK, University of Bath
Appointed	Walter Herzog — Reviewer, National Killam Selection Committee, Killam Prize and Dorothy Killam Fellowship
Appointed	Kati Pasanen — Associate Editor, Journal of Orthopaedic & Sports Physical Therapy
Appointed	Ryan Peters — Guest Editor, Sensors: Special Issue on "Neurological Wearables for Clinical Diagnostics and Therapeutic Interventions"

HIGHLIGHTS

Appointed	Bill Wannop — Co-Editor Footwear Science
M.Sc.	Timi Ajayi — Supervised by Dr. Martin MacInnis Thesis: An Assessment of Detrended Fluctuation Analysis (Alpha 1) in Demarcating Exercise Intensity, Quantifying Training Load, and Predicting Performance.
M.Sc.	Christina Alexander — Supervised by Dr. Leigh Gabel Thesis: The influence of physical activity on bone strength in children and adolescents
M.Sc.	Joshua Cairns — Supervised by Dr. Carolyn Emery Thesis: Injury Prevention in Youth Tackle Football
M.Sc.	Joseph Carere — Co-supervised by Drs. Carolyn Emery and Jonathan Smirl Thesis: Long-term cardiorespiratory, exercise intolerance and autonomic nervous system outcomes following adolescent sport-related concussion
M.Sc.	Allison Caswell — Supervised by Dr. Martin MacInnis Thesis: The influence of biological sex, hemoglobin mass, and skeletal muscle characteristics on cycling critical power.
M.Sc.	Reyna Crawford — Supervised by Dr. Darren Stefanyshyn Thesis: The Influence of Lateral Wedged Insoles on the Performance of Basketball-Specific Movements
M.Sc.	Christy Fehr — Supervised by Dr. Carolyn Emery Thesis: Whistleblowing the whistleblower- are head contact penalties a target for injury prevention in youth and university basketball?
M.Sc.	Andrew Koshyk — Supervised by Dr. Brent Edwards Thesis: Influence of microarchitecture on the mechanical fatigue behaviour of equine subchondral bone
M.Sc.	Meng Li — Supervised by Dr. Walter Herzog Thesis: The nature of sarcomere length non-uniformity.
M.Sc.	Destiny Lutz — Co-supervised by Drs. Carolyn Emery and Kathryn Schneider Thesis: The reality of NMT warm-up programs: Does research translate into real-world implementation?

HIGHLIGHTS

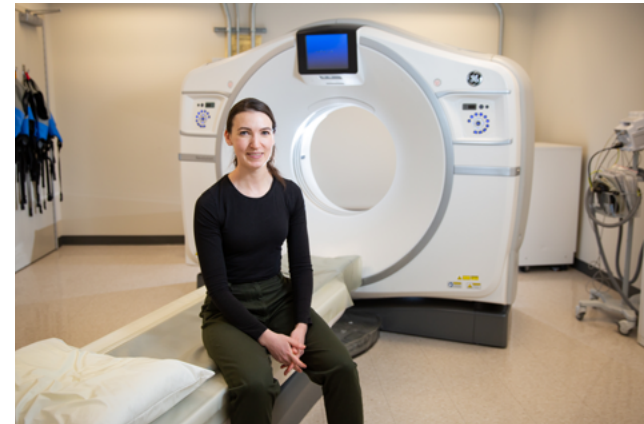
M.Sc.	Jocelyn McCallum — Co-supervised by Drs. Carolyn Emery and Amanda Black Thesis: Sleep Disturbances and Impairments in High School Sport Participants at Baseline and Following a Sport-Related Concussion
M.Sc.	Zachary McClean — Supervised by Dr. Jalal Aboodarda Thesis: The integration of neuromuscular, perceptual, and cardiorespiratory responses is modulated by high-intensity interval training characteristics and blood flow restriction in males and females
M.Sc.	Riley Patterson — Supervised by Dr. Raylene Reimer Thesis: Effects of a paternal diet high in animal protein versus plant protein on offspring metabolic and microbial outcomes in a rodent model



HIGHLIGHTS

- M.Sc. Taylor Price — Supervised by Dr. Carolyn Emery
Thesis: The take on youth rugby in Canada: Video-analyses examining suspected injuries, concussions, and match events in youth rugby players.
- M.Sc. Stacy Sick — Supervised by Dr. Carolyn Emery
Thesis: Is a history of concussions associated with measures of cervical spine, vestibulo-ocular reflex, oculomotor, and dynamic balance in adolescent (ages 10-19) sport participants?
- M.Sc. Matthew Zukowski — Co-supervised by Drs. Matt Jordan and Walter Herzog
Thesis: The effects of force-velocity test specificity on on-ice acceleration performance prediction in elite speed skaters
- Ph.D. Aki Matti Alanen — Supervised by Dr. Kati Pasanen
Thesis: Change of Direction Movement Evaluation in Soccer-Specific Environments with Inertial Measurement Units: Guiding Practice and Test Tasks in Youth Soccer
- Ph.D. Zachary Barrons — Supervised by Dr. Darren Stefanyshyn
Thesis: The Influence of Midsole Thickness on Running, Does Size Matter?
- Ph.D. Olivia Bruce — Supervised by Dr. Brent Edwards
Thesis: Tibial-fibular morphology: variation, sexual dimorphism, and mechanical implications
- Ph.D./M.D. Robert Moore — Supervised by Dr. Tyler Cluff
Thesis: Motor Learning After Stroke
- Ph.D. Franziska Onasch — Supervised by Dr. Walter Herzog
Thesis: On force application in bobsleigh and cycling
- Ph.D. Jason Tabor - Co-supervised by Drs. Carolyn Emery and Chantal Debert
Thesis: Plasma Biomarkers Associated with Sport-Related Concussion in Adolescents: Age and Sex Matter

HIGHLIGHTS



GENERAL COMMENTS



JALAL ABOODARDA

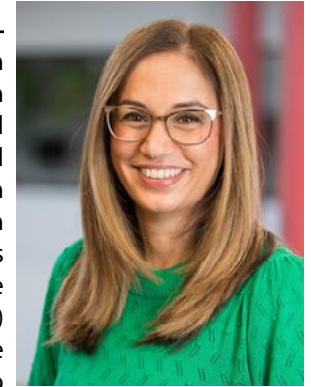
In 2023, Dr. Jalal Aboodarda's research focused on four main projects, including 1) assessing psychophysiological responses determining exercise tolerance during shorter and longer HIIT protocols, 2) comparing the integration of neuromuscular, perceptual, and cardiorespiratory indices of exercise tolerance during HIIT combined with blood flow restriction in males and females, 3) exploring the effects of acute and accumulated fatiguing exercise on performance and perceived fatigability and 4) investigating the effects of ovarian hormonal changes and contraceptive

methods on the integration of neurophysiological, perceptual, and cardiorespiratory determinants of exercise performance. Neurophysiological assessments in these studies included maximal and submaximal 5-s knee extensions during which transcranial magnetic and femoral nerve electrical stimuli were delivered to assess central and peripheral components of performance fatigability and corticomotor responses. Cardiorespiratory assessments (ventilatory gas analysis and heart rate) as well as metabolic responses (blood lactate concentration) were recorded continuously in each exercise session. Immediately prior to each assessment, perceived effort, fatigue, pain, and dyspnea will be quantified.



