

**OBSERVATIONAL ANALYSIS OF INJURY AND HEAD CONTACT EVENTS  
IN YOUTH ICE HOCKEY: PUTTING YOUTH HOCKEY INTO CONTEXT**

by

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## **ABSTRACT**

Concerns about safety in youth hockey have been openly expressed in public and in academic circles. Sports injury literature continue to report that the prevalence of injury in hockey remains high at both the grassroots and elite levels. Much of this injury reporting, however, utilize injury reporting methods that provide very little about how and why these injuries are occurring. The comprehensive prospective observational approach utilized in this thesis proved most effective in understanding not only injury events and head contact events, but how and why they are taking place throughout the course of a hockey game. Knowing the contextual factors surrounding such events are important in building injury prevention strategies and to minimize all types of head contact. As evidenced in this research, the type of head contact being experienced differs according to age level, which means measures to reduce head contact must be targeted at specific age levels. With this said, given the amount of head contact that was documented throughout all levels of hockey, it does warrant further monitoring of the sport to ascertain the extent to which head trauma is impacting player brain development and to strive further in eliminating head contact altogether.

## TABLE OF CONTENTS

<b>LIST OF FIGURES</b> .....	vi
<b>ACKNOWLEDGMENTS</b> .....	vii
<b>CHAPTER I: INTRODUCTION</b> .....	1
<b>CHAPTER II: LITERATURE REVIEW</b> .....	6
Defining Injury .....	7
Reporting Systems.....	10
<i>Retrospective Secondary Reporting</i> .....	11
<i>Prospective Voluntary Reporting</i> .....	15
<b>CHAPTER III: METHODOLOGY</b> .....	19
Sample Group.....	20
Prospective Observational Approach .....	22
<i>Observation grid</i> .....	23
Data Analysis .....	26
<b>CHAPTER IV: Observational Analysis of Injury Events in Youth Ice Hockey in Ontario and Québec (Canada)</b> .....	27
Introduction .....	28
Putting Injury in Context.....	30
Methods.....	31
<i>Field Observations</i> .....	32
<i>Injury Defined</i> .....	33
<i>Data Analyses</i> .....	34
Results .....	34

<i>Injury by Age Category</i> .....	34
<i>Point of Contact by Anatomical Locationl</i> .....	35
<i>Mechenisms of Injuries</i> .....	37
<i>Injury Evnets by Player Position</i> .....	38
<i>Injury Event by Period</i> .....	39
<i>Injury by Ice Location</i> .....	41
Discussion .....	43
Limitations .....	47
Conclusion.....	48
Acknowledgements .....	49
References .....	50
Appendix .....	54
<b>CHAPTER V: Observational Analysis of Head Contact Impacts in Youth Ice Hockey in Ontario and Québec (Canada)</b> .....	55
Introduction .....	55
Background .....	56
Methods.....	59
<i>Field Observations</i> .....	60
<i>Observation Grid</i> .....	61
<i>Data Analyses</i> .....	62
Results .....	63
<i>Head Contact Events by Level of Play</i> .....	63
<i>Point of Contact</i> .....	63

<i>Mechenisms of Head Contact Events</i> .....	65
Discussion .....	67
Limitations .....	74
Conclusion.....	75
Acknowledgements .....	76
References .....	77
Appendix .....	81
<b>CHAPTER VI: CONCLUSION</b> .....	82
<b>REFERENCES</b> .....	90
<b>APPENDICIES</b> .....	102
APPENDIX A: Observation Grid .....	102
APPENDIX B: Informed Consent for Parents (English and French) .....	103
APPENDIX C: Informed Consent for Youths (English and French) .....	111

## LIST OF FIGURES

### CHAPTER IV

Figure 1: Total number of injury events and injury rates by age category .....	35
Figure 2.1: Total number of injury events by point of contact (anatomical location) across all levels .....	36
Figure 2.2: Overall number of injury events by point of contact (anatomical location). .....	36
Figure 3.1: Mechanism of injury events across all levels.....	37
Figure 3.2: Overall number of injury events by mechanism of injury.....	38
Figure 4.1: Total injury events by player position across all levels.....	39
Figure 4.2: Overall number of injury events by player position.....	39
Figure 5.1: Total injury events by period across all levels .....	40
Figure 5.2: Overall number of injury events by period .....	40
Figure 6.1: Map of ice with eight specific regions .....	41
Figure 6.2: Total injury events by specific ice areas across all levels .....	42
Figure 6.3: Overall injury events by specific ice areas.....	42

### CHAPTER V

Figure 1: Head contact events rate across all levels .....	63
Figure 2.1: Total number of head contact events by point of contact across all levels .....	64
Figure 2.2: Overall number of head contact events by pooint of contact .....	65
Figure 3.1: Mechanisms of head conta events by level of play .....	66
Figure 3.2: Overall mechanisms of head contact events.....	66
Figure 4: Map of ice with eight specific regions .....	69

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## **CHAPTER I**

### **INTRODUCTION**

There are many benefits for youth participating in sports. Sports and physical activity have been found to increase physical health, cardiovascular conditioning, strength and endurance, improve self-image, decrease the risk of obesity, and many other beneficial health attributes (Cusimano et al., 2016). However, we cannot ignore the risks involved in participating in sports, especially in contact sports like hockey, which can offset what may otherwise be a positive experience (American Academy of Pediatrics, 2000).

Hockey is among the most popular youth sports in many countries worldwide and has become a popular sport for both men and women. In Canada, hockey is often suggested to be a critical component of Canadian culture, having a profound impact on the values, attitudes, and behaviours of many Canadians (Adams, Mason, & Robidoux, 2015; Bachynski & Goldberg, 2014; Fraser-Thomas, Jeffery-Tosoni, & Baker, 2013). In fact, even though hockey is often considered a dangerous youth sport, Hockey Canada's Annual Report noted a total of 636,539 hockey players (549,614 males and 86,925 females) registered in recreational and competitive hockey leagues in 2015-16 alone and these numbers appear to be rising (Hockey Canada, 2017; Emery, Hagel, Decloe, & Carly, 2010; Darling, Schaubel, Baker, Leddy, Bisson, & Willer, 2011).

The issue of safety in hockey is an ongoing, yet intensifying, source of contention for those involved in the sport, whether as organizers, coaches, participants, parents or fans (Adams, Mason, & Robidoux, 2015). In terms of injury in Canada, sport injury accounts for 66% of all youth injuries (Lacny et al., 2014). Emery et al. (2006) were able

to conclude that hockey was one of the highest risks sports played in high school located in Calgary (Canada) alongside basketball and football amongst male participants. In fact, hockey sits with one of the highest injury rates among youth sports in Canada representing 10% of all youth sport-related injuries (Emery, Kang, Schneider, & Meeuwisse, 2011).

