Proceedings

Scientific research on ice hockey

Québec meeting 2025

May 30th – June 2

UNIVERSITÉ LAVAL

FOREWORD

Dear ice hockey researchers/thinkers/technical directors/fans,

Welcome to Québec City!

One objective of this meeting is to bring together researchers from around the world and take stock of several scientific advances related to the study of ice hockey. As indicated by the diversity of abstracts, the meeting is rich in presentations of scientific research focusing on technical, social, physiological, and psychological issues.

The meeting aims not only to foster exchanges between researchers, but also to inform all stakeholders in the ice hockey community. In fact, this meeting will be fruitful if stakeholders leave enriched with new ideas to deepen their thinking on the many facets of the game, and if researchers leave nourished by the questions asked by those working in the field.

This meeting would not have been possible without the essential contribution of colleagues who agreed to organize a symposium, these symposia having formed the nucleus through which everything else became possible. Thanks to Joe Baker of the University of Toronto, Jean Côté from Queen's University, Carolyn Emery from University of Calgary, Jean Lemoyne from Université du Québec à Trois-Rivières, Shawn Robbins from McGill University, Michael Robidoux from University of Ottawa, and Nick Wattie from Ontario Tech University.

I would like to extend special thanks to the Social Sciences and Humanities Research Council/Conseil de recherches en sciences humaines and Sport Canada, through the Sport Participation Research Initiative program, for providing financial support to this event. I also thank Jean Lemoyne and François Trudeau, from Université du Québec à Trois-Rivières, and Christiane Trottier, from Université Laval, who collaborated on the research grant that led to this support.

SSHRC
CRSH

Bienvenue à Québec!
Bienvenue à l'Université Laval!

Simon Grondin

CONFERENCE SCHEDULE

DAY 1- Friday, May 30, 2025

5 to 7: Registration and reception (Pub, Desjardins Building)

DAY 2 - Saturday, May 31, 2025 (Grand Salon du Pollack)

7.40 – 8h40: Registration

8.45 – 9.00: Welcome and announcements

9.00 – 10.30: Symposium 1 - "Concussion prevention in youth ice hockey: Where are the gaps?"
Organized by Carolyn Emery

10.30 – 10.50: Coffee break

10.50 – 11.30: Symposium 1 continues

11.30 – 12.15: Free talks

1. Vincent Lalande et al. – "When Health meets Performance: The usefulness of inertial movement units through a competitive hockey season"
2. Rob Longstaffe et al. – "Video analysis of anterior cruciate ligament (ACL) injuries in the National Hockey League (NHL)"

12.15 – 13.30: Lunch

13.30 – 15.30 Symposium 2 - "Historical and Contemporary Perspectives on Indigenous Hockey"
Organized by Michael A. Robidoux

15.30– 15.50: Coffee break

15.50 – 17.15: Free talks

1. Vladislav Bespomoshchnov & Geir Jordet – "Beyond the Lab: Rethinking Visual Perception Research in Ice Hockey"
2. Daniel Fortin-Guichard et al. – "Beyond the trained eye: An objective method to predict game sense in team sports"
3. Gergely Géczi & Zoltán Baracskai – "The Competitive Edges of the Future in Professional Ice Hockey: Team Complexity"
4. Madison Fraser et al. – "Elite Canadian ice hockey coaches' perceptions of creating a healthy and high-performing culture of excellence"

DAY 3 - Sunday, June 1, 2025 (Grand Salon du Pollack)

8.30 – 10.30: Symposium 3 - “The factors that affect engagement and positive outcomes in youth ice hockey” Organized by Jean Côté

10.30 – 10.50: Coffee break

10.50 – 12.50: Symposium 4 – “Who’s in net? Advancing Research on Goaltending Development and Participation in Hockey” Organized by Nick Wattie

12.50 – 13.50: Lunch

13.50 –14.30: Free talks
1. Max Bergström et al. - “It’s unrealistic”: Experiences of Swedish Elite Female Ice Hockey Players Considering Parenthood”
2. Simon Grondin et al. – “Shooting left or shooting right in ice hockey?”

14.30 – 15.40: POSTER SESSION

15.40 – 16.00: Coffee break and Poster Session continues

16.00 – 18.00: Symposium 5 - “Biomechanical Analysis of Ice Hockey Skills” Organized by Shawn Robbins

DAY 4 - Monday, June 2, 2025 (Grand Salon du Pollack)

8.30 – 10.30: Symposium 6 - “Development systems around the world” Organized by Joe Baker

10.30 – 10.50: Coffee break

10.50 – 12.10: Free talks
1. Vincent Huard Pelletier et al. – “Breaking Under Pressure? Rethinking How We Measure Choking in Ice Hockey”
2. Adam Pilotte et al. – “Head coaches’ perceptions of the coach-athlete relationship in the National Hockey League”
3. Jean Brunelle et al. – “Prioritize before Specialize: Developing a Model for Adolescent Hockey Player Physical Preparation Using Trainers' Practices to Conceptualize a Curriculum Focused on Motor Skills and Physical Qualities in Line with the Evolution of Physical Maturation”
4. Léandre Gagné Lemieux et al. - Is the 1080 Sprint Still the Gold Standard for Ice Acceleration Testing?

12.10 –13.10: Lunch

13.10 – 15.10 Symposium 7 - “To test or not to test? Reflections about understanding the usefulness (off and on-ice) testing and game tracking technology in the context of competitive hockey” Organized by Jean Lemoyne

15.15 – 16.00: Closing talk: “The role of the International Ice Hockey Federation in the development of ice hockey” - Kalle Väliaho, Development Director, International Ice Hockey Federation

16.00 – ... : Final coffee break and discussions

SYMPOSIUMS

Concussion prevention in youth ice hockey: Where are the gaps?

Organized by Carolyn A. Emery
Chair Sport Injury Prevention Research Centre, University of Calgary

Considering Prevention to Reduce the Burden of Injury in Child and Adolescent Ice Hockey

Carolyn A Emery, University of Calgary

Ice hockey is Canada's national winter sport and one of the most popular sports played by children and adolescents in Canada, with over 500,000 participants under the age of 18 each year. While the benefits of sport are well established, participation in ice hockey is associated with high rates of injury and concussion. Ice hockey is among the top three sports in youth in Canada for participation and accounts for over 10% of all youth sport-related injuries. Concussion is of particular concern in ice hockey at all levels of play and is in the top three sports for concussion incidence rates in youth sports. In this symposium we will focus on ice hockey injuries in children and adolescents. Injury and concussion-specific rates, severity, burden, types, mechanisms, and risk factors will be summarized based on available evidence. Further there has been significant research evaluating injury and concussion-prevention solutions in ice hockey across multiple targets for prevention. Models for prevention will be reviewed and evidence examining primary prevention strategies will be presented across policy and rule changes, personal protective equipment, and training strategies. The evidence evaluating concussion management protocols and education will also be discussed in the context of reducing the risk of recurrent concussion. Further, potential unintended consequences of these strategies will be summarized. Finally, gaps in the research will highlight a lack of focus on the female game and Para ice hockey. Future directions for research that will reduce the burden of injuries and concussion in ice hockey and support lifelong sport participation will be considered.

How Policies and Referees Shape Injury Prevention in Child and Adolescent Ice Hockey

Paul H Eliason, University of Calgary

This presentation will examine the critical role of policy and officiating in reducing injury risk in Canadian child and adolescent ice hockey. It will cover research identifying bodychecking as a major risk factor for injury and concussion, how this evidence informed national and regional policy changes in Canada and the United States, and subsequent evaluations demonstrating significant reductions in injury and concussion rates. Additionally, discussion will include research on the unintended consequences of these policy changes and the essential role of referees in enforcing game rules, particularly those related to head contact. Finally, future research opportunities to further reduce the burden of injury in youth ice hockey will be explored.

Comprehensive overview of personal protective equipment to reduce injury and concussion in youth ice hockey

Ash T Kolstad, University of Calgary

Personal protective equipment is essential for ice hockey player safety. With mandatory use of full gear, including hard-shell helmets for players, this presentation will examine various methods used to evaluate the effectiveness of different pieces of personal protective equipment for injury prevention. As wearing a mouthguard is currently not mandated across all Canadian youth ice hockey leagues, this presentation will highlight the current evidence for mouthguard use, mouthguard type, helmet fit, and helmet characteristics association with concussion while providing evidence-based recommendations to ice hockey organizations, coaches, parents, and players for personal protective equipment use.

Neuromuscular training approach to concussion and injury prevention in youth ice hockey.
David Laperriere, Université Laval

In several team sports, training strategies such as neuromuscular training (NMT) have been shown to be effective as a primary prevention strategy for sport-related injuries. Recently, the Amsterdam International consensus statement on concussion in sport has recommended NMT as a potential concussion prevention strategy based on evidence in males in rugby. However, the effect of NMT on injury and concussion risk in ice hockey is not well understood. In this context, we led a study to evaluate the effectiveness of a NMT training intervention delivered by coaches on the incidence of concussions and injuries in adolescent ice hockey. This presentation will provide an overview of the effects of NMT in informing the prevention of injuries and concussions in different team sports and will define the components of ice hockey specific NMT. Finally, a summary of the results from our study of NMT in hockey will be presented.

Applying instrumented mouthguards to measure head acceleration events in ice hockey
Lyndia Wu, University of British Columbia

Repeated head acceleration events put ice hockey athletes at risk for acute concussions and potential long-term brain changes. Instrumented mouthguard sensors are becoming a standard technology for measuring head acceleration events in sports. By tracking motion parameters such as the linear and rotational accelerations of the head, these sensors enable precise measurements of key biomechanical parameters implicated in brain injury risk. This talk will provide an overview of an instrumented mouthguard study to investigate longitudinal head acceleration event exposure in varsity ice hockey athletes. Monitoring exposure at an individual athlete level may not only provide novel insights on injury mechanisms, but also enable individual risk monitoring and injury prevention in the future.