GENERAL COMMENTS

CINDY BARHA



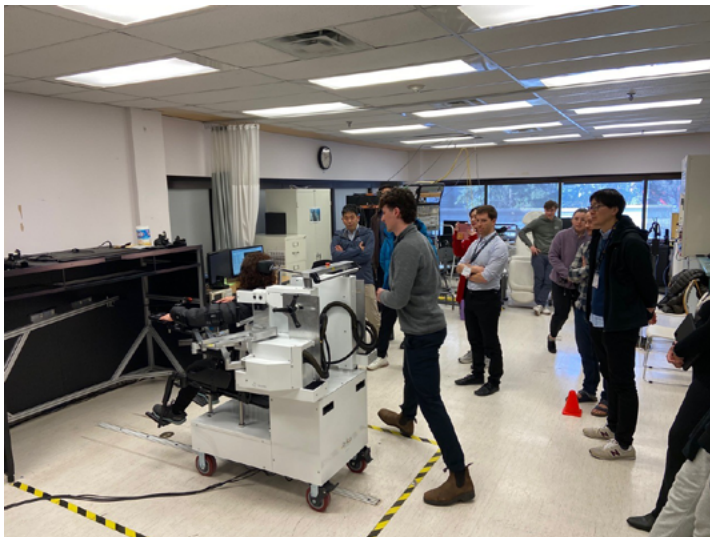
In 2023, Dr. Cindy Barha established the Brain Health Lab which focuses on promoting healthy brain aging by developing efficacious and personalized exercise interventions for cognition and neuroplasticity during critical endocrine transition states using both human and rodent studies. In the past year, the lab extended Dr. Barha's previous work examining how previous reproductive experience (i.e., number of previous pregnancies) alters brain aging trajectories and moderates the cognitive response to exercise after menopause. To support this work, Dr. Barha received a Knowledge Mobilization grant and a Biomedical Catalyst grant from CIHR.



TYLER CLUFF

The Integrative Sensorimotor Neuroscience Laboratory is a growing group in the Human Performance Laboratory. Their work is focused on the mechanistic, multidisciplinary study of human sensorimotor control and learning. The lab combines behavioural experiments with robotics, medical imaging, and computational models to examine the function of the human sensory and motor systems. Work is focused on understanding how basic aspects of sensory processing contribute to human motor control and learning. Ongoing projects in the lab

focus on four topics: 1) the role of sensory feedback in the selection, planning, and control of voluntary movements, 2) basic principles of sensory processing and how they impact individual patterns of human motor behaviour, 3) probing the function of neural circuits that support motor behaviour, and 4) identifying how impairments in sensory and motor function caused by stroke and concussion influence sensorimotor control and learning. Through basic science program and ongoing collaborations, the lab hopes to generate tools that allow for better assessments and monitor deficits in sensory and motor function.



PATRICIA DOYLE-BAKER
Associate Dean Graduate



The Doyle-Baker lab's research area includes reproductive health in populations of female-sexed individuals, particularly athletes. The lab employs both qualitative and quantitative methods and whenever possible use a participant-centered approach, and also uses technology to assist with reducing the large time burden associated with collecting biomarker data and measuring performance metrics.

This year the focus was on different measures of performance, loosely defined as a process to assess the efficiency and effectiveness of a related outcome. These studies investigated the impact of the menstrual cycle on performance readiness, the performance of an app when compared to objective menstrual cycle hormone measures, athletes' reflections on their performance during their menstrual cycle, wearable technology performance during a physical activity intervention, high-performance athlete's knowledge and awareness of atrial fibrillation, a screening tool to evaluate nutritional preparedness and performance in university athletes, and identifying the common performance measures for female athletes.

The lab group aims to increase the representation of females in sport science research and contribute to the methodological rigor that is often lacking while recognizing that this requires large sample sizes. The long-term goal is to develop an individualized performance readiness approach that encompasses a state of optimal physical, mental, and social well-being for long term health.



BRENT EDWARDS

Mechanical fatigue of load bearing biological tissue is an inevitable consequence of physical activity. Over time, habitual loading of the musculoskeletal system causes microdamage accumulation that reduces the overall quality of the tissue and leads to a reduction in stiffness and an increase in mechanical strain with continued loading. Without adequate tissue repair and adaptation, the evolution and accumulation of microdamage may eventually lead to musculoskeletal injury. Mechanical fatigue is believed to play a predominant role in the pathophysiology of musculoskeletal injuries such as bone stress fracture as well as Achilles and patellar tendinopathy.



This past year was marked by some exciting new discoveries related to stress fractures in runners. It has been known for a long time that females have a higher risk of stress fracture than males, but the underlying cause of this sex disparity is unclear. Using advanced medical imaging and statistical approaches, Dr. Edwards' team characterized how bone shape and density vary among young males and females. The findings suggested that the average female tibia is narrower and has a thinner cortex than the average male, which results in higher bone strain in the female tibia during running. In other words, the increased risk of stress fractures in female runners may be explained, in part, by differences in bone geometry, which could be mitigated through targeted interventions to improve bone quality and/or reduce loading magnitudes.

Dr. Edwards' team also reported on the influence that certain osteoporosis therapies may have on the fatigue strength of bone. Although antiresorptive therapy is associated with a large reduction in osteoporosis fracture risk, there is concern that long-term treatment with these drugs may negatively affect bone quality and increase the risk for a fatigue related fracture known as atypical femoral fracture, a stress fracture of the femoral shaft. Interestingly, they found that potent antiresorptive treatments enhance rather than reduce bone quality and fatigue resistance in bone. This work was published in the top journal in the bone field (i.e., the Journal of Bone and Mineral Research) and opens the doors for new hypotheses regarding the association of antiresorptive therapies with atypical femoral fracture.



CAROLYN EMERY

Dr. Carolyn Emery is the Chair of the Sport Injury Prevention Research Centre and co-leads the Integrated Concussion Research Program at UCalgary. In 2023, she and her team continued research priorities informing the reduction of sport-related injuries and their consequences with a focus on children and adolescents, girls, parasport, and adapted physical activity. Her program also has a strong emphasis on concussion and epidemiology. Carolyn considers a multifaceted approach to injury prevention solutions across sport rules and policy, protective

equipment, training strategies, and injury management.