Recent tragic events have brought further attention to the issues surrounding sport-related injuries. In the 2009-10 hockey season, sixteen year old, Ben Fanelli, made headlines across the nation after suffering skull and facial fractures from a body-check in an Ontario Hockey League (OHL) game. The OHL commissioner was cited afterwards, saying: “send out the message to all our players and minor hockey players that we have to be respectful, more respectful, of our opponent” (Branch, 2009). Similar to Fanelli’s case, twenty-year-old, Don Sanderson, died as a result of his head colliding on the ice during a fight in an Ontario Hockey Association (OHA) game in 2009. Mr. Cardwell, president of Sanderson’s team at the time, commented in response to the event:

Any time a tragedy like this happens - and it could have been prevented by a number of rule changes, or the way helmets are made, or the way that they work - that debate needs to happen, because if you lose just one life and you don't learn from it, then we're all making a big mistake. (Cardwell, 2009, par. 4)

Hockey has a level of physical confrontation beyond that of most other sports (Gruneau & Whitson, 1993). The high injury rates are often associated with body checking and a physical style of play, which is routinely described in the media and in public reports as violent and/or aggressive (Cormack & Cosgrave, 2013; Cusimano et al, 2013; Kissick, 2007; McMurtry, 1974). In fact, hockey’s violent and aggressive style of

play has led to it becoming known as a “collision” sport (Marchie & Cusimano, 2003). As a result, there is a very strong correlation between physicality and aggression, prompting Regnier et al. (1989) to state that “when body checking is allowed, a general increase in penalties seem to follow, particularly those of an aggressive or hostile nature, which are more likely to injure the opponent” (p. 97). Cusimano et al’s (2016) most recent article went even further by stating that “injuries are common in all contact sports, but those who play ice hockey are at particular injury risk” (p. 2) These negative associations have been recently exacerbated with the dramatic increase of injuries that have occurred at the elite and the grassroots levels of the sport (Covassin, Swanik, & Sachs, 2003; Emery, Meeuwisse, & McAllister, 2006; Emery et al., 2010; Macpherson, Rothman, & Howard, 2006; Regnier et al., 1989; Yard & Comstock, 2006). King and LeBlanc (2006) observed that youth are at particularly high risk of injury, which some studies suggest is due to the high level of aggression and violent play in these minor leagues (Willer, Kroetsch, Darling, Hutson, & Leddy, 2005). The significance here is that violence and aggression is being depicted as inherent to the sport of hockey, which in turn is associated with the high rate of injury.

After the death of Don Sanderson, as well as the numerous injuries and/or fatalities experienced by hockey players since then, researchers now have the opportunity to better understand the factors resulting in players’ injuries, to study the safety measures enforced by hockey associations/organizations, and to contribute to the discussion surrounding injuries in hockey. The recent public scrutiny of injury in hockey is forcing amateur and professional associations/leagues to reevaluate rules to mitigate the risk of injury. Even the National Hockey League (NHL) has held lengthy General Managers

meetings to address the issue of high velocity body checks that impact the head (Dreger, 2009). Therefore, in order to introduce and implement effective prevention strategies, an understanding of the situational context and injury mechanisms is necessary. By gaining more knowledge on sport-related injuries, researchers in this field will be able to develop and implement effective safety strategies that could improve the environment for these players.

This research was part of a larger study funded by CCM Hockey and the Natural Sciences and Engineering Research Council (NSERC). The study involved two labs: the Neurotrauma Impact Science Laboratory (P.I., Dr. Blaine Hoshizaki) and the Sociocultural Sport Injury Lab (P.I., Dr. Michael Robidoux) of the University of Ottawa. Through an observational research design, researchers working with Dr. Robidoux observed and recorded minor hockey games to document injury and head impact events. Injury events involved players experiencing some form of physical trauma on the ice that may or may not prevent them from resuming play. The recorded events were then given to the Neurotrauma Impact Lab where the impacts were reconstructed to measure force of the head impact situations. The information will be used to help CCM Hockey design protective hockey gear (in particular helmets) that are best suited for the types of impacts players receive during play. The research specific to this thesis, however, had two research objectives: (1) to comprehensively examine the situational factors contributing to injury and head contact events in youth male and female hockey, ranging from the initiation program level to midget level and compare the results between them; and (2) through an observational research design, provide a more nuanced understanding of

“injury” to improve injury reporting and the methods for which injury rates are documented.

## CHAPTER II

### LITERATURE REVIEW

Although injury is now at the forefront of the hockey world, researchers have made great contributions to the knowledge of injury in hockey for the past 40-50 years. The concern around injury in youth sport can be seen in the growing body of literature studying the issue. Researchers from different fields have utilized both quantitative and qualitative methods to document the amount and the types of injuries that occur in youth sport. Quantitative epidemiological studies have increased our understanding of hockey injuries by documenting rates of injuries at all levels (Agel, Dompier, Dick, & Marshal, 2007; Forward et al., 2014; Willer, Kroetsch, Darling, Hutson, & Leddy, 2005). These studies have also documented the frequency of injury, types of injury, and mechanisms of injury. On the other hand, qualitative research into injury has forced researchers to rethink injury, especially as it relates to the normalizing and acceptance of injuries in the modern sports ethic (Charlesworth & Young, 2004; Donnelly, 2004; Howe, 2001; Johns, 2004; Nixon, 2004; Roderick, Waddington, & Parker, 2000; Sabo, 2004; Young, 2004). Qualitative studies have focused more on the environment of the injury, bringing attention to the cultural constructions of injury present in youth hockey (Agel et al., 2007; Emery, Hagel, Decloe, & Carly, 2010; Forward et al., 2014; Hutchison, 2011; Smith, Stuart, Wiese-Bjornstal, & Gunnon, 1997; Stevens, Lasseonde, de Beaumont, & Keenan, 2008; Willer et al., 2005). Documenting the injury experiences has extended the injury literature but has failed to provide qualitative details explaining exactly how the injury occurred. Yet, little attention has been brought to the situational factors surrounding

injury, which is critical if any type of meaningful injury prevention strategies are to be put forward.

The research community has responded to the inherent risks of injury in hockey with a significant increase of effort in the area of injury surveillance. Such research aims to capture, measure, and determine risk factors associated with common injuries in hockey. However, surveillance of sport-related injuries has suffered from methodological inconsistencies surrounding injury definitions and recording methods, combined with a lack of accurate exposure data.

With quantitative injury reporting focusing on the player reporting injury, there is an obvious limitation since enumeration “is influenced by the motivation of the subject to report an injury” (Twellaar, Verstappen, & Huson, 1996, p. 529). In order to move beyond voluntary injury reporting, a move toward qualitative injury reporting designs is necessary where researchers define what an injury is, and from this determine if someone is injured or not based on this definition. Dumas and Laforest (2009) have provided one such model by approaching injury as “any accident that stopped the skaters from practicing, whether requiring first aid or not” (p. 23). Others have also approached injury as something more than simply a visit to a medical institution (Fuller, Ekstrand, Junge, Anderson, Bahr, Dvorak, et al., 2006; Tegner & Lorentzon, 1991). By reviewing the literature it is possible to locate the gaps in injury reporting and to show where improvements still need to be made.