Risk Factors for Head Contact Events and Injury in Canadian Child and Adolescent Ice Hockey
Connor McFaul and Michael A. Robidoux, University of Ottawa

As part of a long-term research project conducted by Neurotrauma Impact Science Laboratory (NISL) at the University of Ottawa, our team has been employing observational video analysis on head impacts occurring in competitive bodychecking hockey levels. This presentation will focus on specific situational factors in gameplay to determine if the head impacts sustained in gameplay are the result of legal or illegal play under current Hockey Canada rules. As findings have only highlighted the nuances of hockey gameplay, our research has also focused on identifying risk factors inherent to the execution of a bodychecking task in situ, by understanding if head impacts are the result of players placing themselves in vulnerable positions, bodychecking technique, or the outcome of tactical puck separation. The findings from our research seek to help address issues of injury prevention by providing tangible examples from hockey gameplay that identify why and how injury occurs in minor hockey.

Concussion education and management in ice hockey: What is the evidence

Kathryn Schneider, University of Calgary

Ongoing dissemination of up to date education for concussion prevention, detection and management is needed given the rapidly evolving literature. A massive open online course (MOOC) in concussion and the Concussion Awareness and Training Tool (CATT) are two tools that are regularly updated and have been shown to be effective tools in disseminating up to date information. In addition, implementation of concussion policies and protocols have been shown to reduce the rate of recurrent concussion rates. However, challenges related to access to knowledgeable health care professionals for diagnosis and management, disseminating and applying concussion management processes have been highlighted across levels of sport. This session will provide an evidence informed overview of concussion educations tools, policy and protocol implementation with a focus on ice hockey specific considerations and recommendations.

Historical and Contemporary Perspectives on Indigenous Hockey

Organized by Michael A. Robidoux
University of Ottawa

Panel Description:
Indigenous peoples have a long history of playing hockey that predate the earliest official game of hockey played in Montreal in 1875. Indigenous cultures across the country have played hockey like games with locally made sticks on ice long before European settlers arrived. The important affinity Indigenous peoples have to the sport has often been overshadowed by a darker history of formally organized hockey being introduced through the Canadian Residential School system. In this panel, Indigenous hockey will be investigated as an especially complex site whereby local and global meanings are consistently negotiated and transformed. Certainly, hockey is part of the Canadian national imaginary, yet it is similarly claimed by Indigenous peoples as emblematic of Indigenous culture and identity. In this panel each presenter will share perspectives on the importance of Indigenous hockey within specific cultural contexts, and the manner in which Indigenous hockey is a unique form of cultural expression. Presenters will offer insight into the malleability of sport that through its expression can be transformed into culturally meaningful practices that are reflective of local designs.

Home-Ice Advantage: Supporting Indigenous Hockey, Building Indigenous Sports Sciences
Jordan Koch and Phillippe Renaud, McGill University

This presentation explores our recent and ongoing work with remote First Nations hockey teams. The primary goal of our work has been to enhance Indigenous participation in sports, particularly hockey, within remote communities by integrating advanced exercise science and community-based methods. Our efforts are guided by the emerging theoretical framework of Indigenous Science, Technology, and Society (Indigenous STS). This framework aims to support Indigenous-controlled technological and scientific initiatives by bridging the gap between academic research and community needs. It also recognizes that, like sports, the fields of science and technology have historically contributed to colonialism. By prioritizing Indigenous knowledge and leadership, our research demonstrates how Indigenous Peoples can leverage advanced exercise science to achieve their community goals. This approach shifts the focus from merely studying Indigenous athletes to enhancing their skills and capabilities.

Bringing Home to the Away Game: Cultivating Support for Indigenous Hockey Players who Leave their Communities
Darren Zanussi, Queen’s University and Jaydlin Spooner, Toronto Metropolitan University

This paper builds on earlier work by the Indigenous Hockey Research Network which advocated for an increase in Indigenous-controlled elite hockey spaces. Interviews with current and former elite Indigenous hockey players explain how their family and community were imperative to their success, and the turmoil felt as youths when they moved to an unfamiliar setting. This is dissimilar to non-Indigenous players who can more easily find familiar cultural surroundings if they must relocate for elite hockey. While an increase in Indigenous-controlled spaces helps address this issue, there is still the matter of elite hockey academies and teams located in southern and urban Canada. These programs play a central role in the advancement of hockey players, yet consistently place Indigenous youth at a disadvantage. This paper explores how established, non-Indigenous run elite hockey spaces can successfully provide a sense of comfort and community to Indigenous players. While this cannot match the impact of an Indigenous-controlled space, improvements made by settlers are imperative to making the sport of hockey more welcoming and equitable.

Cree Nation Bears: Emergence, struggle and relevance of the only all indigenous hockey team in Quebec
Freddy Perowne, First Assist / Indigenous Hockey Research Network

This presentation builds on the work by the Indigenous Hockey Research Network and findings in the Truth and Reconciliation commission report around creating competitive environments for Indigenous athletes. Founded as a tournament team in the 1990's the Cree Nation Bears program brings youth from the 9 James Bay Cree communities together to compete in the Abitibi-Témiscamingue league sanctioned by Hockey Quebec. This program has played a central role in the advancement of hockey players to the next level by introducing more formalized structured ways of play before young athletes leave their communities to go south. Examining the internal and external forces that most effect the Bears program, can help inform other indigenous programs, but also educate the overarching sporting community about the importance of such a program, the relevance of safe spaces, and the continued struggle faced by marginalized groups within the dominant hockey culture.

Indians Do Cry: The Three Periods of Lac Seul First Nation (ice) Hockey
Mike Auksi, McGill University

The game of hockey, as practiced by the people of Lac Seul First Nation, symbolizes over seventy-five years of athletic excellence and collective resilience. This talk provides the listener with a snapshot of my doctoral dissertation. The first period of this study opens with Lac Seul’s ironic hockey creation story and is actualized by the first hockey tryouts at Pelican Lake Indian Residential School (Pelican) in December 1948 (Te Hiwi & Forsyth, 2017). The irony of our hockey creation story lies in our ancestors having fallen in love with the game while attending Pelican, where the deployment of hockey aligned with the school’s mandate of assimilation. The second period unofficially begins on September 1, 1968, when Pelican formally transitioned to the Federal Indian Day School program. This resulted in the first Lac Seul hockey players entering mainstream hockey systems and teams (Kenora Thistles, Queen Elizabeth High School, etc). The formal start of the second period takes place in Sioux Lookout, Ontario, opens in 1971 with the first iteration of the Northern Bands Hockey Tournament (community-based hockey), and is preceded by a four-team Indian Friendship Centre hockey gathering in 1970. The third period is characterized by Lac Seul hockey players who assertively navigate both community-based and mainstream hockey systems, and spans from the year 200 through to the present.

The factors that affect engagement and positive outcomes in youth ice hockey

Organized by Jean Côté
Queen's University

The first talk of this symposium will provide a double-feature summary of the work done to develop and test the 1616 Program. Initiated by Brandy and Andrew Ladd of the Ladd Foundation, the program aims to maximize the potential of hockey participation for children. The program, named after Andrew's NHL playing number and the year 1616 when the term 'buffalo' was first introduced, promotes a 'Buffalo Mindset'—emphasizing identity, belonging, and support. Through a partnership with the Ladd Foundation, this project delivers and evaluates a story-based positive youth development (PYD) program for young ice hockey players in North America. Supported by a team of researchers, the program has undergone proof of concept, RE-AIM evaluation, and vigorous testing of its various components. The second talk of the symposium will focus on a research program aimed at identifying psychological attributes associated with optimal development. The research presented will focus on different psychological attributes prioritized in ice hockey programming at various developmental stages, from initiation to high expertise. The last talk of this symposium will focus on the influence of parents in Canadian ice hockey. This talk will address the impact of parental behaviour on athlete development, identifying antecedents of negative behaviours and offering practical solutions for administrators, coaches, and parents to improve the likelihood of positive outcomes for youth athletes.

Introducing the 1616 program: Using partnerships and storytelling to promote positive youth development

Luc J. Martin and Jean Côté, Queen's University

Considering the prevalence of adult-centric professionalized youth sport environments, researchers and practitioners need to develop programming that emphasizes positive youth development (PYD). This presentation aims to introduce the '1616' story-based PYD program for ice hockey players and discuss its development, implementation, and evaluation. 1616 is a 10-week program where professional and elite ice hockey role models share their stories through interactive online videos. These videos describe relatable experiences based on PYD theoretical concepts that serve as reflective tools for youth to apply in their own personal development. The program targets youth (10-13 years of age), their coaches, and parents/guardians. Close to 800 teams in Canada and the United States have taken the program, comprising over 5000 youth, 6000 parents/guardians, and 1000 coaches. 1616 was created using an integrated knowledge translation approach, and both process and outcome assessments were conducted using mixed-methods approaches (e.g., focus groups and pretest-posttest questionnaires). Four peer-reviewed articles have now been published on the program's development, implementation, and evaluation and will be summarized in this presentation.