Highlights include scaling-up the SHRed Injuries neuromuscular training coach and train-the-trainer workshop implementation and evaluation in youth rugby, basketball, football, field hockey, ice hockey, ringette, and soccer, with a focus on concussion prevention. Tackle training program development and law change evaluation are highlighted in youth rugby. The SHRed Injuries surveillance program has been scaled-up internationally with a focus on youth concussion, collision sport, and dance (US, UK, Australia). The SHRed mobile has been actively engaged in research and knowledge translation provincially and nationally, supporting rural and Indigenous community partnerships in the prevention and management of injuries and concussions. The SHRed Consequences of Concussion cohort study and a randomized controlled trial evaluating a multifaceted approach to treatment following concussion in youth will inform better outcomes following concussion in youth.

Dr. Emery continues to lead a program of research focused on safe participation and healthy outcomes associated with adapted physical activity programs for children with disabilities (Calgary Adapted Hub Power by Jumpstart). In 2023, Dr. Emery co-led the Sport-related Concussion Prevention systematic review and meta-analyses informing the 6th IOC Conference on Concussion in Sport and contributes to the International Concussion in Parasport expert group leading research and knowledge translation in Parasport. Dr. Emery is co-leading the IOC Female Athlete Injury prevention (FAIR) Consensus.

SALVATORE FEDERICO

Continuum Mechanics is the study of matter at a length scale at which the existence of the atomic structure can be neglected, and matter can be treated as continuous rather than discrete. Research in the Continuum Biomechanics Group is devoted to the mathematical foundations of Continuum Mechanics and its applications to the Biomechanics of Soft Tissue. In particular, the lab group is interested in modelling soft tissue accounting for its structural elements, i.e., collagen fibres, cells, non-fibrous extracellular matrix and fluid. Most phenomena of structural rearrangement in a biological tissue can be described under the umbrella of growth and remodelling. Structural damage is what can initiate injury and disease.

A main theme is the modelling of articular cartilage. Articular cartilage is the thin layer of connective tissue covering the end of bones in our joints: for the span of a lifetime, it provides stress redistribution and an extremely low-friction contact. When the tissue degenerates because of diseases such as osteoarthritis, it cannot perform its function properly and this results in pain, limitation of mobility, and ultimately a decrease in quality of life. Understanding the relationship between the tissue structure and its function, remodelling and damage processes may shed light on the causes of the initiation of degeneration, and suggest possible treatments to prevent disease.



LEIGH GABEL

Dr. Leigh Gabel had a successful funding year in 2023, receiving funding from several internal seed grants and the Alberta Bone and Joint SCN to begin a randomized controlled clinical trial examining resistance training for preventing bone loss during peri- and early menopause. Study recruitment began in 2023 as did several graduate students working on the project.

Dr. Gabel also secured an NSERC discovery grant and early career supplement for investigating bone adaptation to mechanical loading during adolescence and received a CIHR Project Grant as Co-PI investigating bone health in children and adolescents with type 1 diabetes. Dr. Gabel received an honorable mention from UCalgary's Student's Union for excellence in teaching.



WALTER HERZOG



This past year, Dr. Walter Herzog's team addressed the problem why sarcomeres in skeletal muscles are non-uniform in length and why this is advantageous for muscle contraction and force production. Furthermore, they identified that protein unfolding in the sarcomeric molecule titin occurs in a different way than had been thought for the past twenty years, which has great consequences for the mechanical properties of sarcomeres and muscles. In their research on joint biomechanics and osteoarthritis, they developed a pre-clinical model of diet-induced obesity aimed at testing the hypothesis that aerobic capacity is crucial in reducing obesity, metabolic syndrome, and musculoskeletal degeneration in animals exposed to a high-fat and high-sucrose diet. Also, they started to develop a pre-clinical model of stroke to study sarcomerogenesis in spastic muscles following stroke and in children with cerebral palsy.

They are also testing a novel treatment option against muscle stiffness, as observed in children with cerebral palsy, with the goal to reduce the number of surgeries required to restore and preserve mobility.

In their applied research on back biomechanics, they confirmed previous research that neck manipulations do not produce longitudinal strains in arteries of the neck, and that the positioning of the head and neck is of great clinical importance for successful cervical spinal manipulations, and they provided novel information on optimal muscle synergies in sports, such as cycling.



JOHN HOLASH

In 2023, Dr. John Holash was involved in several projects in exercise health physiology.

As a leader in the Movella Cross-Country Skiing Biomechanics Competition, he supervised a team of graduate and undergraduate students in this international competition creating a computer algorithm to estimate force and effort in cross country skiing. His team investigated the mechanical properties of skeletal muscle in children with Cerebral Palsy and

investigated how flash freezing affects skeletal muscle force characteristics.

In applied studies, Dr. Holash examined the impact of cold on athletic performance and the biomechanics of the double poling technique in cross-country skiing. He was featured as an "Innovative Educator" in a video series by the Taylor Digital Library and served as an expert media source for several television and radio interviews on the body's response to cold environments.

MATT JORDAN

This was a productive year for the Integrative Neuromuscular Sport Performance Laboratory (INSPL) and the Muscle Strength Lab. Ongoing research through the Dinos Athletics Excellence Fund supported baseline testing of 260 varsity U-Sport athletes related to an ACL injury/reinjury prevention research project. Three papers stemmed from this work, examining the relationship between muscular strength, asymmetry, perceived limb function and attitudes towards training. Importantly, this research takes

a holistic bio-psycho-social approach to the problem of ACL injury/reinjury prevention. Together, Dr. Jordan and Dr. Kati Pasanen have been providing support to U-Sport athletes, coaches and support staff through the INSPL to help reduce the burden of ACL injury.

Dr. Jordan continues to collaborate on the International Ski Federation Return to Snow Consensus statement, and is contributing to leading research on bio-psycho-social models of injury rehabilitation. Additional international collaborations include with Edith Cowan University and a collaboration on a successful Australian Sport Commission research grant. Ongoing research projects include examining the effects of cueing strategies on hop kinetics in ACL injured and noninjured athletes, examining the effects of menopause on muscle-tendon function and studying the effects of muscular strength and compression garments on soft tissue vibrations in female runners.



AMIN KOMEILI

In 2023, Dr. Amin Komeili continued his research on human assistive devices by developing a cycling ergometer capable of applying asymmetric assistive torque. The R&D, manufacturing, and sensor integration of the cycling ergometer took about a year. They are now ready to embark on conducting innovative experiments, such as muscle fatigue development in response to exercise programs, the effect of assistive torque on joint forces during cycling, and markerless kinematics of cycling. Also, Dr. Komeili started a new branch of research in iHADLab, focusing on wearable technologies for disease diagnosis. In a Mitacs-supported project and collaboration with a SenseSi partner, the iHADLab team developed a microfluidic wearable chip for collecting sweat from the skin surface and estimating the stress level.

MARTIN MACINNIS

The Molecular, Exercise, and Environmental Physiology (MEEP) Laboratory is an integrative physiology laboratory primarily interested in understanding how humans respond to exercise training. Led by Dr. Martin MacInnis, the MEEP Laboratory employs a wide breadth of techniques, ranging from the biochemical and molecular analysis of human tissues to whole-body measures of exercise metabolism, tolerance, and performance. The overall aim of their research program is to understand how humans respond to exercise.