### **Defining Injury**

In the world of sport injury, there is considerable discrepancy about what constitutes an injury. Inconsistency between sports and subjective player responses are

only two variables that significantly affect how an injury is defined and how injury data are recorded and used (Noyes, Lindenfeld, & Marshall, 1988). Although the definition of what constitutes a recordable injury in epidemiological studies remains a contentious issue, two definitions have emerged over time. These definitions are based on: (1) medical treatment, which incorporates injuries requiring any treatment by a team physician, whether or not they result in loss-of-time from competition or training; and (2) loss-of-time, which incorporates injuries that result in loss-of-time from competition and/or training (Brooks & Fuller, 2006). These two definitions of injury illustrate how a simple definition can influence the impact rates of injury being reported.

Historically, defining an injury by the amount of time lost from participation has been the most common and easiest definition to use (Noyes, Lindenfeld & Marshall, 1988). An injury is usually defined as the inability of an athlete to return to the field of play on either the same day or the day following an injury (Noyes, Lindenfeld & Marshall, 1988). However, using time-lost from play appears to be more sport-specific, which cannot be readily compared across sports. This definition also assumes that all players respond to an injury in a similar manner. Further, there is no scientific way to assess when an injury should impair a player's athletic performance. The same injury in two different athletes may cause one player to stop participating, while the other will experience no impairment in performance. Adding to the complexity, sports like hockey are known to be informed by hyper-masculine values where players are taught to be tough and play through pain/injury. Playing through pain becomes a means for players to express that the endurance of pain enhances one's character and moral worth. "Pain is regarded as more important than pleasure and sacrifice is assumed to be required in order

to establish self-worth, social acceptance and status gain” (Sabo, 2004, p.64). Donnelly (2004) argues that “having one’s own identity accepted (confirmed) by a peer group (comradeship) may involve taking physical risks in order to avoid a social/reputational risk – a risk that may be perceived to have even more severe consequences at this time of one’s life” (p. 45). So not only do peers reaffirm competence and confirm one’s identity, they also create a culture of risk where putting one’s body at physical risk is less dangerous than putting oneself in a socially stigmatized position by not taking the physical risk. Consequently, social acceptance becomes the most valued ideal of young athletes, and one’s body is used as an instrument in order to achieve such acceptance. To consolidate acceptance and camaraderie further, Charlesworth and Young (2004) describe playing through injuries: “when asked what motivated them [athletes] to play while injured and in pain, the reason most frequently cited by athletes was not wanting to ‘let down’ fellow teammates” (p. 166). These are only a few examples of why players might play through pain, and which illustrate how injury non-disclosure might affect time-lost injury reporting.

The other form of sport injury reporting is that which describes an injury as any playing situation that leads to a participant receiving medical attention. Medical attention is defined as any treatment given by a physician or trainer, whether or not the situation leads to the participants missing or not missing time from competition or training (Noyes, Lindenfeld & Marshall, 1988). A definition of sports injury based on medical criteria will be biased towards a large proportion of serious, mostly acute injuries and there will be fewer less severe or overuse injuries represented. Exclusionary criteria would exclude lumps, bumps, bruises, scratches, and abrasions, which easily overwhelm any data

collection system, and may have little long-term sequelae for the athlete (Noyes, Lindenfeld & Marshall, 1988). The problem with such a definition is that it cannot be used for many minor sport teams because training personnel are not present (Noyes, Lindenfeld & Marshall, 1988; Brooks & Fuller, 2006). Further, the more inclusive the injury definition (e.g., lumps, bumps, bruises), the larger the numerator (or number of injuries) since it includes more cases counted in the injury total. Exclusion factors (e.g., excluding minor injuries) therefore artificially decrease the numerator (i.e., the injury rate). This means that the definition of injury is a set of inconsistent inclusionary (and exclusionary) criteria, which further complicates the separation of those who are “injured” from those who are not (Noyes, Lindenfeld & Marshall, 1988; Brooks & Fuller, 2006).

### **Reporting Systems**

In order to better understand the situation faced in injury prevention research, it is important to also consider the various ways in which injury is typically reported. Two types of reporting practices have been used over the years: (1) retrospective secondary reporting; and (2) prospective voluntary reporting. In the case of retrospective reporting, it uses the largest statistical data pool, such as emergency departments and insurance claims, in order to get injury information. However, in prospective reporting studies, researchers study selected team(s) and record injuries over the course of the season. Retrospective reporting works with massive data sets, but does not have access to firsthand information, whereas prospective reporting works with smaller data sets, but provides more detailed information about specific injuries.

### *Retrospective Secondary Reporting*

As mentioned earlier, retrospective secondary reporting focuses on injuries that have been documented by emergency departments or insurance claims. Such injury information relies on self-reported injuries (e.g., whether the player goes to the hospital, and/or is recommended to visit the emergency department from either a coach, team trainer or parent as a result of injury). Additionally, retrospective designs can be done through surveying players at the end of a season in order to document how many injuries they recalled over the course of their season (Emery et al., 2006). One of the strengths of using such large injury databases is that they provide researchers with a vast array of injury events that can reveal general trends about the types and mechanisms of sport injury.

Every year numerous children are injured severely enough while playing hockey to attend an emergency department. For example, Yard and Comstock's (2006) seminal review of hockey injuries in the United States collected all injuries reported to the United States emergency departments from 1990 to 2003. From this study, a total of 172,128 estimated injuries occurred while playing hockey. The vast scope of this dataset does have its limitations, however, as only 6.8% (11,869 injuries) had an associated anatomical location and physician diagnosis associated with injury. Further, only 1.2% of all estimated injuries (1,841) contained enough information to determine the mechanisms of injury. Thus, the frequency of injury is well documented (i.e., in terms of how they define an injury); however, the details surrounding the injury appear to be virtually non-existent.

In Canada, McFaul (2001) reviewed the Canadian Hospitals Injury Reporting Prevention Program (CHIRPP) during the 1998/1999 seasons, which was later analyzed by Macpherson, Rothman, and Howard (2006) over a seven-year span (i.e., between 1995 and 2002). Macpherson et al. (2006) were able to identify that hospitals outside the province of Quebec where body-checking is not allowed until bantam accumulated information showing that body-checking hockey at the pee-wee level had significantly more injuries than non body-checking hockey. The principal strength of CHIRPP is the fact that it covers a vast population by having hospitals participate from across the country, generating a massive dataset (Mackenzie & Pless, 1999). There are limitations, however, in particular about the situational factors around injury. The details for each injury event were not consistent, as it depends on the type of questions asked during triage. Secondly, there is an under-representation of seriously injured patients, because they bypass the usual registration procedures. Third, those patients who refuse to complete the forms may also be missed (Mackenzie & Pless, 1999). However, the major problem with CHIRPP is that they do not provide rates. They cannot determine the context of injury and the total number of participants. Therefore, similar to the Yard and Comstock (2006) study, the research from CHIRPP could only provide information about injury frequency, without providing contextual details that might help reduce injury.