Beyond skating and shooting: Cultivating personal growth through hockey player development

Jean Lemoyne, Université du Québec à Trois-Rivières

The development of an ice hockey player is a long-term journey in which young athletes evolve to cultivate competencies in a wide range of sport-specific skills. Beyond these skills, the quality of the sporting experience is a crucial factor that contributes to enhancing personal attributes and fulfilling personal development. In this regard, little is known about the impacts of engagement in ice hockey on psychosocial assets during the early stages of development, from youth to adolescence. This presentation aims to provide an overview of the impacts of ice hockey on psychological attributes from initiation into the sport to competitive hockey. Based on actual theoretical background, this presentation summarizes the results from recent studies conducted on enjoyment (U9) and an exploratory study that focuses on developing the 4Cs among competitive ice hockey players (U13-U17). As for the studies conducted among U9 players, results suggest that enjoyment emerges from six dimensions: 1) play, 2) making efforts, 3) learning skills, 4) interactions with coaches, 5) team dynamics and 6) parental support. As for the competitive hockey players research, some significant changes were observed regarding Competence and Character. In addition to these observations, results suggest that coach-induced motivational climate might play a minor contribution in fostering the 4Cs. In the quest to optimize players' pathways in hockey, practical applications emerge from these studies.

Culture change: Ideas to optimize parent behaviour in youth ice hockey programming

Alex Murata and Jean Côté, Queen's University at Kingston

Although participation in youth ice hockey programming can provide athletes with a variety of invaluable lessons and positive developmental outcomes, many facets of "hockey culture" in its current state have resulted in negative experiences for players, coaches, and other volunteers/invested partners. Concerning hockey parents specifically, incidents of undesirable parent behaviour have been identified as contributing to program attrition in athletes and have even resulted in criminal charges being laid. Examples of this include parents placing unreasonable pressure on their children to perform as well as parents verbally or even physically abusing their children or other individuals within the minor hockey environment. Given these issues, the purpose of this presentation is to first explore the hockey parent "problem" through the lens of culture change—with a focus on social norm change—before providing suggestions to potentially help minor hockey programmers improve their parents' behaviours using research/literature originating within these domains.

Who's in net? Advancing Research on Goaltending Development and Participation in Hockey

Organized by Nick Wattie
Ontario Tech University

In team sports, the goaltending position is regularly referred to as a specialty position due to its unique demands relative to other players on a team. In ice hockey research, goaltenders are regularly excluded from analyses and studies due to their positional differences and comparatively small sample sizes. This symposium will cover a range of topics with a specific focus on this often-ignored position, including the impact of training demands and practice structure, scaling youth hockey playing surfaces and equipment, and the potential role of performance analysis to inform practice planning.

Implementing age-appropriate intermediate nets in 10U ice hockey to prevent injuries and increase player development

Richard Murray, Hendrix College

Two major problems that are faced by the goaltending development community are the prevalence of overuse injuries to the hip and groin, and a lack of goaltenders for teams at the older, 14U to 18U, age groups. Both of these problems may be caused, in part, by the development environment at younger age groups. At the 10U age group, when players are less than 78% of their adult height, games are played on full sized surfaces with full-sized adult nets. This environment may lead to excessive movements that could contribute to overuse injuries and a lack of success that might reduce retention of players that choose the goaltending position. To prevent injuries by reducing lateral movement, and to increase retention by allowing for more success in the game environment, a rule change was introduced in the Southern Amateur Hockey Association that requires the use of age-appropriate intermediate nets (75% of full-size) during all games played between teams in the affiliate. The effect of the change in net size on goaltender movement, player shots, and scoring is being analyzed. In addition, challenges associated with making change in a youth sports environment will be discussed.

Smaller Nets for Smaller Goalies: A Comparison of Youth Goaltending Behaviors in Scaled Ice Hockey Conditions

Zoe McGee, Ontario Tech University

Scaling, the process of modifying the rules, playing area and/or equipment of a sport to match the individual characteristics and abilities of an athlete, has been examined and implemented across a number of sports globally. However, there has been inconsistent global adoption of scaling environments in youth ice hockey. One such scaled condition is modified net sizes at the under 10 age group. A case study (n = 12 games) was performed comparing goaltending specific behaviors in adult size nets versus a modified net size (150cm by 100cm) in Under-10 Swedish goaltenders playing in cross-ice 3v3 hockey. A follow up study (n = 60 games) measured goaltending behaviors alongside shot characteristics in the same population. Both studies revealed that goaltenders' behaviors did not differ between net conditions, which may indicate that smaller nets do not negatively affect goaltending behaviors while being more developmentally appropriate relative to body size.

Re-imagining Ice Hockey Team Practice Design: A Data-Driven Approach to Adopting a Goaltending First Perspective
Ben Csiernik, Ontario Tech University

While a number of skill acquisition frameworks (i.e. challenge-based framework) have been proposed, limited research exists examining ice hockey team practice design, both in regard to skill acquisition and in athlete load monitoring. Further, many of the studies that do exist exclude goaltenders due to the unique demands of the position. We will discuss results from a case study in a women's collegiate setting examining team practice design and its impact on differential ratings of perceived exertion (dRPE), and show that goaltenders are most impacted by team practice design. Additionally, using the results of an expected goal model trained on 14,222 shots in women's varsity collegiate ice hockey, we propose areas of focus for practice design that would better support goaltenders while improving team level tactical approaches. By better understanding how goals are scored, practice design can be optimized for goaltenders and at the team level.

My journey in goaltending and the evolution of the game
Thomas Magnusson, Swedish Ice Hockey Association

In his presentation I will share insights from a career in goaltending development spanning over five decades, illustrating the non-linearity in the evolution of the game, which is commonly referred to as the pendulum effect. I will discuss the considerable shift recently seen in the continuous arms race between players and goalies. A swing from a contest where the netminders for a long time were in the lead, to a situation today where they, to a greater extent, find themselves exploited by shooters who have not only honed their individual technical scoring abilities but have also gained a better understanding of how goalies generally try to stop pucks. I will also describe the Swedish Goalie Coach Certification Program, and share some thoughts on measures necessary to move the game of goaltending forward, such as implementing a more evidence-based approach to goalie coaching and to the game itself.

Biomechanical Analysis of Ice Hockey Skills

Organized by Shawn Robbins
McGill Ice Hockey Research Group, McGill University

Ice hockey skills require complex movements from players and goaltenders to successfully complete. It is difficult to analyze hockey player motion and the impact of equipment on these skills due to the environmental constraints in which the game is played; however, specific biomechanical tools, which aim to analyze the mechanical aspects of motion, can help us objectively evaluate ice hockey skills. Such tools include 3-dimenional motion capture cameras, force sensors, pressure sensors, and inertial measurement units. This symposium will examine how these tools have been utilized to evaluate hockey related skills and the impact of equipment on player performance and safety. Specifically, differences in movement patterns during skating and shooting between elite vs. recreational players and males vs. females will be explored. The impact of goalie equipment and specialization on goalie related skills will be examined. New research utilizing machine learning to detect the frequency of task completion by players during practices and games will be highlighted. Finally, the impact of equipment design on player kinematics and performance will be presented.

Kinematic analysis of butterfly technique in goaltenders across skill levels

Margaret Harrington, University of Toronto

This presentation will describe a recent study of kinematic differences in the butterfly technique among goaltenders with varying skill levels and sports specialization. The butterfly position is widely used in modern goaltending as it improves net coverage but is also associated with an increased risk of lower extremity injuries. Understanding the biomechanics of goaltending could help improve performance while minimizing the risk of injury. Using Theia3D markerless motion capture technology, this study analyzed goaltenders’ movement during transitions to the butterfly, including the butterfly drops from standing, butterfly slides, and power slides. Key findings were differences in joint angles, frontal plane coverage, and knee and ankle positioning among recreational, competitive, and Junior A players. Additionally, early specialized goaltenders exhibited increased hip internal rotation and abduction at lower hip flexion angles, but lower angles at higher flexion, which may suggest the development of avoidant or adaptive strategies to deal with potential hip injuries.

What can and can't goaltender equipment do

Ryan Frayne, Dalhousie University

Ice hockey goaltenders are highly susceptible to hip injuries, specifically cam-type femoroacetabular impingement (FAI), due to the compromising hip postures and transient ice contact forces that their bodies experience while performing common save techniques like the butterfly, reverse vertical horizontal (RVH) and the T-push. Goaltender leg pads, along with being highly effective at decreasing blunt force trauma from pucks, can also minimize the ice contact forces through the medial knee riser. However, modern leg pad designs also promote goaltenders to frequently use the highly effective kneeling save techniques like the butterfly and RVH, which have been linked to FAI because of the required extreme hip internal rotation and flexion. Simply stopping these movements would be detrimental to goaltender performance; therefore, the purpose of this research is to understand the effects of ice hockey goaltender equipment on athlete safety and performance.

Differences in male and female body kinematics and skate pressure in forward, turning, and backwards skating

Philippe Renaud, McGill University

This study examined differences in spatiotemporal performance variables, lower limb joint angles, and plantar pressure in elite ice hockey players during forward skating and tight turns on ice. Twenty-six elite ice hockey players (12 male and 14 female) performed trials of a 19.5 m forward skating task and a 23 m 180-degree tight turn task (toward the left and right). Lower limb joint angles were measured using an inertial measurement unit-based motion capture system and compared sexes using Statistical Parametric Mapping. Plantar pressure was measured with pressure insoles inserted into the skates. Significant differences in joint angles between sexes were revealed, primarily evident in hip adduction and knee flexion during forwards skating, as well as hip internal rotation, knee flexion, and ankle internal rotation during turning. Results have practical implications for training in tight turn technique, as well as female-specific considerations in both on and off-ice training and equipment design.