In 2023 the research group published research focused on: 1) the use of wearable technologies for exercise testing/prescription and 2) the extent to which responses to exercise are influenced by sex.

In the wearable technology area, they continued work into the applications of running power to exercise physiology, publishing two studies. First, they demonstrated high reliability and validity for assessing running power on a treadmill with a commercially available inertial measurement unit (Stryd). Using the same device, they published a study demonstrating that critical power and speed for track running are concordant, providing new opportunities to prescribe exercise in the field.

The MEEP Lab also continued research in sex-based differences. They reported that quadriceps critical torque and fatigue induced by exercising were similar for males and females, and that skeletal muscle mitochondrial content was an important correlate of critical torque and has a role in fatigue resistance. These results demonstrate that sex differences in exercise physiology are often diminished when participants are matched for aerobic fitness.

The group also completed studies that: 1) refined a non-invasive method for assessing skeletal muscle oxidative capacity, 2) examined the effect of blood withdrawal on endurance performance, 3) applied detrended fluctuation analysis to heart rate and gait data, and 4) methods to assess rock climbing performance. Finally, they began a comprehensive training study comparing the effects of two exercise frequencies on aerobic fitness.



BENNO NIGG

The Nigg lab group concentrates on locomotion topics that are health and performance related with special considerations for footwear, apparel, and equipment. This last year, 1) they made significant progress in our understanding of the teeter totter concept, a potential mechanism that explains the effect of shoe design features on running performance, 2) developed shape modeling algorithms to create better fitting ice hockey skates, 3) and proposed a new modeling concept, the roll-over curve, to improve the

ability to predict a footwear's ability to influence running energetics. Lastly, the Nigg group celebrated the Top 7 Over 70 Award that was received by Principal Investigator, Dr. Benno Nigg.

Advanced footwear technology aft shoes have substantially improved long distance runnig performance, however the underlying mechanisms responsible for improvements remain unclear. This year, the group designed a novel methodology to test the teeter-totter theory, worked on providing experimental evidence for the theory, and quantified the effect of shoe features on the teeter-totter mechanism.

The fit of an ice hockey skate is vital to the comfort and performance of an athlete. Through collaboration with leading hockey skate manufacturers, the group has developed a statistical shape model of the foot. This will serve as a guide for future skate design and an algorithm that has the ability to predict consumer skate preference, thus matching them with skates that optimize fit, comfort and performance.

Since the inception of sport biomechanics, continuous effort has been made to design innovative shoe features that enhance athletic performance. To test the effectiveness of new shoe designs, researchers rely on experimental methods where large-scale data is collected in a lab. The data collection process is laborious; the Nigg group proposes a computational model that is capable of efficient and robust shoe performance evaluations using the concept of the rollover curve. By linking rollover curbe shape to running energetics, the rolloever curve produced by different shoe designs can be calculated and compared. The group has completed the development of this model and is currently in the validation phase by comparing model-predicted performance with experimental studies.

KATI PASANEN

Dr. Kati Pasanen's lab develops, evaluates, and implements sport specific training strategies for injury prevention in athletes of all performance levels, with a special research interest in prevention of anterior cruciate ligament (ACL) injuries in female team sport athletes.

In 2023, Dr. Kati Pasanen's work focused on four main research areas, including (1) assessing change of direction movements with inertial measurement units in youth female and male soccer players, (2) developing and evaluating sport specific cutting and landing tests for university female team sport athletes, (3) investigating risk factors for knee injuries in team sport athletes, and (4) exploring the effects of two training programs on injury risk in female and male runners. In addition, together with Dr. Matt Jordan, Dr. Pasanen has been providing support to U-Sport athletes, coaches and support staff to help reduce the burden of ACL injury.





RYAN PETERS

In 2023, Dr. Ryan Peters' research was focused on both basic and applied science. In terms of basic science, he and his team have been investigating the muscle spindle and the stretch reflexes they evoke in great detail. This includes single-unit recordings from human muscle spindles using the technique of human microneurography, as well as novel experiments that used VR-induced threat (virtual height platform) to assess context-dependent modulation of muscle stretch reflexes. Dr. Peters was invited to present these results at

the satellite meeting of the Society of the Neural Control of Movement in May of 2023.

In terms of applied research, Dr. Peters continued to advance his industry partnership work with Neursantys Inc. He tested novel therapeutic applications for neurostimulation technologies aimed at improving gait and balance in community senior living homes and supported the productization of this technology into a new wearable device called "Neurvesta".

RAYLENE REIMER (DE BRUYN)



In 2023, Dr. Raylene Reimer's research continued to focus on understanding how nutrition and the bacteria that live in our intestine (gut microbiota) interact to affect our risk of developing chronic diseases such as obesity and type 2 diabetes. Changes to the gut microbiota in early life play a particularly strong role in increasing or decreasing the risk of many diseases later in life including obesity and asthma. The Reimer lab has focused their recent animal work on several aspects of early life microbiota development. In the first instance, they examined how a diet low in fiber affects the microbiota in maternal milk and the impact this has on offspring obesity risk. They also examined how birth via C-section affects the development of anxiety-like behaviors in rats and whether this can be reversed with consumption of prebiotic fiber in early life.

The Reimer lab is also actively engaged in human clinical trial research and is studying how prebiotic fiber supplementation can improve health outcomes in children and young adults with type 1 diabetes. Ultimately the goal of the Reimer lab is to design and evaluate diets aimed at optimal gut microbiota profiles and metabolic health.



JONATHAN SMIRL

Dr. Jonathan Smirl's research team works with the Sport Injury Prevention Research Centre and the Human Performance Laboratory. His team is focused on understanding the physiological and autonomic disruptions which occur following concussion. The aim is to use this knowledge to develop informed interventions which can be used to aid in the recovery process during both the acute and chronic symptom periods.



Dr. Smirl's team is leading the exercise-based measures in the Pan-Canadian Surveillance in High Schools to REDuce (SHRed) Concussions project. They are collaborating with other Canadian institutions on objectively quantifying the extent concussed athletes rest and exercise following concussions. Dr. Smirl's lab is collecting data on numerous fronts including: field based measures of physical activity, developing new testing protocols for establishing exercise prescriptions following concussion, assessing cerebral blood flow changes while cycling with progressive lower body negative pressure, assessing the long-term effects of concussion on autonomic function as well as developing a multimodal assessment of cerebrovascular function by merging transcranial Doppler ultrasound with functional near infrared spectroscopy and electroencephalography.

Through this multifaceted and integrative approach to concussion research and collaboration network, Dr. Smirl's team aims to create new approaches and interventions which will enable us to objectively assess physiological disruptions following concussion and improve outcomes for individuals following this traumatic injury.