Retrospective secondary injury reporting has come under scrutiny in recent years because not all injuries get reported to hospitals (Mackenzie & Pless, 1999). In fact, Williamson and Goodman (2005) concluded that, “studies based solely on administrative records (such as official injury reports or hospital records) or reports from team staff (such as athletic therapists, physicians, and volunteers) may not account for all

concussions” (p. 131). King and Leblanc (2006) also stated that the reporting of injuries in hockey “is likely the tip of the iceberg, since many injuries, particularly concussions, which may have long-term consequences on the developing brain, are underreported” (p. 163). Lastly, Juhn, et al. (2002) found that “it is likely that players under-report concussions, as most concussions do not involve loss of consciousness, and players are concerned that they will be removed from practice or games” (p. 47). Considering these authors’ results, it is clear that hockey players face different types of pressure to not report injury in comparison to non-contact sports, especially if it means jeopardizing their position on the team (Young, White & McTeer, 1994).

Emergency departments are not the only databases that are mined for injury data. Molsa, Kujala, Myllynen, Torstilla and Airakinen (2003) assessed injury rates at all levels of Finish hockey through insurance data claims. Likewise, Montelpare and McPherson (2004) used injury insurance claim databases to assess minor hockey injuries through the Canadian Hockey Association (CHA, what is now Hockey Canada). These claims, however, have limited information as Montelpare and McPherson could not identify 54% of musculoskeletal locations of injuries, and classified the undetermined bodily locations as “other”. Without actually observing the injuries, they were unable to accurately assess injury, which demonstrates the limitations of using this type of reporting system,

The Hockey Canada Injury Insurance Program is designed to supplement personal insurance as Hockey Canada (2010) states: “If you have access to any other insurance you must pursue it through them first. Hockey Canada shall cover those costs not covered by your primary insurance to our policy limits”. With Canada having a publically funded

healthcare system, most standard medical costs are covered under provincial insurance. Further, a large portion of the Hockey Canada insurance injury report is reserved for dental claims, but all minor hockey players wear full facial protection, which virtually eliminates dental injuries (i.e., dental insurance claims are very rare because of their equipment). Thus, it is clear that using the database to understand injury is problematic (i.e., it is not a record of injury, but rather of claims filed for specific injuries). Therefore, these large datasets can be compiled through retrospective secondary reporting, but there are gross limitations in the type of information they produce.

The last method of retrospective reporting is through surveying. One example of this is Emery, Meeuwisse, and McAllister's study (2006), which involved surveying 2,873 adolescents from 24 Calgary (Canada) high schools in order to compare injury rates in different sports. From this large sample, Emery et al. (2006) were able to conclude that hockey was one of the highest risk sports played in high school (alongside men's basketball and football). In such a study, it is important to assess how injury in hockey compares to other sports in order to see differences in injury rates and severity of injury. However, Emery et al. (2006) also acknowledged that the precision of the information presented might be subject to bias due to the nature of the self-report survey technique. Thus, self-reporting injury is convenient for researchers, but it generally leads to underreporting (Mackenzie & Pless, 1999).

While epidemiological reports are important by showing vast injury trends over large populations and large geographic areas, studies have shown that the underreporting of injuries affect the estimation of injuries (Mackenzie & Pless, 1999; Molsa, Kujala, Myllynen, Torstilla & Airakinen, 2003; Montelpare & Macpherson, 2004; Juhn et al.,

2002; King & Leblanc, 2006; Williamson & Goodman, 2005; Young, White & Mcteer, 1994). This underreporting can be due to the fact that for an injury to be recorded it requires a trip to the hospital or for someone to fill out an insurance claim. Those who either do not go to the hospital, do not fill out an insurance claim, or simply do not disclose their injury, are absent from these databases. Moreover, most studies provide only details on injury frequency, and very little on situational factors contributing to injury, which makes it difficult to recall how the injury occurs. Information like the types of injury, anatomical location, mechanism of injury, area of the ice where the injury occurred, time of game, and also the position of the player, are all important details that are missing. Thus, more information will be useful in order to find ways to diminish injuries in youth hockey (Agel, Dompier, Dick & Marshal, 2007; Smith, Stuart, Wiese-Bjornstal & Gunnon, 1997; Stevens, Lassonde, de Beaumont & Keenan, 2008; Willer, Kroetsh, Darling, Hutson & Leddy, 2005).

#### *Prospective Voluntary Reporting*

The second type of injury research is prospective voluntary reporting, which has researchers working in affiliation with teams or associations, who in turn, report injuries directly to researchers (Darling, Schaubel, Baker, Leddy, Bisson, & Willer, 2011; Emery, Hagel, Decloe, & Carly, 2010; Smith, Stuart, Wiese-Bjornstal and Gunnon, 1997).

Collecting injury information throughout the year allows for more detailed reporting. Also, since researchers are part of the reporting process, coaches, parents, and players are more likely to report an injury when researchers are closely monitoring their season of play. A well-designed prospective reporting system can also locate important information relating to mechanisms, musculoskeletal locations, and characteristics of

injury. Further, in the few qualitative studies done on injury in youth hockey, researchers have highlighted many potential factors contributing to the issue of injury, such as fatigue, players' positions, injury ice area locations, and raised aggression levels (Agel et al., 2007; Emery et al., 2010; Forward et al., 2014; Smith et al., 1997; Hutchison, 2011; Stevens et al., 2008; Willer et al., 2005).

Recently, Emery, Hagel, Decloe, & Carly (2010) studied 2,154 Peewee (11-12 years old) hockey players in Calgary (Canada) where body-checking is permitted. They also had people report to them from the province of Quebec (Canada), where body-checking is not introduced until Bantam (13-14 years old), to determine if there were differences in injury rates between these two groups. It was the responsibility of the partnering hockey teams' trainers to document and submit the injury reports to the research team, which Emery et al. (2010) acknowledged as one of their limitations. Since injury information was reported once a week, and researchers did not actually attend games, it was possible that minor injuries may have been underestimated and detailed injury information was not acquired. Again, relying on a non-member of the research team in order to collect all information may not provide all the required and desired information.

Similarly, Darling, Schaubel, Baker, Leddy, Bisson, & Willer (2011) conducted a 5-year prospective study on youth hockey. Interestingly, there are disparities between these two studies: Emery et al. (2010) reported that body-checking is the leading cause of injury (intentional contact), whereas Darling et al. (2011) reported that 66% of all injuries resulted from unintentional contact (which included contact with boards and/or ice). It is difficult to scrutinize such a discrepancy since injuries were reported from team officials

and only later validated second-hand by physicians or researchers; however, neither of these studies involved firsthand observation and provided little in the way of description about the injuries themselves. For example, they failed to provide critical information pertaining to the type of contact (i.e., fall to the ice, collision, collision against boards, collision then fall to the ice, hit by puck, hit by stick, etc.). Moreover, there is information lacking in regard to the location on the ice where injuries are occurring, or if injuries are happening on legal/illegal plays. Such information is difficult to assess without direct observation and comprehensive recording of on-ice activity.