Biomechanical Differences in Backwards Skating Across Sexes and Player Positions in Ice Hockey

Natalie Schwarz, McGill University

Hockey is a fast-paced sport that requires defensemen to match the speeds of forwards to protect the net. Despite its importance, backwards skating has remained largely unexplored. Biomechanical differences have been observed in previous studies between male and female players during various skating tasks but have not been researched during backwards skating. This study analyzes the kinematic differences in backwards c-cuts between male and female ice hockey players, as well as between forwards and defensemen. Using an Xsens 17 Inertial Measurement Unit (IMU) suit, joint angle data were collected to assess backward c-cut mechanics. A Principal Component Analysis (PCA) was conducted to identify key movement components. Additionally, a Continuous Relative Phase (CRP) analysis examined joint coordination across the groups. The results from this study are essential to furthering understanding of backward skating mechanics and comparing player differences based on sex and position, which inform training strategies and equipment design.

Breaking the Ice: Exploring sex-based variations in the mechanics of ice hockey slap shot

Ethan Wilke, McGill University

The objective of this study was to compare joint angles and spatiotemporal variables between male and female ice hockey players during skating slap shots. Thirty-nine collegiate players (25 men, 14 women) participated. Kinematic data were collected using a Xsens 17-inertial measurement system. Key variables included joint angles for the trunk, upper, and lower extremities, as well as temporal measures for shot execution time, and the backswing, downswing, and follow-through phases. Statistical Parametric Mapping (SPM) was applied to analyse sex-based differences in joint kinematics. Temporal data were compared using two-way ANOVAs. Results indicated that males exhibited longer backswing, downswing, and follow-through phases, contributing to longer overall shot execution times. Males also demonstrated greater trunk flexion and lead shoulder flexion, while females showed more lead shoulder abduction, elbow flexion, and trail wrist extension during the backswing and downswing phases. These findings highlight the influence of anatomical and strength differences on slap shot mechanics. Considering sex-specific biomechanical differences in the development of training regimens and equipment design may enhance performance and development in ice hockey for all.

Transforming hockey analysis with transformer networks: AI based hockey event classification

Andrew Phillips, McGill University

The introduction of artificial intelligence (AI) has revolutionized the way sports data is collected and analyzed, opening new possibilities for what can be achieved in the field of sports science. Human activity recognition (HAR) in the dynamic game of hockey traditionally relied on manual annotation and analysis from humans, a time-consuming task prone to error and bias. Partnering AI algorithms with movement data from wearable sensors, HAR models can be developed and implemented to provide deeper, more efficient, and more meaningful insights into hockey data. This study recorded 48 hockey players performing shots and other hockey events in a game-simulated environment using 17 wearable inertial measurement units. The segmented labelled data was used to develop and compare three deep-learning models using data from three different sensor configurations. Findings from this study can have implications on how movement data is detected and analyzed in real-game environments, advancing the application of AI in hockey biomechanics and analytics.

Development systems around the world

Organized by Joe Baker
Tanenbaum Institute for Science in Sport, University of Toronto

Research on athlete performance and development continues to advance at rapid rates. However, putting this research into practice can be challenging. One challenge faced by sport coaches, administrators and other stakeholders is capturing the complex process of athlete development over the extensive period required for skill acquisition. In this symposium, international leaders in the science and practice of ice hockey player development will present and discuss their approaches to holistic player development. After a short introduction, the session begins with a presentation by Rabinovitch et al. that provides an overview of her scoping review on previous research examining elements of player development in hockey. This is followed by presentations by Lind and Martel on the player development systems of Sweden and the United States. In the final presentation before a moderated question and answer session, Johnston et al. presents an overview of research on player development in women's hockey.

Beyond center ice: A scoping review on long-term psychosocial player development in ice hockey

Hannah Rabinovitch, Kathryn Johnston, & Joe Baker
Tanenbaum Institute for Science in Sport, University of Toronto

Research on ice hockey player development typically examines on-ice technical and tactical skills, with a physical development focus. Considerably less attention has been paid to psychosocial development. The goal of the present scoping review was to analyze the research literature on psychosocial male ice hockey player development. A PRISMA-based approach was used on 5 databases to identify applicable articles published over the last 25 years. As development is a blurry term across the literature, the search strategy was intentionally broad. More specifically, the initial search term used was "Hockey" (but not "ball" OR "field" OR "sledge" hockey), to capture as many articles as possible. Following duplicate removal, 6223 articles were extracted for title/abstract screening. Titles and abstracts were screened according to the following inclusion criteria: a) written in English, b) examining ice hockey, c) biological male or mixed sex players of any position, d) a psychosocial focus, e) a competitive sport sample (i.e., not recreational players). The next step involved reading the full-text of the 359 articles identified in the title/abstract screening and applying exclusion criteria. A total of 112 articles were coded for the variables of interest such as; study-design, country, continent, sample size, age, psychosocial tool/measurement, psychosocial foci, and key findings. Preliminary results indicated that the most studied psychosocial aspects in ice hockey were team cohesion, social identity, and aggression. The findings have the potential to identify key factors affecting player behaviour both on and off the ice and inform directions for future research to benefit athletes, coaches, and other stakeholders involved in athlete development.

Player development in the Swedish Ice Hockey Association
John Lind – Director of Education & Research, Swedish Ice Hockey Association

The development of young athletes remains a central concern for sports organizations, coaches, and policymakers. For the Swedish Ice Hockey Association, balancing long-term engagement and societal benefit with elite performance is a key priority. Supporting intrinsic motivation, enjoyment, autonomy, and a sense of belonging within sport environments is essential to sustaining both athlete well-being and development.

Athlete development is a complex, long-term process influenced by genetic, environmental, psychological, and training factors. While no universal blueprint exists, general principles can guide effective youth sport structures. The Swedish Ice Hockey Association's evidence-informed model adopts a person-centered approach, emphasizing a broad view of talent, long-term development trajectories, and developmentally appropriate environments. It also highlights the value of diverse training experiences in childhood and adolescence. This framework aims to support inclusive systems that nurture performance potential while promoting health, retention, and equity in youth ice hockey.

USA Hockey's approach to player development
Ken Martel, USA Hockey

In 2009, USA Hockey introduced the American Development Model (ADM) to enhance the understanding of player development among local youth hockey programs, administrators, coaches, parents, and players. The ADM aims to foster evidence-based practices and an athlete-learner-centered approach. USA Hockey has continuously refined its player development pathway and educational programs to align with current research and effectively communicate these advancements to key stakeholders, including coaches. This ongoing evolution is crucial in adapting to the dynamic and often challenging environment of youth sports.

Additionally, USA Hockey actively supports research initiatives focused on player development and safety. Over the past 15 years, the National Hockey League (NHL) has witnessed significant growth in the number of American players, reflecting the impact of improved development programs and increased participation in youth hockey.

Breaking the Ice: What do we know about women's and girl's ice-hockey development?

Kathryn Johnston, Hannah Rabinovitch, Joseph Baker
Tanenbaum Institute for Science in Sport, University of Toronto

We are at an exciting time in sport history, where there are more opportunities for recreational and professional sport engagement for girls and women than ever. In North America, the newly formed Professional Women's Hockey League (PWHL) has allowed women and girls to strengthen and extend their ice-hockey careers and has brought with it a surge media/broadcast attention, fan engagement, and scientific research. Given how quickly this area is evolving, a descriptive overview of the current research was conducted to better understand research priorities and identify critical areas requiring further investigation in the years to come. More specifically, a scoping review was performed on the available scholarship focused on athletes identified as women and girls who participate in ice-hockey. Through database searching, 6223 articles examining ice-hockey more broadly were identified, which were filtered to 325 articles meeting the inclusion of a) examining samples described a 'women', 'females', 'girls', or 'mixed', b) written in English and in full-text and peer-reviewed form, and c) focused on the athletes themselves and not other interest-holders like coaches, parents, teachers, etc. Once a final sample was identified, articles were coded based on their study design, participant country, sample size, competition level, age, and focus/foci of the study. The presentation will report on descriptive trends for the chosen variables, and draw together general findings and directions for future research.

To Test or not to Test? Reflections about the usefulness of on-ice testing in the context of competitive hockey

Organized Jean Lemoyne
UQTR Hockey Research Lab, Université du Québec à Trois-Rivières

This symposium provides insights about recent research results in relation with the associations between on-ice test and their links with performance in real settings (e.g., the game of hockey). An overview of combine tests, physical attributes that are tested and promising areas on research to translate test performance to game performance.

Through the eyes of strength and conditioning coaches: Testing competitive youth hockey players – lessons learned n regard with off-ice and on-ice tests

Julien Glaude-Roy, Université du Québec à Trois-Rivières

Determining key performance indicators (KPI) to make informed and individualized training prescription can be a challenge in the context of competitive youth ice hockey. Based on previous studies, the substantial amount (and variety) of tests available can be overwhelming and confusing for professionals eager to maximize skating performance. Should testing be focused on the ice, off the ice or both? This presentation will review the validity of various tests used by researchers to assess the physical ability of competitive (and promising) hockey players. A special focus will be set towards selecting as few KPI as possible while proposing solutions to maximize players' engagement in the training process. At the end of this presentation attendees should be able to critically select their own KPIs for physical assessment of competitive youth hockey players and build engaging solutions for them.