DARREN STEFANYSHYN

Over the past year, we have continued to focus on questions related to human locomotion, sport performance and sport injury biomechanics with the goal of tuning the properties of the equipment to specific athlete characteristics to maximize the performance and minimize the risk of injury.

Investigation into how the mechanical aspects of traction and stiffness of sport surfaces were prioritized in 2023, with specific projects investigating artificial infilled turf, pickleball courts and hardwood basketball courts.



Research into footwear properties also continued, specifically related to cleated footwear as well as advanced footwear technologies. Research into the midsole material, thickness and deformation of running shoes was a main topic of research with work also being conducted on the construction of footwear such as using 3D printed materials. Lastly, work this year has also focused on exploring differences between male and female athletes in terms of their footwear

needs, specifically investigating aspects related to forefoot bending stiffness, cushioning properties and required traction of footwear.

PRESENTATIONS

Efficacy vs. effectiveness of injury prevention training programs in sports - Kati Pasanen
Finnish Rehabilitation Specialists Annual Conference, Tampere, Finland, online. March 21.

Noisy tendon stimulation for probing human muscle spindles and stretch reflexes. – Ryan Peters
Society for the Neural Control of Movement. Victoria, Canada; April 17.

Assessing and Monitoring Interlimb Force-Time Asymmetries. - Matt Jordan
Washington Spirit; September 1.

Assessing and Monitoring Interlimb Force-Time Asymmetries. - Matt Jordan
Australian Institute of Sport, online; September 27.

Career Planning for Strength & Conditioning Coaches. - Matt Jordan
Sport Scientist Canada, online; October 13.

The Importance of Explosive Strength after ACL Injury. - Matt Jordan
Take a Knee Conference, online; October 13.

Personalizing Exercise for the Aging Brain. - Cindy Barha
Amazing Brain Science Talks, Healthy Brain, Healthy Lives, McGill and Brain Canada Foundation. Ottawa, Canada; October 14.

Assessing and Monitoring Interlimb Force-Time Asymmetries. - Matt Jordan
Seminar for Los Angeles Lakers; October 20-21.

Optimizing bone in adulthood: don't "stress" - Brent Edwards
McCaig Institute Wood Forum, Building Better Bones. Calgary, Canada; November 4.

Planting the seeds for healthy bone development. - Leigh Gabel
McCaig Institute Wood Forum, Building Better Bones. Calgary, Canada; November 4.

Assessing and Monitoring Interlimb Force-Time Asymmetries. - Matt Jordan
Seminar for Arizona Diamondbacks; November 11.

MEDIA and INTERVIEWS

[Why some people are taking a wintry dip from the banks of the Bow River.](#) –

John Holash
CBC News, Omar Sherif; January 30.

[‘Mommy Brain’ Is Not a Thing, Say Scientists.](#) – Cindy Barha

Newsmax, Lynn Allison; February 8.

[Best of Health Magazine: The Many Health Benefits of Nordic Skiing.](#) – John

Holash
Readers Digest, Lisa Kadane; February 10.

[Monitoring stress levels from your sweat? Calgary team tests out sensor.](#) –

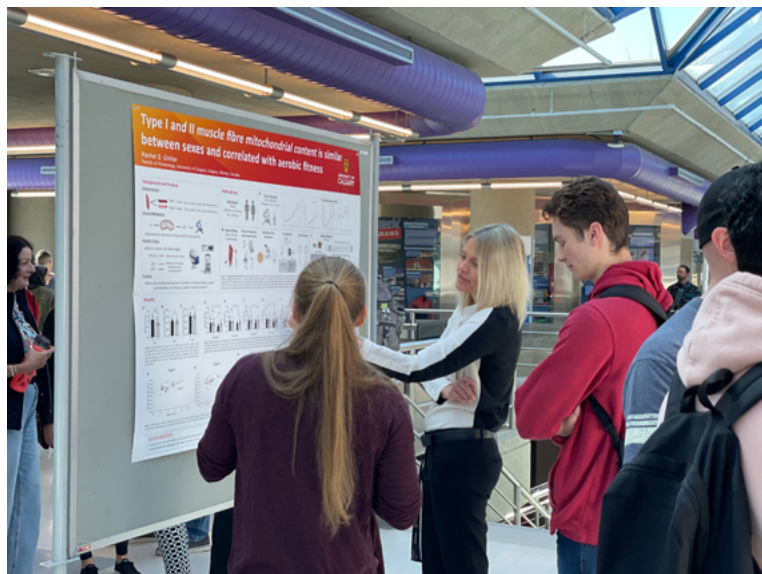
Amin Komeili
CTV News, Kevin Fleming; March 14.

[Innovator/Educator John Holash](#) – John Holash

Taylor Institute for Teaching and Learning Video Series; April 2.

[“You are what your grandfather ate.”](#) – Raylene Reimer

Arch Magazine, Jacque Moore; April 20.



[Dr. Carolyn Emery helps to create and lead United Kingdom Concussion Prevention Network. Collaboration aims to reduce sport-related concussion rates.](#) – Carolyn Emery

UCalgary News; May.

[Everything You Need to Know about Strength Training.](#) – Matt Jordan

Training Science Podcast, Jack Mclean; June 15.

[New testing protocol prevents knee injuries in female athletes](#) – Kati Pasanen

UCalgary News, Nada Hassain; July 26.

[New award supports the next big stars in concussion research. Accelerating Research in Concussion \(ARC\) Award supports up-and-coming researchers ready to make the next big discovery.](#) – Carolyn Emery

UCalgary News; July.

[ACL injury prevention in women’s sport](#) – Kati Pasanen

The Homestretch, CBC Radio, Chris de la Torre; August 1.

[Dinos Athletics helps researchers get a leg up on traumatic knee injuries.](#) –

Matt Jordan
UToday, Giovanna Alves; August 4.

[Interview in Minute by Minute pp. 80-81](#) – Patricia Doyle-Baker

Costco Connection, S Natarajan; August.

[Popular diets: carbon footprints and diet quality.](#) – Raylene Reimer

Carleton University Journalism Program, Isabella Stephenson;
September 26.

[Raising awareness about the impact of concussions.](#) – Ash Kolstad (Ph.D.),

Supervisor Carolyn Emery
Global News; September.

[A little generosity goes a long way.](#) – Walter Herzog

Podcast recorded in connection with the 2023 Cy Frank Legacy Award. McCaig Institute, University of Calgary, Daniyya Chaudry and Tanya Cherpukaran; October 11.

[Are you ready to take the plunge? Experts weigh in on cold plunge benefits.](#) –

John Holash
Global News, Allison Dunfield; October 26.

[For a ski season without injury, start training early.](#) – Matt Jordan

New York Times, Jenny Marder; October 26.

PUBLIC ENGAGEMENT

[Exercise and Brain Health: Why Women Should Prioritize Movement.](#) - Cindy

Barha
wmnHealth.org, Lindsay Borthwick; October 27.