With a much smaller sample size, Smith, Stuart, Wiese-Bjornstal and Gunnon (1997) had three varsity and three junior varsity high school teams participate in their study on injury. This study was categorized as prospective voluntary, as they followed the teams for one season and recorded injuries that were voluntarily reported by players to team physicians. There were three important outcomes from the study: classifications of musculoskeletal locations of injury (e.g., head, knee, wrist, etc.); characteristics of injury (e.g., concussion, contusion, laceration etc.); and mechanisms of injury. However, the authors went even further and made recommendations about equipment changes, rule enforcement, and the need for more training about delivering and receiving body-checks. They also suggested the Fair Play program—a program introduced to deter violence and aggression that rewards teams and individual players with few penalties and punishes teams and players with a larger numbers of penalties —would be a good place to start interventions to reduce injury in hockey. While there might be some merit to these suggested interventions, it is difficult to determine how such assessments could have been made without the researchers actually observing the style of play, and witnessing

what actually transpires over a course of a hockey game. To offer recommendations that might reduce the risk of injury, it is necessary to comprehensively examine contextual factors (e.g., aggression, violence, legal/illegal plays, and delivering/receiving body-checks) surrounding injury.

### **CHAPTER III**

#### **METHODOLOGY**

Based on the limitations identified in previous injury reporting research, this study documented on ice behaviour and factors contributing to 'injury'. Unlike previous research, it did not document 'injury', but rather injury events. In this case an injury event was defined as an observable situation where a player experienced some form of physical distress that leads to a player leaving the game as a result of physical trauma (as mild or serious as it might be). This research also documented all head contact events occurring during the course of a hockey game. A head contact event was described as any clear contact to a player's head by way of person to person contact, head to boards, head to ice, stick to head, puck to head, or any combination of factors. The main objective of the research was to comprehensively examine the situational factors contributing to injurious play in youth male and female hockey, ranging from the initiation program level to midget level. The situational factors that were looked at during the course of the study were: position of the player (e.g., forward, defensemen, goalie), period of play (e.g., first, second, third, overtime), body location hurt (e.g., lower body, upper body, head/neck), mechanism of injury (e.g., collision, collision against boards, collision followed by a fall to the ice, fall to the ice, hit by a puck, hit by a stick), zone where the event occurred (e.g., offensive, neutral, defensive), and specific area of the event (e.g., along the boards, open ice).

In order to attempt to comprehensively document injury events, this study used a observational research design involving both a quantitative and qualitative modes of analysis. In game observations was be the primary data collection method and involved

watching live hockey games, as well as video recording them, in order to document injury events as they occur in game situations. In addition to video recording games, extensive field notes were taken at each game describing in details the situational factors for each injury event. The field notes and video recordings were shared with the Neurotrama Impact Science Laboratory, where injury events were reconstructed to determine the forces involved in the event and the impact these forces have on the brain. The data generated from the lab analysis is not presented in this thesis, but will inform collaborative research articles to be written over the course of this research.

### **Sample Group**

To meet the objectives of this study, a combination of purposive, convenient, and snowballing sampling was employed. As defined by Tongco (2007), purposive sampling is performed when researchers recruit the population that match some specific description. These particular characteristics are established so that the recruited participants are representative of a wider population or society (Tongco, 2007). Convenient sampling, on the other hand, is a sampling technique that enables researchers to easily recruit participants due to the fact that they are readily available and willing to participate (Tongco, 2007). These participants also permit researchers to develop generalisations that can be related from their study's participants to the whole population (Tongco, 2007). Finally, snowball sampling was utilized based on networking that occurred when recruiting the first few teams.

For the purpose of this study, the sample groups needed to be composed of body checking and non-body checking players in both male and female competitive leagues, ranging from the initiation program level to the midget level. Since this research was

taking place in the Ottawa and Gatineau regions, it was possible to cover numerous games. Ideally, we anticipated recruiting two teams from each level [i.e., initiation program (5-6 years old), novice (7-8 years old), atom (9-10 years old), pee-wee (11-12 years old), bantam (13-14 years old), and midget (15-17 years old)], and from both male and female leagues. Considering what was involved in getting to each game, and the time required to document them, it was decided that a minimum of 15 games (home and away) for each team would be sufficient. This will provide around 240 games total over the course of the two year study, if there are two teams from each level and for both male and female leagues (two mixed initiation program teams, two mixed novice teams, two mixed atom teams, two male pee-wee teams, two female pee-wee teams, two male bantam teams, two female bantam teams, two male midget teams, and two female midget teams for a total of 18 teams). However, we were unable to recruit teams for the female bantam and female midget level leaving us with a total of 14 teams. As body checking is only allowed starting at the bantam level, this would mean that the study would have ten teams playing non-body checking (two mixed initiation program teams, two mixed novice teams, two mixed atom teams, two male pee-wee teams, and two female pee-wee teams), and four teams playing body checking (two male bantam teams, and two male midget teams). In addition to providing an important comparative dimension to the study, there are important questions currently being raised by hockey practitioners and academics about when body checking should be introduced in minor hockey. This study thus provided comparative injury data between identical age groups and skill levels in body checking and non-body checking leagues.

### **Prospective Observational Approach**

Most hockey injury inquiries, like other youth sport injury studies, have focused primarily on medical based reports where other less visible injuries like “bruises, scratches, cuts” are overlooked (Dumas & Laforest, 2009, p. 24). Observations in natural settings are useful to analyze injury, and can make a great contribution to the quantitative enumeration of injury (Stuart et al., 1995). Dumas and Laforest (2009) observed injuries in skateparks where only 1% of injuries received medical attention. In the context of hockey, where it is well known that players are often encouraged to play through pain and injury, direct observations are important to document what might not be recorded as an official injury through more traditional enumerating approaches (Boyer, 2011; Hutchison, 2011; Stuart et al., 1995). Further, and more directly related to hockey, Williamson and Goodman (2006) achieved success in their study of injury in youth hockey by combining official injury reporting sheets and retrospective player surveys with direct observations of on ice play. The authors claimed that the observation component was necessary, as it allowed them to characterize concussions through observing rapid acceleration and deceleration of the head, which lead to trauma and injury (Williamson & Goodman, 2006). Without the observation component to complement the medical assessment of a concussion, it would be difficult if not impossible to determine how injuries occur.

In observational studies, the ability of just one researcher to collect all data in all places is virtually impossible, thus a team approach to data collection is necessary (Laforest & Dumas, 2003). In order to conduct the research for this study, a team of trained volunteers was assembled to attend games and document on ice play. The team of

volunteers was made up of undergraduate students from the University of Ottawa's School of Human Kinetics. A total of 30 volunteers agreed to assist with data collection. To effectively manage the data collection, three volunteers were assigned to each game (i.e., one volunteer to record, and two volunteers to fill in the observation grid [described below]). Before starting collecting data, the volunteers needed to attend a seminar held by the supervisors of the study in order to know what was exactly that the research was looking to collect. The new volunteers then attended their first game accompanied by one of the supervisors so they could see how the data collection was actually done. In order, to reduce subjectivity volunteers needed to cover different teams and levels. That way the recruited teams were observed by many trained volunteers. The research team also videotaped all games to assist in post-game analysis. Digital video records of sport events contain a rich source of valuable but frequently untapped information, and are therefore a promising resource for the analysis of the antecedent events. The widespread availability of video replay technology allows the viewer an opportunity to look back in time objectively. The retrieval of video evidence enabled a frame-by-frame analysis of all on ice play to better understand why and how injuries occurred. Most importantly, reviewing video allowed us to understand exactly what led to injury. The video was then analyzed to better understand why and how injury events occur. Parkkarri, Kujala, and Kannus (2001) explain that "careful video analysis of the mechanisms of sports injuries would likely reveal new ways to decrease the number of injuries" (p. 993).