What happens on the ice stays on the ice: **establishing standard for speed and acceleration in high level ice hockey players**

Petr Šťastný, Charles University, Prague, Czech Republic

Acceleration and sprinting are essential components of the ice hockey game, enabling the use of individual and team tactics. Thus, acceleration and sprint testing should be integral to the training and selection process, where the testing tools must be capable of distinguishing between performance levels, age categories, individual conditions, and individual trainability. Consequently, selecting the sprint test necessitates a clear and evidence-based justification of the testing distance and instructions. The presentation justifies the selection of testing distance, equipment, and player instructions, as previous data reports measured values ranging from 4 to 48 m or even assessed acceleration based on stride counts. The results of previous studies will be presented alongside game requirements and practical experiences from measurements in elite senior, junior, and U18 categories. Since the acceleration phase significantly influences sprints over longer distances, the increased test distance correlates with higher speed ($r = 0.70$) and has a negative relationship with provided acceleration ($r = -0.87$). For practical reference and research needs, there remains a lack of consensus on a standardized measure of ice hockey acceleration and sprint testing. Considering match demands and the most reported test distances, 6.1 m is the recommended distance for peak acceleration and 30 m for peak speed. Future studies should focus on developing optimal testing equipment and report the sprint time, acceleration, and speed of each individual, along with the number of skating strides.

The demands of ice hockey and the role of testing in assessing players' performance: an overview of research

Jamie Burr, University of Guelph

The demands of ice hockey have changed over time, reflecting shifts in game speed, strategy, and player development. This presentation explores research on performance in hockey and physical preparation, including physical demands, as captured through game tracking technology. Additionally, we examine the role of on- and off-ice testing in assessing player potential and the evolving physiological and anthropometric characteristics of hockey players. As the game continues to evolve, understanding the relationship between physical attributes, performance metrics, and long-term success remains a key focus for researchers, coaches, and scouts.

Panel discussion (with all presenters) – To test or not to test? Reflections about the usefulness of on-ice testing in the context of competitive hockey

Can we test players without testing by taking account of what really happens on the ice? This part of the symposium will discuss the emergence of new tracking technologies and their potential contribution to the future of testing. Each presenter will address some key challenges in regard with emerging technologies as methods for performance assessment in real settings and practical applications will be discussed in this last part of the symposium.

Talks

Special talk

The role of the International Ice Hockey Federation in the development of ice hockey

Kalle Väliaho
Development Director
International Ice Hockey Federation

“It´s unrealistic”: Experiences of Swedish Elite Female Ice Hockey Players Considering Parenthood

Max Bergström, R. Høigaard, N. P. Aspvik, and S. A. Sæther
Department of Sociology and Political Science, Norwegian University of Science and Technology, Trondheim, Norway

The number of elite female athletes combining athletic careers with motherhood has increased during the last decades. Many mother-athletes return to an equal or an even better level of performance postpartum. Despite numerous success stories across a variety of sports, there are currently no mother-athletes in Swedish elite ice hockey. Therefore, the aim of this study was to explore how Swedish elite female ice hockey players perceive challenges associated with initiating and maintaining the mother-athlete role. Qualitative data were collected through semi-structured interviews with 7 elite female ice hockey players (5 prepregnancy and 2 mothers/former athletes) and analyzed using thematic analysis. Thematic analysis revealed three main challenges facing elite female ice hockey players: a*) Financial challenges*, b) *Unclear maternity rights* and c) *Negative notions*. Due to these challenges, the participants considered elite ice hockey and parenthood as incompatible. Consequently, they felt forced to either retire from elite sports early or postpone parenthood to post career. Continued work with improving the financial support and developing clear maternity policies is essential to prevent early dropouts before elite female ice hockey players have reached peak performance. Enabling more players to prolong their athletic careers during pregnancy and postpartum will likely produce more positive mother-athlete role models. Further, keeping more players in the sport for a longer period could help women´s ice hockey to develop to its highest optimal quality (e.g., level and competition).

Beyond the Lab: Rethinking Visual Perception Research in Ice Hockey

Vladislav Bespomoshchnov and Geir Jordet
Department of Sport and Social Sciences, Norwegian School of Sport and Social Sciences, Oslo, Norway

Skilled visual perception is a foundational property of expertise in sport. Two prominent approaches to studying this phenomenon stem from information processing and ecological dynamics paradigms. While the information processing approach has provided valuable insights, concerns regarding ecological validity have been raised. To date, much of the research in ice hockey (and other team sports) relied on laboratory-based or simulated scenarios that may not accurately reflect the perceptual demands of a competitive game. This presentation advocates for a paradigm shift towards exploring visual perception through the lens of ecological dynamics. Specifically, it encourages methods like representative experiment design, field-based observations, and mixed-methods to elucidate the dynamic properties of athletes' perception-action coupling within complex performance environments. By drawing on different methodological approaches in other sports like scanning in football (soccer), this presentation will exemplify potential avenues to study visual perception in ice hockey in a more ecologically valid manner.

Prioritize before Specialize: Developing a Model for Adolescent Hockey Player Physical Preparation Using Trainers' Practices to Conceptualize a Curriculum Focused on Motor Skills and Physical Qualities in Line with the Evolution of Physical Maturation

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This presentation outlines the foundations of a Quebec physical preparation model specifically designed for adolescent ice hockey players in schools from Secondary 1 to 5. Based on the field practices of physical trainers, this model aims to structure a curriculum centered on the development of a repertoire of motor actions specific to ice hockey (puck handling, jumps and dynamic sequences linked to skating), the progressive mastery of basic muscle-building movements (squat, deadlift, bench press, clean) and the learning of relative strength exercises such as pull-ups. The approach is designed to be sensitive to the evolution of adolescents' physical maturation, to ensure safe, adapted and transferable progression to on-ice performance. It also incorporates a strong pedagogical dimension, aimed at instructing youngsters in the theoretical knowledge of training - principles of overload, adaptation and recovery - to encourage the emergence of more autonomous athletes committed to their development. By combining practical expertise and didactic reflection, this proposal seeks to better align the demands of top-level sport with the educational goals of Quebec schools.

Cette présentation propose les fondements d'un modèle québécois de préparation physique spécifiquement conçu pour le joueur de hockey adolescent évoluant dans une structure scolaire du l^{er} au 5^{e} secondaire. En s'appuyant sur les pratiques terrain des préparateurs physiques, ce modèle vise à structurer un curriculum centré sur le développement d'un répertoire d'actions motrices propres au hockey (maniement de la rondelle, sauts et enchaînements dynamiques liés au patinage), la maîtrise progressive des mouvements de musculation de base (squat, deadlift, bench press, clean) et l'apprentissage des exercices de force relative comme les tractions. L'approche se veut sensible à l'évolution de la maturation physique des adolescents afin d'assurer une progression sécuritaire, adaptée et transférable à la performance sur glace. Elle intègre également une dimension pédagogique forte, visant à instruire les jeunes sur les savoirs théoriques de l'entraînement — principes de surcharge, d'adaptation et de récupération — pour favoriser l'émergence d'athlètes plus autonomes et engagés dans leur développement. En croisant expertise pratique et réflexion didactique, cette proposition cherche à mieux arrimer les exigences du sport de haut niveau aux finalités éducatives de l'école québécoise.

Beyond the trained eye: An objective method to predict game sense in team sports

Daniel Fortin-Guichard[1, 2], Kathryn Johnston[1], Thomas Romeas[3,4], Magdalena Wojtowicz[5], Jean Lemoyne[6], David L. Mann[7], Simon Grondin[8], and Joseph Baker[1]

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Talent identification in sports requires a prediction of how athletes will perform in the future based on a sample of their behaviors. Perceptual cognitive-skills or 'game sense' in sports jargon is important for performance, yet sport organizations lack objective and validated measures to predict it. This study aimed to establish the degree to which subjective evaluations of athletes' in-match perceptual-cognitive skills could be predicted by their performance on objective perceptual-cognitive tests. The perceptual-cognitive skills of 40 highly-trained ice-hockey players were assessed by their coaches and the results were compared with the athletes' performance on four laboratory perceptual-cognitive tasks (neuropsychological battery, multiple-object tracking, temporal occlusion, virtual reality). Athletes were also assessed by scouts throughout a hockey season and during small-sided games. Scout judgments best predicted coach rankings, with measures from small-sided games, neuropsychological battery, virtual reality and temporal occlusion improving prediction. Results suggest that adding perceptual-cognitive testing could help scouts better measure athletes during talent identification.

Elite Canadian ice hockey coaches' perceptions of creating a healthy and high-performing culture of excellence

Madison M. Fraser[1], Danielle Alexander-Urquhart[2], and Gordon A. Bloom[1]
[1] McGill University
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Although hockey is one of the most dominant sports in Canada, hockey culture has been associated with negative behaviours that influence team culture on and off the ice. With the understanding that coaches play a critical role in shaping team culture, this study explored Canadian Hockey League (CHL) coaches' perceptions of creating and maintaining a healthy and high-performing sport culture for elite 15–20-year-old male hockey players. Six CHL hockey coaches were interviewed and data were analyzed using a reflexive thematic analysis. Coaches described several challenges in creating a culture of excellence, including acquiring parental buy-in, dealing with misbehaviour, and managing high-performance expectations. Coaches addressed these challenges by modelling expected behaviours, holding athletes and staff accountable, fostering effective leadership, and developing trusting and respectful relationships among the team. Looking forward, coaches consistently recommended an increase in coach education on how to build and sustain a culture of excellence.

Is the 1080 Sprint Still the Gold Standard for Ice Acceleration Testing?

Léandre Gagné Lemieux, Nicolas Lamarre, Maxime Chabot, and Simon Laurendeau
SciencePerfo Inc., Québec, Canada

Background:
The 1080 Sprint is widely used for measuring acceleration in various sports contexts, but its validity for ice-specific acceleration testing remains under investigation. Understanding its accuracy in comparison to other high-precision systems is crucial for optimizing performance assessments in ice sports.