[Mandatory Neck Guards in Hockey.](#) - Paul Eliason (PD), Supervisor Carolyn

Emery
CBC: On The Coast with Gloria Macarenko; November.
Radio West, Sarah Penton; November 2.
All Points West, Jason D'Souza; November 2.

[This 12-year-old runner broke a world record. But competition isn't the only thing she's up against.](#) - Leigh Gabel

Toronto Star, Kerry Gillespie; November 3.

[Calgary PhD student partners with retirement community to test wearable fall-prevention technology for seniors.](#) - Ryan Peters

CBC, Lily Dupuis; November 12.

[What do probiotics do?](#) - Raylene Reimer

The Allsorts Podcast, Desiree Nielsen; November 29.

[Apple Podcasts](#)

[Spotify](#)

[PhD student honoured with Killam Award for research to prevent concussions.](#)

- Carolyn Emery
UCalgary News; November.

[The push for mandatory neck guards in hockey.](#) - Paul Eliason (PD), Supervisor

Carolyn Emery
Global News; November.

[Deep Dive into Peak Performance](#) – Matt Jordan

Power Athlete Podcast, John Welbourn; December 10.

[Everything you need to know about probiotics and the gut microbiome.](#) -

Raylene Reimer

[From Peri to Post: Candid Conversations from Triathletes on Menopause.](#) -

Patricia Doyle-Baker
The TriDot Triathlon Podcast, Vanessa Ronksley; December 11.

[Selecting the right metrics for vertical jump testing.](#) – Matt Jordan

Sportsmith, Matt Jordan; October 13.

PUBLIC ENGAGEMENT

TOURS and EVENTS HOSTED

[HPL Open House for High School Students.](#)

All lab groups participated in this event, hosting over 500 Calgary and area high school students in the HPL.
May 10.

University of Calgary Alumni All-Access Tour.

Tour for Alumni of UCalgary, welcoming over 50 alumni to the facility;
May 21.

Tour for delegates from Curtin University, Australia.

July 17.

Alberta Innovates High School Youth Researcher Summer Program Tour.

Tour for students in the HYRS program, Alberta Innovates; August 11.



PUBLIC ENGAGEMENT

WORKSHOPS, FORUMS, PANELS and WEBINARS

- Concussion prevention in youth sport: A multifaceted approach to prevention. - Carolyn Emery
360 Concussion Care Ontario, Ottawa, Canada; January.
- Optimizing primary prevention of concussion: Sport-specific policy changes and prevention strategies that make a difference in concussion prevention. - Carolyn Emery
American Physical Therapy Association Combined Sections Meeting, San Diego, USA; February.
- SHRed Concussions: Concussion Surveillance in Youth Sport. - Carolyn Emery
UK Concussion Prevention Network, Bath, UK; March.
- Concussion Surveillance: Informing best practice, policy and research process. - Carolyn Emery
Physical Medicine and Rehabilitation residents, Faculty of Medicine, Harvard University, Cambridge, USA; March.
- SHRed Injuries: Opportunities for injury prevention in youth sport. - Carolyn Emery
Spaulding Network Sport Medicine, Harvard University, Cambridge, USA; March.
- SHRed Concussions: A focus on primary concussion prevention. - Carolyn Emery
Special Grand Rounds, Faculty of Medicine, Harvard University, Cambridge, USA; March.
- Global Chair University of Bath Public Lecture. - Carolyn Emery
Bath Cricket Club, Bath, UK; April.
- [2023 IOC Sports Medicine Physicians Workshop.](#)
IOC Workshop for physicians; April.
- Injury surveillance informing best practice and policy in injury prevention. - Carolyn Emery
IOC Diploma Course Fellow Symposium, Edinburgh, UK; May.
- Global Chair University of Bath Public Lecture. - Carolyn Emery
Bath Cricket Club. Bath, UK; April.

PUBLIC ENGAGEMENT

- Injury Prevention in Youth Sport. - Carolyn Emery
UK Collaborating Centre on Injury and Illness Prevention in Sport, Edinburgh, UK; May.
- Bone health and movement: from childhood to outer space - Leigh Gabel
International Society of Bone Morphometry Early Career Investigator Webinar Series; May 3.
- Parental perceptions of risk and safety: Do they undermine child and youth physical activity, and can they be reframed? – Patricia Doyle-Baker, G Falkner, JF Huertas-Delgado, B Alguren
ISBNPA Annual Conference, Uppsala, Sweden; June 16.
- 25 years of prevention in sports. - Carolyn Emery
2023 GOTS Luxembourg, Luxembourg; June.
- Concussion Definition and Prevention. - Carolyn Emery
Edinburgh Orthopaedics and Sport Medicine Conference, Edinburgh, UK; June.
- How Exercise Boosts Brain Health – Whether You Live with Dementia or Not.- Cindy Barha
Dementia Talks! Canada, Alzheimer Society of Canada and Brain Canada, webinar; July 24.
- Change of direction movement training and testing in youth soccer and injury prevention recommendations. - Kati Pasanen, Aki Matti Alanen
Coach Workshops for Calgary Blizzard, Calgary West Football Club; June.
- Updates on Concussion Prevention from the 6th Consensus on Concussion in Sport. - Carolyn Emery
Sport Physiotherapy Canada, virtual; September.
- [Prebiotics and gut microbiota: establishing a healthy trajectory from early life to adulthood](#) - Raylene Reimer
BENEO-Institute, webinar; September 20.
- Workshop Symposium – Patricia Doyle-Baker, S Philips, K Elliot Sale
CSEP Annual Conference, Calgary, Canada; October 12.

PUBLIC ENGAGEMENT

Workshop Symposium – Patricia Doyle-Baker, S Philips, K Elliot Sale, K McGawley, M Taylor
CSEP Annual Conference, Calgary, Canada; October 13.

Female Athlete's Health: Adding the X's and O's – Patricia Doyle-Baker
Squash Canada Professional Development Webinar; October 16.

Time to SHRed Concussions: Concussion Prevention in Grassroots through Elite Sport. - Carolyn Emery
Royal Victoria Children's Hospital, Murdoch Children's Research Institute, Melbourne, Australia; October.

Time to SHRed Concussions: Concussion Prevention In Youth Sport. - Carolyn Emery
Australia Institute of Sport, Melbourne, Australia; October.

Time to SHRed Concussions: SHRed Concussions: Opportunities for Prevention in Youth Sport. - Carolyn Emery
LaTrobe University, Melbourne, Australia; October.

Sport Injury Prevention Research Centre Program. - Carolyn Emery
IOC Research Centre Meetings, Stellenbosch, South Africa; October.

Research Centre Training and Career Development Network. - Carolyn Emery
IOC Research Centre Meetings, Stellenbosch, South Africa; October.

Prevention Updates from the 6th Consensus on Concussion in Sport. - Carolyn Emery
Australasian College of Sport and Exercise Physicians and Sport Medicine New Zealand, Wellington, Australia; November.