***Observation grid.*** To systematically observe the multifaceted events that transpire over the course of a hockey game, this study implemented an observation grid to document all observed injury events. The observation grid has been informed by previous

observational studies (Boyer, 2011; Hutchison, 2011; Stuart et al., 1995). Sociologists have noted that injury and the personal emotional ramifications of injury in youth sport have been, and still are, almost completely ignored (Young, 2004). Thus through the proposed classification of injury, injury could be documented whether the player reported it or not. An injury, according to Canadian Intercollegiate Sports Injury Registry (CISIR), is “any injury resulting in one or more complete or partial sessions of time loss” (Meeuwisse et al., 2003, p. 380). Such a notion of time loss due to injury has been a successful method for researchers to use in order to diagnose the severity of injuries in other sport injury studies (Messina, Farney, & DeLee, 1999; Schick & Meeuwisse, 2003). Thus, a time lost component was incorporated into the observation grid. The study used a similar, but simplified, approach to the one designed and used by Laforest and Dumas (2003) for their study on skateboarding. In this case an injury event was defined as an observable situation where a player experienced some form of physical distress that led to a player leaving the game as a result of physical trauma (as mild or serious as it might be). It only used two stages of severity: (1) kept playing, or (2) left the game. If the player kept playing, this event was discarded from the list of “injury” and was counted as “potential injury”, and if the player left the game it was then counted as an “injury”. In order to confirm to the best of our ability, this study followed three stages of verification. The first step was to have different volunteers attend games and observe it while recording it for further observation. The second step involved one of the volunteers who did not attend the game to go through the video and fill in the observation grid to see if any events were missed. Only the events matching both the live observation and the video analysis were kept for further analysis. Lastly, the video was also viewed by a

member of the Neurotrauma Lab in order for them to collect all head impact events for their own research but also to compare with our results.

To categorize situational factors leading to injury events, the study also drew from previous epidemiological studies, which identified the following mechanisms of injury: contact with another player/collision (Agel et al., 2007; Marchie & Cusimano, 2003); contact with stick or puck (Agel et al., 2007; Stuart et al., 1995); contact with ice/fall on ice (Smith et al., 1997); and contact with boards (Boden & Jarvis, 2009; Juhn et al., 2002). These mechanisms were the same across all three body locations in our observation grid which were: lower body, upper body, and head/neck. Other important information will be recorded, such as fatigue, which was then recorded by the period (e.g., first, second, third, or overtime) and the time of the period the injury event has occurred (Hutchison, 2011; Smith et al., 1997; Steven et al., 2008).

Similar to Hutchison's (2011) study, it also looked at the player's position and the zone in which the injury event has occurred (i.e., defensive zone, neutral zone, or offensive zone). Like Hutchison (2011), we also looked more precisely at the events occurring either in the perimeter (i.e., side boards, corners, end boards, and the side of the net) or the open ice. Side boards referred to the boards and glass and three feet of the ice surface from the boards towards the middle of the rink, spanning all three zones. The corners referred to the rounded portion of the boards and glass connecting the side boards and end boards, including three feet toward the middle of the rink. The open ice was the interior portion of the ice not accounted for in the operational terms described in perimeter. From Hutchison's results, it is evident that the position of the player is an important, and necessary, factor to consider when studying injury events in hockey.

Moreover, by gathering this information, we were able to categorize the injury events experienced, to systematically determine primary causes of injury events, and to discover any injury event trends that might be evident in these levels of hockey.

### **Data Analysis**

Like mentioned earlier this study used an observational research design which included both quantitative and qualitative data analysis. The injury rate was calculated using two of the most frequent denominators. It was then divided by a thousand athletic exposures. In this case athletic exposure was counted as any time a player was dressed up for the game and his/her name was on the line-up. The rest of the data collected was transmitted via descriptive analysis. Descriptive statistics were employed in order to compare situational factors across all levels, gender, skill and rule differences (i.e., body-checking versus non-body checking). Qualitative analysis consisted of providing descriptive details around each injury event and head contact event. Rates of injury/head contact events are important to document, but the additional qualitative description, outlining how and why injury/head contact events are occurring, is critical for determining possible steps forward to prevent these events from happening.

**CHAPTER IV**  
**INJURY EVENTS IN YOUTH HOCKEY**

**Observational Analysis of Injury Events Across Minor Ice Hockey in Ontario and  
Québec (Canada)**

Submitted and accepted to the *World Hockey Forum Volume 2*

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Keywords: Hockey; injury; youth; bodychecking; injury reporting

## INTRODUCTION

Physical activity can have tremendous benefits, however, there are risks involved in participating in sports, especially in contact sports like ice-hockey<sup>1</sup> (Cusimano et al., 2016; American Academy of Pediatrics, 2000). Despite advances in equipment technology and player protection, injuries in hockey continue to be a growing concern for players, parents and league officials (Hutchison, 2011). Specific to Canada, sport injury accounts for 66% of all youth injuries (Lacny et al., 2014). Canadian data suggest that hockey injuries account for up to 10% of the injuries suffered by adolescents (Emery, Meeuwisse, McAllister, 2006), and that injury rates in hockey have increased each year since the 1970s (Molsa, Kujala, Nasman, Lehtipuu, & Airakinen, 2000). Cusimano et al (2016) support this stating: “injuries are common in all contact sports, but those who play ice hockey are at particular injury risk” (p.1). These high injury rates are often associated with body checking and a physical style of play, which is routinely described in the media and in public reports as violent and/or aggressive (Cormack & Cosgrave, 2013; Cusimano et al, 2013).

These characterizations of the sport as violent, aggressive and unsafe have triggered public outcry about Canada’s national winter pastime. *The Toronto Star* went as far as saying that “the future looks bleak for Canadian minor hockey” (Therrien, 2012). In another report by CBC, hockey legend Wayne Gretzky was asked to respond to the apparent hockey crisis, to which he replied: “What do you say to parents today who would love their kids to be playing hockey, girls and boys, but they say two things, they

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<sup>1</sup> To be referred to as hockey from this point forward.

say: it's just too expensive...and it's too rough. And I don't mind them playing in leagues where there's no hitting, but I'm not going to let them go through the potential of serious injury, concussion, what have you" (The National). Interestingly, what none of these reports or studies acknowledge is that according to Hockey Canada's data, hockey registration in Canada has not been declining, but in fact increasing over the past decade (Hockey Canada, 2017). Hockey Canada's Annual Report noted a total of 636,539 hockey players (549,614 males and 86,925 females) registered in recreational and competitive hockey leagues in 2015-16 alone (Hockey Canada, 2017). What is perhaps even more disconcerting is the tacit acceptance that hockey in general is a violent and aggressive sport that is unsafe for participants to play. Hockey is played by boys and girls across all ages and all skill levels, and to associate all hockey with the more aggressive NHL version of the sport misrepresents the diverse ways the sport is experienced by the vast majority of participants. Without wishing to dismiss concerns about player safety, the characterization of hockey as a violent and unsafe sport is not consistent with the two years of observational research our group conducted across all levels of minor hockey in Ontario (Canada) and Quebec (Canada). In this paper we present the results of two years of observational research conducted documenting the frequency, type, and situational factors surrounding injury events in youth hockey across age, gender, skill and rule difference (i.e., body-checking versus non-body checking). The results from this study indicate that injuries are experienced differently across age, gender and skill level, and that rarely was play ever violent or aggressive.