Methods:
Preliminary data was collected using the 1080 Sprint during ice acceleration tests. These results were then compared to data from other precise measurement systems, focusing on standard acceleration metrics (e.g., split times, max velocity) and detailed movement mechanics (e.g., asymmetries, force-velocity profiles, spatiotemporal data for each stride).

Results:
Initial findings suggest that while the 1080 Sprint provides reliable standard acceleration data, its performance in capturing more detailed movement mechanics may differ from other systems. Differences in force-velocity profiles and asymmetries were noted, highlighting potential limitations in the 1080 Sprint's ability to fully capture the dynamics of ice-specific movements.

Conclusion:
The 1080 Sprint remains a strong training tool for general acceleration, but its application for detailed biomechanical analysis on ice should be taken with care. This study offers valuable insights for enhancing the accuracy of performance assessments in ice sports and supports ongoing development of more precise measurement tools.

The Competitive Edges of the Future in Professional Ice Hockey: Team Complexity

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In professional ice hockey, the ever-increasing competition requires the creation of novel competitive edges that the players and team can harness for maximal performance. As sports teams are inherently complex to a certain degree, they show some of the features of complex systems that can be harnessed and converted into a competitive edge. These features are based on non-linearity (creating synergies between players in situations in which the players catalyze each others' game) and diversity (which enables a team to be robust and adaptable simultaneously). Increasing the complexity of these teams requires methods to identify where they are located on a scale from structure to chaos, complexity being in the middle zone of the scale. The teams are inherently self-organizing towards this maximal complexity, named the edge of chaos, as in maximal complexity, the competitive edges of the future are found.

Shooting left or shooting right in ice hockey?

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For researchers interested in laterality, ice hockey is of particular interest as it is a very lateralized game. Holding a hockey stick is a bimanual asymmetric task, i.e., a task where both hands contribute to the action (stick handling or shooting) but have different roles. During this talk, data from two recent studies will be presented. In the first part, data drawn from the general population will be briefly reported: they will reveal the likelihood that left-handed or right-handed people shoot left or right in ice hockey and how the shooting preference in ice hockey is related to other bimanual asymmetric activities and to other motor or sensory lateral preferences. In the second part, an analysis of data based on the performances of National Hockey League players will be presented. It will show that the preference for shooting left or right has an impact on performances, an impact that depends on players' position and origin.

Breaking Under Pressure? Rethinking How We Measure Choking in Ice Hockey

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Choking in sports is a highly relevant concept that can be defined as a significant performance decline in high-pressure situations, despite the athlete’s ability to succeed in low-pressure conditions (Mesagno & Hill, 2013). Until now, choking has almost only been measured in controlled laboratory environments, which raises the question of its reproducibility in real-game situations. This phenomenon is typically assessed using self-reported questionnaires on anxiety, self-consciousness and coping (e.g., the Sport Anxiety Scale-2, Self-Consciousness Scale, and the Coping Inventory for Competitive Sport) (Gropel & Mesagno, 2019). However, current methods fail to differentiate between adaptive and maladaptive coping strategies influencing choking susceptibility. This presentation illustrates these limits with concrete examples from Quebec's provincial ice hockey teams. Several proposals will then be made to improve our definition of this concept, the validity of its measurement, and different feasible interventions that could be carried out in the context of ice hockey.

When Health meets Performance: The usefulness of inertial movement units through a competitive hockey season

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Abstract

Background: Load management has been studied more closely in the recent years with the development of inertial movement unit technology (IMU). This emerging technology is used mainly in the domain of load management, injury prevention and preparing return to the game. IMU allows a better understanding of volume, intensity and force output metrics that are performed by players during a game. Despite the emergence of IMU, quantitative evaluation of those metrics during a full competitive season remains limited in scientific literature.
Purpose: This study aims to describe volume and intensity metrics' fluctuation during in-season games in two different scenarios: 1) home games vs road games and 2) game outcomes (win versus lost).
Methods: Data was collected using IMU technology (Vector S7, Catapult Sports) worn by players (n = 20) evolving in U Sport first division. Volume (Playerload (PL) and On-Ice load (OIL) and intensity (PL/min and Explosive Efforts (EE)) were collected throughout a season. Generalized linear modeling and repeated measures ANOVAs were conducted to evaluate the evolution of IMU measures and verify the impact of the two conditions.
Results: Results showed a significant drop of PL between the 1st and 3rd period and of OIL between all periods. A significant drop of PL/min and EE was also observed between all periods. However, no significant differences were observed between game outcomes (win vs lost), despite some higher values observed in victories. Interestingly, some significant differences were observed in home games, where the volume and intensity outputs were higher.
Conclusion: The between-period drop observed aligns with what was demonstrated in previous studies. This project being one of the few to study match outcomes related to IMU metrics raises interesting avenues towards a bridging of the gap between research results and field applicability.

Video analysis of anterior cruciate ligament (ACL) injuries in the National Hockey League (NHL)

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Previously, we determined that the incidence of anterior cruciate ligament (ACL) ruptures was 0.42/1000 game hours in the National Hockey League (NHL) over a 10-year period. Following ACL reconstruction and rehabilitation, career length did not differ between controls. However, players that had undergone an ACL reconstruction demonstrated a decrease in goals and points per game and season. On average, it took players 249 days to return to play. Given that almost seven players per year can be lost for a season due to ACL injury, we set out to determine the most common mechanisms of ACL rupture in the NHL over a 20-year period. Video footage and injury data was captured through publicly available on-line sources. In total, we acquired video footage and information for 42 ACL tears between 1995-2024. A 14-question survey was developed to determine the mechanisms of injury amongst NHL players. At least two reviewers answered each of the questions for 42 injuries. Descriptive statistics were generated for age at the time of injury, height and weight. Frequency statistics were calculated to determine the most common mechanisms of injury. A total of 37 players were included; five of whom tore their ACL on two separate occasions. The average age at time of injury was 28.9 (±4.6) years with an average height and weight of 186.5 (±4.3) cm and 91.9 (±5.8) kg, respectively. Seventy-one percent of players tore their ACL at or beyond the midpoint of the season. Fifty-five percent of injuries resulted from a direct blow to the knee, 43% of which were induced by a valgus force. Sixty-seven percent of injuries occurred near the boards in either the offensive, defensive or neutral zones. Seventy-nine percent of injuries occurred when the player did not have the puck on their stick and 71% of ACL ruptures occurred with the knee in less than 45 degrees of flexion. Sixty-seven percent of injuries were sustained when the player was on the inside edge of the affected leg. This study allowed us to gain further insight into the mechanisms of injury to identify potential rule changes, training modifications, or tactical and technical skills that can be enhanced to reduce this devastating injury.

Head coaches' perceptions of the coach-athlete relationship in the National Hockey League

Adam Pilotte, Gordon A. Bloom, Marc Glaude
McGill University

While substantial research has outlined the importance of the coach-athlete relationship for the development, satisfaction, and success of athletes, few studies have examined this relationship in professional team sports despite the unique challenges of this context, such as an overemphasis on winning and the frequent dismissal of coaches. Therefore, the current study explored the perspectives of 13 current or former National Hockey League head coaches on the coach-athlete relationship. Coaches participated in semi-structured interviews and the data were analyzed using a reflexive thematic analysis. Among the findings, coaches emphasized getting to know their athletes on a personal level to help tailor their communication style, while remaining cognizant of maintaining professional boundaries. Furthermore, maintaining alignment with other key stakeholders (i.e., general manager) was perceived as critical, as misalignment could hinder the coach-athlete relationship. These findings offer applicable strategies for building relationships that are conducive to sustained success in professional sport.

Posters

Small area games and age-adapted gameplay for ice hockey: A review of literature

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To optimize skill acquisition and ensure adequate energy expenditure, many suggest the use of small area games. However, few studies have directly addressed these impacts in the specific context of hockey. This project aims to summarize the scientific literature that has addressed this issue. Through a scoping review, this project put forward the impacts of small area games by considering 6 facets: 1) age of participants, 2) playing format, 3) rules/regulations, 4) motivational outcomes, 5) physical activity levels and 6) skill acquisition. To proceed, a systematic review was carried out following PRISMA guidelines. Targeted keywords were selected to find publications dealing with the impact of playing in small sided games and age adapted playing formats. Three dimensions were considered: physiological, socio-affective and technical skills. This study suggests implications for researchers and practitioners aiming to optimize skill acquisition, enjoyment and learning ice hockey in the early years of participation.

Have the physical and fitness characteristics of male AAA ice hockey athletes changed over the past 8-years?

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The purpose of this study was to determine if physical and fitness characteristics of male AAA ice hockey athletes have evolved over the past 8 years (2017-2024). Data collected during pre-season ‘combine’ style testing of male adolescent ice hockey athletes (12–17 years of age) was extracted from a performance database. Compared to the earliest data (2017 and 2018), athletes now (2023 and 2024) have lower body fat (8.83±4.6% vs. 7.25±3.86%; $p<0.001$; $d=0.36$) and can perform more push-ups (29.5±10.0 reps vs. 36.1±11.0 reps; $p<0.001$; $d = 0.64$). Regression analysis showed that the year of testing was predictive of body fat (adjusted R2=0.007; $b=-0.90$; $p=0.005$), maximal push-up repetitions (adjusted R2=0.07; $b=0.26$; $p<0.001$), broad jump (adjusted R2=0.005; $b =-0.08$; $p= 0.02$) and 5-10-5 shuttle (adjusted R2=0.013; $b=0.12$; $p<0.001$). These results indicate that adolescent ice-hockey athletes have evolved to be leaner with improved upper body muscular endurance over the past 8-years.