Presentations on "exercise and aging", "the best way to develop cardiovascular fitness as a mature athlete" – John Holash
Foothills Master Cross-Country Skiing Group, Calgary, Canada; April-December 2023.

PUBLIC ENGAGEMENT

Neuromuscular Training Workshops - SIPRC
28 workshops in 2023 for 130 coaches in rugby, field hockey, football, ice hockey, ringette, soccer.
Calgary, Canada
Cranbrook, Canada
Edmonton, Canada
Vancouver, Canada

Neuromuscular Train-the-Trainer Workshops - SIPRC
Two workshops in 2023 for 19 workshop facilitators.
Calgary, Canada
Cranbrook, Canada

The Sport Injury Prevention Research Centre Research Community Engagement (CARE) Symposium - SIPRC
Calgary and virtual; September.



OTHER KNOWLEDGE TRANSLATION ACTIVITIES

WEBSITE RESOURCES

[SHRED injuries Neuromuscular Training Warm-Up Programs.](#)

- Sport Injury Prevention Research Centre
a public-facing resource aimed at supporting coaches and teachers
in their delivery of neuromuscular training warm-up programs.

OTHER KNOWLEDGE TRANSLATION ACTIVITIES

[SHRed Mobile in Alberta.](#) - Sport Injury Prevention Research Centre

In 2023, the SHRed Mobile travelled over 3,500 kilometers across
Alberta, gathering data on the sports and recreation activities
youth are engaging in, and the concussion sustained through those
activities. Cities visited:

Bonnyville, AB
Cold Lake, AB
Grande Prairie, AB
Peace River, AB
High Level, AB
Lethbridge, AB
Brooks, AB
Siksika First Nation, AB
Samson Cree First Nation, AB

Developing an injury prevention program for a team, Continuing education in
physiotherapy. - Kati Pasanen
Course for Sport Physiotherapists, FYSI RY, Finland; August.

Abughazaleh N, Boldt K, Rios JL, Mattiello SM, Collins KH, Seerattan RA, Herzog W. Aerobic and resistance training attenuate differently knee joint damage caused by a high-fat-high-sucrose diet in a rat model. Cartilage. 2023 DOI: <https://doi.org/10.1177/19476035231193090>

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- Lennartz R, Khassetarash A, Nigg SR, Nigg BM. Master of Technique - Objective 2 Identification of player motion restriction caused by protective equipment. Technical Report for CCM.
- Liu T, Alizadeh S, Aguerro J, Vienneau J, Nigg SR, Nigg BM. Forefoot Hollow Shoe – A Biomechanical Analysis. Technical Report for Li-Ning.
- Matijevich E, Nigg SR, Nigg BM. Master of Fit - Objective 2 Evaluation of Skate Shape. Technical Report for CCM.
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- Ruschkowski J, Wannop JW, Esposito M, Stefanyshyn DJ. Mechanical Testing of Different Tufting. Technical Report for FieldTurf.
- Stefanyshyn DJ, Trama R, Brandstatter T, Heiser T, Stefani S, Wannop JW. Soccer Traction Maps. Technical Report for adidas.
- Trama R, Denis Y, Vogel A, Wannop JW, Stefanyshyn DJ. Sport Court Pickleball Surfaces. Technical Report for Sport Court.
- Trama R, Fukuchi C, Wannop JW, Stefanyshyn DJ. Forefoot Bending Axis: Weight Bearing CT Scans. Technical Report for adidas.
- Trama R, Fukuchi C, Wannop JW, Stefanyshyn DJ. Forefoot Bending Axis. Technical Report for adidas.
- Vienneau J, Matijevich E, Khassetarash A, Catala I, Aguerro J, Nigg SR, Nigg BM. Quantifying co-contraction and the effect of Dr. Scholl's pain insoles on low back and knee pain patients. Technical Report for Dr. Scholl's.

TECHNICAL REPORTS AND BRIEFS

- Vienneau J, Nigg SR, Nigg BM. FitFlop Running Shoe Study Phase II: Preliminary assessment of pressure, comfort, material properties and durability. Technical Report for FitFlop.
- Vienneau J, Nigg SR, Nigg BM. Highlights of the Sixteenth Footwear Biomechanics Symposium – Osaka.
- Wannop JW, Fukuchi C, Brandstatter T, Stefanyshyn DJ. Avanti SS24 Running Performance and Biomechanics. Technical Report for adidas.
- Wannop JW, Fukuchi C, Papin T, Stefanyshyn DJ. Cushioning Requirements for Individual Runners. Technical Report for adidas.
- Wannop JW, Fukuchi C, Papin T, Stefanyshyn DJ. Evaluation of adidas adistar Cushioning. Technical Report for adidas.
- Wannop JW, Fukuchi C, Stefani S, Heiser T, Stefanyshyn DJ. Insole Preference and Walking/Running Biomechanics. Technical Report for Superfeet.
- Wannop JW, Trama R, Brandstatter T, Heiser T, Stefani S, Stefanyshyn DJ. Male and Female Differences in Soccer Biomechanics. Technical Report for adidas.



KEYNOTE AND INVITED LECTURES

- Reimer R. The lasting impact of parents' diet and the fascinating gut microbiome. Canadian Centre for Agri-Food Research in Health and Medicine. Winnipeg, Canada; January.
- Herzog W. The role of titin in muscle function: proposal vs. evidence. Muscle Health Research Centre, York University. Toronto, Canada; February 3.
- Gabel L. Can we tailor pre- and in-flight exercise to prevent bone loss? Findings from the TBone study. NASA Countermeasures Working Group Meeting. Location; February 15.
- Emery CA. Optimizing primary prevention of concussion: Sport-specific policy changes and prevention strategies that make a difference in concussion prevention. American Physical Therapy Association Combined Sections Meeting. San Diego, USA; February.
- Pasanen K. Efficacy vs. effectiveness of injury prevention training programs in sports. Annual Conference for Physiotherapists and Occupational Therapists. Tampere, Finland; March 20-21.
- Emery CA. SHRed Concussions: Concussion Surveillance in Youth Sport. UK Concussion Prevention Network. Bath, UK; March.
- Reimer R. Early life nutrition and the gut microbiome: establishing a healthy trajectory. Children's Hospital Research Institute of Manitoba. Winnipeg, Canada; March.
- Cluff T. Flexible control of sensory feedback in upper limb reaching movements. Society for the Neural Control of Movement Satellite Meeting. Victoria, Canada; April 17.
- Jordan MJ. Assessing Mechanical Muscle Function: Kinetic Analysis of the Jumping Athlete. XX Congress of the Brazilian Biomechanics Society, Bauru, Brazil; April 18.
- Jordan MJ. The Biomechanics of Muscle Strength and Power after ACL Injury. XX Congress of the Brazilian Biomechanics Society. Bauru, Brazil; April 20. (Keynote)
- Herzog W. The force-velocity relationship of skeletal muscle: basic considerations. 20th Congress of the Brazilian Society for Biomechanics. Sao Paulo, Brazil; April.