## **PUTTING INJURY IN CONTEXT**

There is inconsistency in sport injury reporting primarily due to the lack of consensus around how injury is defined and how injuries are reported (Noyes, Lindenfeld, & Marshall, 1988). There are two competing definitions, one based on medical treatment, the other, on time lost. A definition based on medical treatment involves players receiving some form of medical treatment (typically a doctor), but does not necessarily miss time as a result of the incident. Time lost definitions, on the other hand, incorporate injuries that result in loss of time from competition and/or training, but do not necessarily require any medical treatment (Brooks & Fuller, 2006). The difference in injury definition impacts the rate of injury being reported, but so too does the method by which injuries are actually documented. There are generally two types of injury reporting practices: (1) retrospective secondary reporting; and (2) prospective voluntary reporting. Retrospective injury reporting relies on secondary data collected from a variety of databanks, such as those established by hospital emergency departments and insurance companies. In contrast, prospective reporting is a primary data collection method, which involves monitoring the injuries participants experience over a period of time.

Retrospective injury reporting is useful because it provides information about large populations over large geographic areas. The injuries being reported, however, need to be quite serious in order for them to receive medical/hospital treatment, or to have an insurance claim filed for them. As a result, it is believed that injury frequency is typically underreported in retrospective studies, capturing only the more serious types of injury. Moreover, relying on secondary injury reports reduces reliability and is limited in terms of information about how and why the injury occurred. On the other hand, prospective

reporting provides more detailed information about how injuries are occurring, but generally work from smaller sample sizes, and the results are more difficult to generalize. Despite these limitations, there have been important retrospective and prospective studies conducted on hockey, primarily focusing on injury frequency (Agel, Dompier, Dick, & Marshal, 2007; Forward et al., 2014; Willer, Kroetsch, Darling, Hutson, & Leddy, 2005).

While there have been many studies reporting on rates of injury in hockey, very little attention has been paid to the situational factors surrounding injury, which is critical if any type of meaningful injury prevention strategies are to be put forward. In addition, most retrospective and prospective injury studies rely on voluntary injury reporting, which is an obvious limitation since enumeration “is influenced by the motivation of the subject to report an injury” (Twellaar, Verstappen, & Huson, 1996, p. 529). To begin addressing these limitations, the research conducted in this study incorporated a prospective research design that moves beyond voluntary or involuntary injury reporting, and through in game observations documents injury event situations where players receive any form of physical distress.

## **METHODS**

The purpose of this study was to compare the types and mechanisms of injury events across age and skill level for male and female hockey players in the Ottawa (Ontario) and Gatineau (Quebec) regions of Canada. This paper focuses on data collected from games during the 2016-17 and 2017-18 seasons. A total of 204 games (6122 athletic exposures) were observed across all levels of play: 20 initiation program (5-6 years old) games (557 athletic exposures); 20 novice (7-8 years old) games (511 athletic exposures); 29 atom (9-10 years old) games (863 athletic exposures); 43 pee-

wee girls (11-12 years old) games (1290 athletic exposures); 42 pee-wee boys (11-12 years old) games (1288 athletic exposures); 31 bantam boys (13-14 years old) games (996 athletic exposures); and 19 midget boys (15-17 years old) games (617 athletic exposures). Only teams playing at competitive levels were recruited for this study. Teams were recruited via a combination of convenience (geographic location) sampling, and snowball sampling. All teams that were approached consented to participate in the study. The parameters of the study were approved by the University of Ottawa's Research Ethics Board.

In order to attempt to comprehensively document injury events, an observational research method was employed. Observations involved watching hockey games in person, as well as video recording them in order to review injury events that might have been missed live. In addition to video recording games, extensive field notes were taken at each game describing in detail the situational factors for each injury event and further descriptive analysis of injury that might be of interest.

### **Field Observations**

It is virtually impossible for one person to observe all play at all times, thus a team approach to data collection was conducted, similar to what was done in Dumas and Laforest (2009). In order to conduct the research, a team of trained volunteers was assembled to attend games and document on ice play. The team of volunteers was made up of undergraduate students from the University of Ottawa's School of Human Kinetics. A team composed of three researchers attended each game in both years to provide detailed notes pertaining to all aspects of injury, fill out observation grids to properly categorize injury, and video record game-play. The cameras were stationed in the middle

of the ice at the top of the stands to most effectively capture the zone of the ice where the play was occurring. The cameras were located on tripods to facilitate the movement of the camera and stabilize the filming. Video footage was then downloaded into *VLC Media Player Software*<sup>®</sup> where all injuries were subjected to frame-by-frame analysis. By reviewing the video with multiple observers, bias from initial injury reports were reduced and researchers could ensure that all incidences of injury were documented. Data collection ended at the conclusion of the second hockey season.

### **Injury Defined**

This study took a novel approach to reporting ‘injury.’ Working from a time-loss injury definitional framework, an injury event was defined as any observable situation where a player experienced some form of physical distress that led to him/her leaving the ice and not returning. Most time loss definitions require a player to leave the game and not return for the next athletic event. Without having access to opponent team players, it was impossible to confirm if players missed the following athletic event. Moreover, the inconsistency in team schedules meant some players had more days off in between games/practices than others, which adds another layer of inconsistency in injury reporting. For example, one team might play the next day, whereas another team may have up to seven days before their next practice/game, which distorts the amount of ‘time lost.’ Therefore, while the injury threshold in this study is low, it provides a more consistent definition that is equally applied to all participants. One final caveat is that even if a player did not leave the game as a result of physical trauma, the event was still documented providing details about how the trauma was experienced and what factors

led to the trauma occurring. It is important to note, however, that final injury rates reported here only take into account those situations where players did not return to play.