An Assessment Tool for Puck Control

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In the field of ice hockey, scientifically based methods focus primarily on assessing non-specific motor skills. To assess specific skills, methods of direct and indirect observation, along with resulting expert analysis, are utilized. However, these analyses are often biased by the personal experience and knowledge of the expert. In this study, we outline the use of item response theory and Guttman scale techniques to develop a puck control assessment tool containing 17 items tailored for ice hockey players aged from 6 to 15 years. Analysis was performed on data collected from 357 participants. The item bank contained 74 items was created. Subsequently, these items underwent rigorous testing and analysis using the Rasch model and Mokken analysis and involved multiple iterations of item selection for the final tool. Developed Assessment tool was used to set standards for puck control in ice hockey, specifically for players aged from 6 to 15 years in the Czech Republic, rated on a scale from 1 to 17. A total of 1102 players were tested to define the standards.

Physical and physiological adaptations occur over a single hockey season

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The purpose of this study was to determine if physical and physiological characteristics of male AAA hockey athletes change over the course of the 'in-season'. A total of 1020 participants (age range=12-18 years old) had data extracted from pre-and post-season combine testing conducted between 2017-2024. Height (1.17±0.44 cm; $p=0.008$; $d=0.123$), body mass (1.51±0.52 kg; $p=0.004$; $d=0.134$), absolute peak (20.03±9.10 W; $p=0.028$; $d=0.122$) and average power output (16.24±6.80 W; $p=0.017$; $d=0.132$), broad jump (2.92±1.01 cm; $p=0.004$; $d=0.136$), grip strength (2.41±0.89 kgf; $p=0.007$; $d=0.127$), 20-meter sprint (0.03±0.01 s; $p=0.007$; $d=0.163$) and 5-10-5 shuttle time (0.07±0.01 s; $p<0.001$; $d=0.244$) improved from pre- to post-season. However, maximal number of push-ups decreased (2.42±0.48 reps; $p<0.001$; $d=0.239$). Over the course of a hockey 'in-season' athletes grow bigger, improve their absolute anaerobic power output, speed and agility, and maximal strength, but show decreases in muscular endurance, albeit these changes are very small to small in effect size.

Cross-cohort Comparison of the Psychological Determinants of Ice Hockey Performance

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Talent identification is a complex process that requires evaluating multiple characteristics in athletes. To achieve this, researchers, recruiters, and coaches employ both quantitative and qualitative measures. However, despite recruiters' best efforts to assess talent, this identification is imbued with subjectivity (e.g., evaluations based on personal implicit experiences or judgments of athletes' intangible traits), leading to errors during drafting. Recent studies have objectively measured psychological determinants of talent in 95 promising young hockey players aged 15-16 using questionnaires and video sequences (to assess anticipation, decision-making, and eye movements). These studies identified self-regulation, the number of AOIs (areas of interest), eye fixations, decision-making, and fixation time as psychological characteristics predictive of talent three years later. A replication of these objective measures was conducted on a second cohort of 108 other players to verify the generalizability of the predictors. Performance data from this second cohort will be available in time for the conference.

Le hockey comme vecteur pour le mode de vie actif chez les Peuples des Premières Nations / Hockey as a vector for a physical active lifestyle in First nation communities

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Contexte: Encore aujourd’hui, les conséquences de la colonisation sur les peuples autochtones sont bien réelles (Brant et al. 2019). Si certains réussissent à prospérer, beaucoup d’entre eux doivent composer avec de nombreux problèmes, tels que la pauvreté, le décrochage scolaire, l’alcoolisme et la toxicomanie (Brant et al. 2019). Bien que de nos jours les bénéfices de la pratique sportive sont connus, peu de programmes de sports organisés existent pour les jeunes autochtones (Bean & Forneris, 2016). Au Canada, parler de sport réfère implicitement au hockey sur glace. Étant le sport national d’hiver des Canadiens, le hockey a également toujours fait partie de la culture des peuples autochtones, et ce bien avant la colonisation (Bean & Forneris, 2016). Des recherches ont montré que le sport permet d’aider les jeunes autochtones à développer des valeurs personnelles et sociales telles que l'honnêteté, le respect et le courage en plus de procurer un meilleur soutien dans la poursuite de leurs ambitions (Bruner et al. 2016). Sherry & Rowe (2020) affirment que les autochtones sont portés à être moins actifs considérant plusieurs facteurs. Certaines barrières telles que l'emplacement des installations, le personnel de soutien minimal et les coûts financiers jouent un rôle important dans la participation sportive des jeunes de ses communautés (Bean & Forneris, 2016). Chez les communautés autochtones, la pratique du sport diffère d’un peuple à un autre, et les jeux traditionnels ont une double dimension spirituelle et utilitaire (Wilson et al. 2019). Le modèle de développement de l'athlète autochtone (MDAA) propose une conceptualisation holistique comprenant quatre aspects essentiels du développement personnel des participants : 1- physique, 2- mental (cognitif et émotionnel), 3- spirituel et 4- culturel (Wilson et al. 2019). Selon ce modèle, en équilibrant ses quatre aspects, le participant a de grandes chances de réussir dans son sport (Wilson et al. 2019).

Objectif : Inspiré du modèle holistique de développement de l’athlète autochtone, l’objectif général de cette étude est de vérifier l’impact du hockey comme vecteur favorisant l’adoption d’un mode de vie actif chez les jeunes d’une communauté innue. Ce projet comporte deux objectifs spécifiques : 1- décrire les facteurs qui motivent les jeunes innus face à la pratique du hockey, 2- porter un regard sur les croyances des jeunes relativement aux quatre composantes (physique, mentale, culturelle et spirituelle) et l’impact de celles-ci sur la pratique du hockey sur glace.

Retombées attendues : Ce projet s’inscrit dans une démarche de partenariat de recherche impliquant chercheurs et praticiens. En plus de contribuer à l’avancement des connaissances en lien avec le modèle holistique de développement de l’athlète autochtone, il permettra de cibler les éléments à prioriser pour motiver les jeunes à adhérer à la pratique sportive et au maintien de celle-ci et pourra contribuer à mettre en place des bonnes pratiques de promotion de la pratique sportive chez les jeunes Innus.

Do NHL players respond to violence with violence?

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Some social psychology theories suggest that violence breeds violence. To test this hypothesis in professional hockey, we examined whether NHL teams that receive more hits respond with fights or actions leading to suspensions or fines. Using online data since 2010 for fights and 2016 for suspensions and fines, we performed linear mixed-effects models with hits received as the independent variable. Results show that teams receiving more hits do not engage in significantly more fights (Std. beta = -0.02, 95% CI [-0.09, 0.05], $p = 0.624$). However, they are more likely to commit actions resulting in suspensions or fines (Std. beta = 0.16, 95% CI [0.04, 0.27], $p = 0.006$). These findings suggest that experiencing physical aggression does not necessarily lead to more fights but rather increases the likelihood of behavior penalized by the NHL Department of Player Safety, contributing to the debate about the necessity of violent actions in ice hockey.

Opportunities in the Hockey Industry: Integrating with CCM R&D

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Fighting in the NHL: a Deterrent to Cheap Shots or an Ineffective Tradition?

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Some hockey organizations have tried to make the sport safer, but fighting persists, particularly in the NHL. Proponents argue that fighting may serve as a social regulation mechanism (Plassche et al., 2022). Our study examines the relationship between fighting and cheap shots by analyzing suspensions and fines in the NHL. Specifically, we seek to determine whether teams that fight more frequently are less targeted by these unsportsmanlike acts. To do so, we analyzed publicly available online data on fines and suspensions from the 2016 through 2024 seasons. Preliminary analysis performed using a linear mixed-effects model reveals a statistically non-significant effect of the amount of fights a team participates in, and the quantity of cheap shots dealt against them (Std. beta = 0.09, 95% CI [-0.02, 0.21], $p = 0.099$). These results call into question the role of fighting as a social regulation mechanism and add to the research contesting its necessity in hockey.

An Analysis of Scoring in the CHL: Is it Getting Easier and Does It Change Drafting Decisions in the NHL?

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Introduction

Scoring in the Canadian Hockey League (CHL) varies across seasons within the three sub-leagues making up the CHL, which may influence the perceived value of players within the CHL. This study investigates National Hockey League (NHL) drafting behaviours associated with scoring trends in the CHL.

Methods

The goal scoring of all CHL skaters was collected between the 2004-2005 & 2023-2024 seasons (n = 31, 139) who played >= 1 game in a single season. Goal scoring was standardized and analyzed in relation to league, season and goals per game. Goal scoring was then correlated with the number of NHL draft selections during each season between the 2014 and 2023 NHL drafts.

Results

CHL scoring demonstrated a slight increase over the course of twenty seasons. However, z scores for goals over time across all three sub-leagues demonstrated no noticeable change suggesting, top scorers remained consistently more productive over the twenty seasons. Goal scoring in the CHL presented a - 0.114 correlation with NHL draft selections with wide variability between the three sub-leagues.

Conclusion

While CHL scoring has increased, no relationship has been found between CHL scoring and NHL draft decisions. Future research may explore confounders associated with CHL scoring increasing with no change in the NHL draft selections from the three sub-leagues. Further understanding of the changes occurring in the CHL may have important implications for decision-makers in the NHL.

Evaluating the use of inertial measurement unit technology during an ice hockey shooting task

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This study evaluated an IMU system to measure joint kinematics in comparison to an optoelectronic system, while ten high-level players performed 10 static wrist and slap shots, collecting concurrent IMU and marker-based recordings. The participant's joint angles from the two systems were compared using Root Mean Square Error (RMSE) and the Coefficient of Multiple Correlation (CMC). Across all joints, average RMSE were comparable about the sagittal and frontal planes, though the transverse plane had a higher RMSE. CMC about the sagittal, frontal, and transverse planes indicated very good (0.91), good (0.78-0.80), and moderate (0.70-0.74) waveform similarity, respectively. The differences were predominantly attributed to the biomechanical model differences rather than technologies. Hence, future research should standardize models and calibration procedures, and investigate longer, more complex tasks. The similarities in sagittal and frontal absolute measures and measures over time suggest IMUs are a practical option to objectively analyze ice hockey shooting techniques.