KEYNOTE AND INVITED LECTURES

Barha CK. Sex differences in the cognitive-enhancing ability of exercise training for older adults: Possible role of hormones and genotype. Partnership for Women's Health Research Canada and Society for Women's Health Research Pre-conference Symposium: From Cells to Society: Research and Advocacy to Advance Mature Women's Health. Calgary, Canada; May 7.

Jordan MJ. Force Plate Analysis and Athlete Monitoring after Injury: Quantifying the Return to Performance Transition. National Basketball Association Health & Performance Meetings. Chicago, USA; May 17.

Herzog W. The Killam Initiative on Rhythm. Killam Prize Winner Celebration 2023. Ottawa, Canada; May.

Reimer R. Prebiotics and gut microbiota: establishing a healthy trajectory from early life to adulthood. Today's Dietitian Spring Symposium. Savannah, USA; May.

Emery CA. 25 years of prevention in sports. 2023 GOTS Luxembourg. Luxembourg; June. (Keynote)

Emery CA. Concussion Definition and Prevention. Edinburgh Orthopaedics and Sport Medicine Conference. Edinburgh, UK; June.

Herzog W. Osteoarthritis: One disease – many causes. The Canadian Orthopaedic Research Society, Ian Macnab (President's) Memorial Lecture. Calgary, Canada; June. (Keynote)

Herzog W. The future of scientific publishing. The American College of Sport Medicine. Denver, USA; June.

Jordan MJ. Assessing the Envelope of Function after ACL Injury: A Performance Based Approach to Athlete Monitoring. Elite Basketball Rehab Conference, University of Las Vegas. Las Vegas, USA; July 8.

Herzog W. The exciting history of paradigm shifts in skeletal muscle contraction 29th Congress of the International Society of Biomechanics. Fukuoka, Japan; July. (Keynote)

Jordan MJ. The Biomechanics of Muscle Strength and Power after ACL Injury: New Perspectives on Return to Sport Testing. 8th Annual Vail Scientific Summit. Vail, USA; August 21.

KEYNOTE AND INVITED LECTURES

Edwards, WB. Multiscale modeling of fatigue failure in whole-bone and bone tissue: implications for the prediction of stress fracture. Henk Schamhardt Memorial Lecture, 9th International Conference on Canine and Equine and Locomotion. Utrecht, The Netherlands; August. (Keynote)

Stefanyshyn D. The rich research tapestry that foreshadowed Advanced Footwear Technology and what it suggests for the future. 16th Footwear Biomechanics Symposium. Osaka, Japan; August.

Herzog W. Structural and functional changes of skeletal muscles in children with cerebral palsy: why are spastic muscles weak? 77th Annual Conference of the American Academy for Cerebral Palsy and Developmental Medicine (AACPD), McKeith Award Lecture. Chicago, USA; September. (Keynote)

Herzog W. From basic muscle mechanics to applications in animal and human locomotion. Calgary International Equine Sports Medicine. Calgary, Canada; September. (Keynote)

Herzog W. Harnessing innovative preclinical models to advance osteoarthritis research and treatment. Cy Frank Lecture, McCaig Institute for Bone and Joint Health, UCalgary. Calgary, Canada; September.

MacInnis MJ. Skeletal Muscle Mitochondria: Mechanisms and manifestations. Graduate Seminar, School of Health and Exercise Science, UBC Okanagan. Kelowna, Canada; September.

Barha CK. Moderation of aerobic training effects on the brain by biological sex & BDNF Val66Met polymorphism: Integrating rodent and human research. 'Exercise for Healthy Brain Aging: Understanding the Underlying Mechanisms' Symposium, Canadian Society for Exercise Physiology (CSEP). Calgary, Canada; October 12.

Jordan MJ. Jumping to Health with Muscle Power: Your Mechanical Biomarker for Health and Performance. Canadian Society of Exercise Physiology Conference. Calgary, Canada; October 14.

Edwards, WB. Effects of antiresorptive drugs on bone mechanical properties – Implications for AFF pathogenesis. New Insights into Osteoporosis Treatment Symposium, Annual Meeting of the American Society of Bone and Mineral Research. Vancouver, Canada; October.

KEYNOTE AND INVITED LECTURES

Emery CA. Time to SHRed Concussions: SHRed Concussions: Opportunities for Prevention in Youth Sport. LaTrobe University. Melbourne, Australia; October.

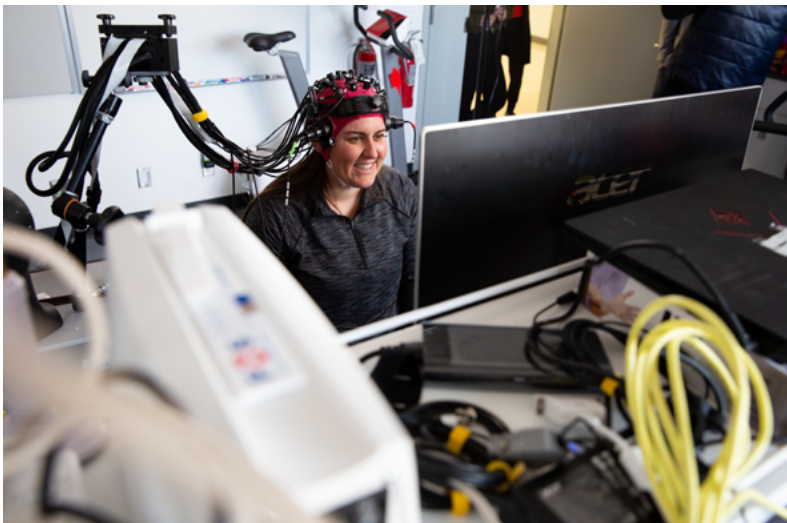
MacInnis MJ, Din C. Adding inquiry to exercise physiology laboratories: Redacting recipes and increasing psychological safety. Canadian Society for Exercise Physiology Annual General Meeting. Calgary, Canada; October.

Reimer R. Nutrition and diabetes: prevention and intervention. McFarlane Diabetes Symposium. Calgary, Canada; October.

Emery CA. Concussion Prevention in Youth Sport. Australasian College of Sport and Exercise Physicians and Sport Medicine. Wellington, Australia; November. (Keynote)

Stefanyshyn D.J. Exploring new opportunities for customized sport equipment based on individual biomechanics. Korea National Sport University International Conference. Seoul, Korea; November.

Peters RM. Noisy tendon stimulation for probing human muscle spindles and stretch reflexes. Society for the Neural Control of Movement. Location; date.



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ACKNOWLEDGEMENTS

adidas International
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ACKNOWLEDGEMENTS

(IOC)	Patricia Pennock
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Joan Snyder	Resman Holdings Community Services
Jumpstart, Canadian Tire	Ringette Canada
Killam Foundation	Rugby Canada
Lacrosse Canada	School Sport Canada
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MITACS	Sport Court
Movesense	Sport Injury Prevention Research Centre
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