Impact of Acute Fatigue on Hip Kinematics in Ice Hockey Goaltenders suffering from Femoroacetabular Impingement Syndrome

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Femoroacetabular impingement syndrome (FAIS) is prevalent in ice hockey players, particularly goaltenders, due to repeated movements and postures placing the hip at extreme ranges of motion (ROM). Little is known regarding the impact of FAIS on movement variability and hip kinematics in this population. This study aimed to analyze the impact of fatigue on hip kinematics in goaltenders with FAIS. Fourteen goaltenders with FAIS performed T-push (TP), C-cut (CC), Butterfly (BF) and Power Push+Reverse Vertical Horizontal (RVH) before and after an experimental fatigue protocol. This protocol consisted of the aforementioned movements performed in a sequence and repeated until exhaustion criteria, based on heart rate and perceived exertion, were met. Preliminary analysis reveals similar hip ROM as previously reported. Following fatigue protocol, ROM was increased in both hips during BF and in the right hip during RVH to the right. Further analysis will compare symptomatic and asymptomatic goaltenders within this group.

Support for performance and well-being in university ice hockey student-athletes

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Throughout their academic journey, student-athletes are confronted with multiple challenges that may hinder their performance and well-being—precisely at a time when they are expected to function at their highest potential. The interaction between factors influencing athletic performance within the context of university sports and their impact on student-athletes' well-being remains insufficiently understood, as do the concrete strategies that could support them in navigating these challenges. This study aims to elucidate these interactions through a comprehensive, year-long data collection process involving physical assessments (on-ice and off-ice), validated questionnaires (addressing psychological aspects, sleep quality, family support, nutrition, and injuries), and both individual and group interviews. Findings will be synthesized within an ecological model, with each system representing the collected data and the dynamic interactions among components. It is anticipated that certain variables will exert a direct influence on the physical and psychological competencies of student-athletes—positioned at the center of the model—and thereby affect their overall performance and well-being. Ultimately, the study seeks to inform the development of evidence-based interventions aimed at optimizing the support structures surrounding university hockey student-athletes, in order to foster both their athletic excellence and holistic development.

Les aptitudes perceptivo-cognitives et la performance en hockey de haut niveau

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L’analyse cognitive dans le sport de haut niveau est un champ en pleine expansion. La performance sportive se base sur une approche holistique, qui inclut les aspects physiques, technico-tactiques, psychologiques et cognitifs. Des outils basés sur la réalité virtuelle ont été développés pour mesurer et entrainer ces compétences. Bien que certaines études s’intéressent à l’efficacité du système Sense Arena ® pour mesurer les variables cognitives et de jeu, on ne sait pas, à ce jour, si les performances réalisées en contexte virtuel (Sense Arena) reflètent fidèlement celles observées sur glace en match. Cette étude vise à évaluer les relations entre les résultats obtenus sur Sense Arena et les indicateurs de performance chez des hockeyeurs universitaires. Plus spécifiquement, ce projet vise deux objectifs : 1) vérifier l’évolution des paramètres perceptivo-cognitifs et 2) vérifier les associations entre ces paramètres et les performances mesurées en situation de match. Les participants sont les joueurs d’une équipe masculine universitaire de hockey (n=18). Les variables mesurées incluent les résultats du Sense Arena (temps de réaction, vision périphérique, efficacité, temps de dégagement, couverture du terrain, recherche de ligne de passe ouverte, suivi des joueurs) ainsi que les statistiques de match, mesurées à l’aide de la plateforme Instat®. Trois prises de mesure ont été effectuées durant la saison : au début de la saison et à la mi-saison. Plusieurs corrélations ont été trouvées entre les statistiques de matchs et les mesures cognitives des jeux du Sense Arena®.

Write, throw, shoot:
Descriptive data about the lateral preferences of young ice hockey players

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In the general population, it is difficult to accurately predict whether someone will shoot left or right in ice hockey based on the preferred hand for throwing a ball or writing, but we know that in the Canadian population, right-handers are more likely to shoot left and left-handers are more likely to shoot right. We also know that over the history of the National Hockey League (the main professional hockey league), there have been more left-handed than right-handed players (but their preferred hand for unimanual tasks is unknown). Here, we report descriptive data on the lateral preferences of 161 elite (U20) ice hockey players and 159 children aged 4 to 8 years. Overall, the hand used for writing is better than the hand used for throwing a ball in predicting the shooting side in ice hockey: while 80.70% of players writing with their left hand will shoot right and 77.95% of players writing with their right hand will shoot left, only 59.09% of players writing with their left hand will shoot right and 71.74% of players writing with their right hand will shoot left. Also, these distributions are quite similar in both age groups.

The role of perceptual-cognitive skills in the prevention of injuries in university-level ice hockey

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Athletes participating in ice hockey are at increased risk of injury due to being subjected to a high prevalence of impacts. Preventative strategies, such as perceptual-cognitive skills (PCS), are warranted to protect their health. University-level male ice hockey players (UQTR Patriotes) were recruited for this study. PCS were assessed at pre-season and at mid-season through three-dimensional multiple-object-tracking, using a tool called NeuroTracker. Rate and type of injury were recorded as they occurred throughout the first half of the regular season. The association between PCS (i.e., NeuroTracker scores) and injuries was studied through point-biserial correlations ($p<0{,}05$). Preliminary results suggest no association between the variables of interest. Injuries appeared to be mostly due to collisions. Despite the lack of correlation, there is an established link between PCS and sport performance. Therefore, there is still potential for clinical applications in the prevention of injury through the improvement of PCS with different tools.

A comparison of ice hockey players and musicians on timing tasks: Preliminary analyses

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Timing is crucial in sports and music. Ice hockey in particular is a sport that includes important spatiotemporal cues to be considered, such as the speed and position of the players or the puck on the field. Being better at timing than the general population would mean increasing the chances of a player successfully completing an action, such as intercepting a pass from an opposing player. While it is well-known that musicians outperformed non-musicians in several timing tasks, few studies have been conducted on how highly skilled athletes compare to expert musicians in these tasks. Groups of musicians, skilled hockey players, and participants with no unique musical or sports expertise were compared on a series of three timing tasks that were performed both visually and auditorily: discrimination (350, 700 and 1400 msec intervals), reproduction (400, 900, and 1400 msec intervals), and production (500, 1000, 1500 msec intervals). Overall, the results reveal that, for both the production and the reproduction tasks, musicians had less variability than the hockey players and the participants of the control group. For the discrimination task, in the auditory condition, hockey players have more correct responses than control participants, but musicians are better than hockey players; and for all groups in the auditory modality, discrimination is more difficult at 1400 than at 350 ms.

Exploring the Use of Objective Performance Measures to Mitigate Relative Age Effects in Youth Ice Hockey

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Research shows that a few months' age difference can significantly impact athletes' development and sport success. Relative age effects (RAEs) occur when age grouping policies unintentionally favour athletes born just after an arbitrary cut-off date, creating an uneven playing field. This disadvantages younger athletes within a cohort, hindering fair competition and talent development. Some approaches aim to reduce RAEs by evaluating athletes based on physical characteristics rather than age, though their effectiveness remains untested. Our study analyzes how physical attributes and performance among U13 ice hockey players correlates with relative age, using a standardized battery of on- and off-ice tests to measure indicators of success in the sport (e.g., speed, agility). By examining the relationship between relative age, physical attributes, and performance measures, this research aims to improve talent identification and development in ice hockey and highlight ways to mitigate RAEs in team sports, similar to strategies in individual sports.

Age Effects in Athlete Development:
A Data-Driven Review of a Multi-Dimensional Concept

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Relative age effects (RAEs) have been extensively documented in youth sports, where artificial age cutoffs create advantages for relatively older athletes throughout development. Despite four decades of research, these effects persist in many sports, particularly in ice hockey, where misaligned cutoff dates between developmental systems and professional selection create unique challenges. This study examines how varying age cutoffs influence development trajectories and career outcomes in elite hockey, using novel analytic approaches to explore the "underdog effect" where relatively younger athletes who survive selection barriers may achieve greater success. We analyzed 10,485 unique NHL-drafted players from 1980-2024, examining birth quarter distributions, time to league entry, and career permanence (defined as playing ≥ 5 seasons and ≥ 268 games). Using Cox proportional hazards models and multinomial regression analyses, we investigated how birth quartile influenced player career trajectories while controlling for draft position, nationality, anthropometrics, and playing position. Results revealed that while relatively younger players (Q3/Q4) were significantly underrepresented in the draft (comprising only 35% of selections), those who were drafted demonstrated faster NHL entry times (HR=1.44, 95% CI=1.24-1.68, $p<0.001$ for Q4 vs Q1) and higher likelihood of achieving career permanence. These findings support the "underdog hypothesis," suggesting that relatively younger athletes who overcome systemic disadvantages develop compensatory skills that may enhance long-term performance outcomes. Future athlete development systems should consider implementing strategies such as bio-banding or "future teams" to better support relatively younger athletes, potentially increasing talent retention and development across the entire player pool.

Preparing person-centered ice hockey coaches in Quebec through tertiary education: The story of the Baccalauréat en intervention sportive

(a polyptych consisting of four posters, aligned in a row)

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