### **Data Analyses**

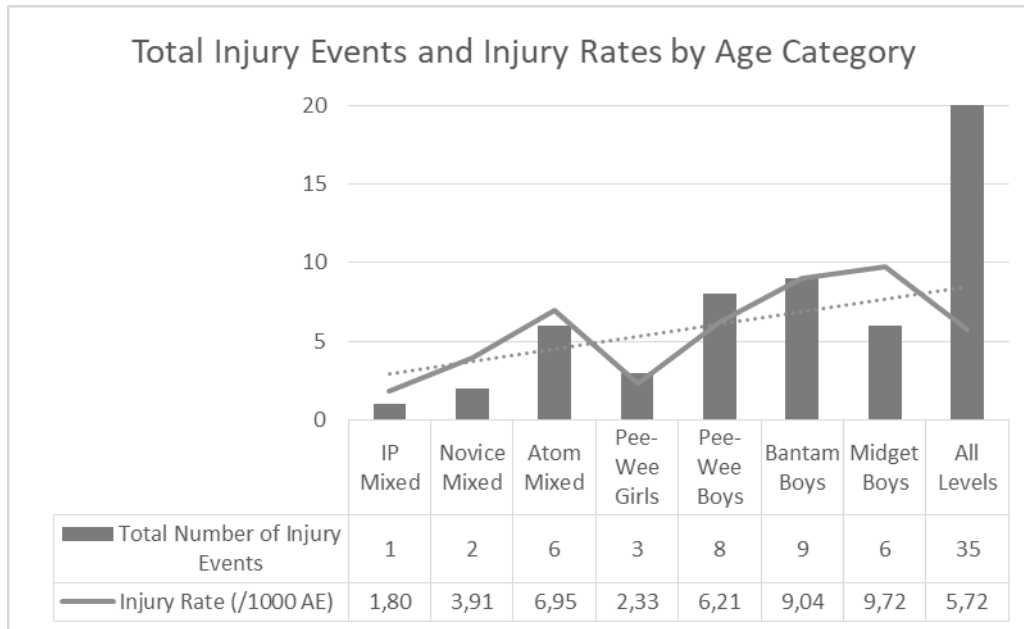
The rate of injury was compared by way of Athletic Exposures (AE). Borrowing from Dick, Agel and Marshall (2007), athletic exposure is defined as a player participating in one practice or competition where they are exposed to the “possibility of athletic injury regardless of the time associated with that participation” (p. 174). The number of injuries for each team of the same level was added together and then divided by the number of AE for that particular level, which is consistent with previous studies (Agel, Dompier, Dick & Marshal, 2007; Powell & Barber-Foss, 1999; Turbeville, Cowan, Owen, Asal & Anderson, 2003). Each individual injury was considered to be an independent event, and non-hockey related injuries were excluded from the analysis. Following descriptive analyses, comparisons of rates and characteristics between levels were performed using descriptive statistics. All statistical analyses were performed using *Microsoft Excel 2016 Software*<sup>®</sup>.

## **RESULTS**

### **Injury by Age Category**

The level of play had significant effect on the number of injury events (IE) that occurred over the two year period. A linear progression was observed from the initiation program level up to the highest level of midget, with initiation program at 1.80 IE/1000AE and midget at 9.72 IE/1000AE (Figure 1.1). The only exception was at the girls pee-wee level where the injury rate dropped back to 2.33 IE/1000AE. In general, as

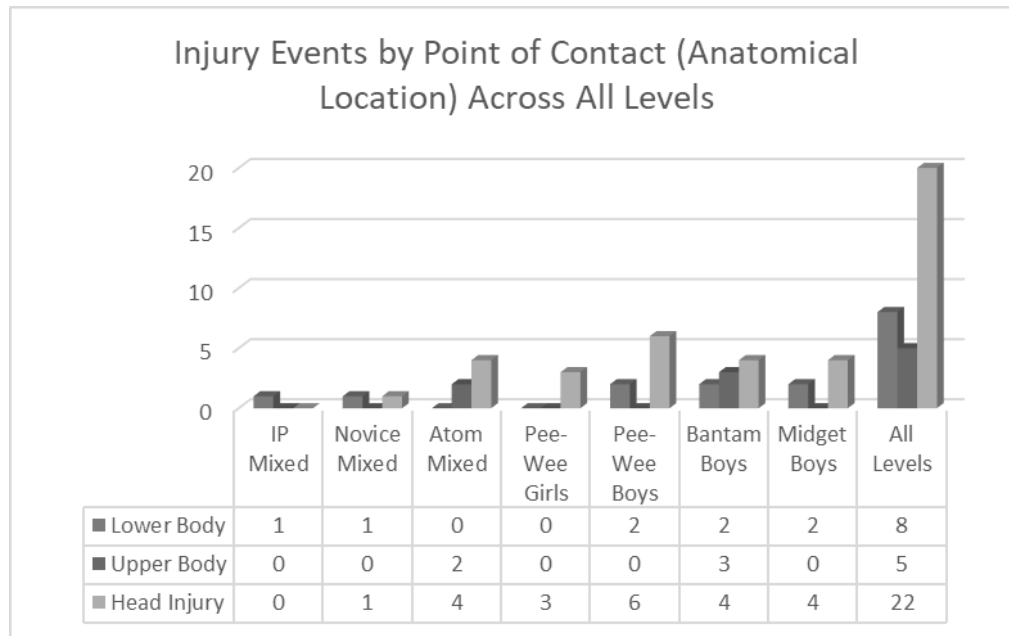
the level increases, so too do the injury rates, especially at the levels where body-checking is allowed.



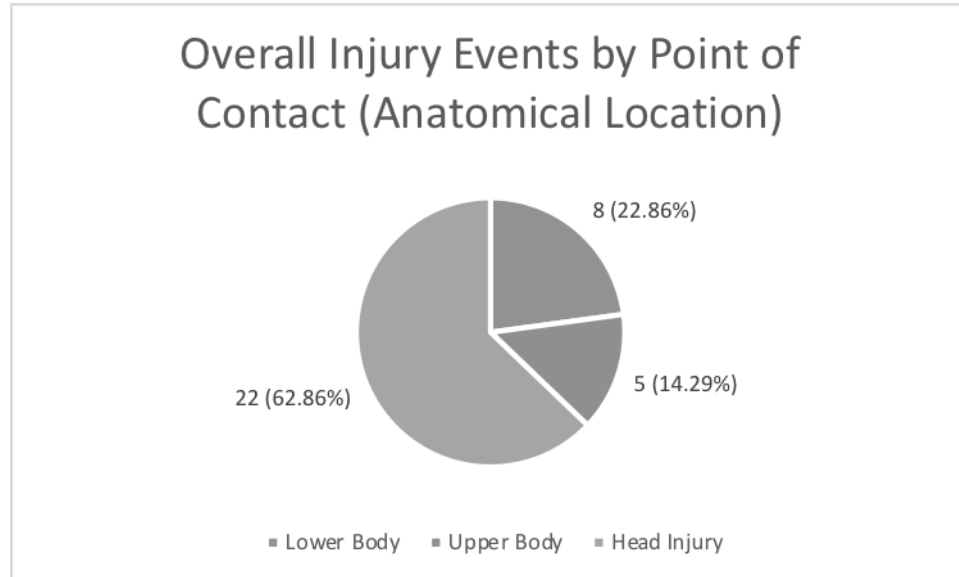
**Figure 1.** Total number of injury events and injury rates by age category.

### Point of Contact by Anatomical Location

The total number of injury events was broken down by what part of the body was contacted for the physical trauma to occur. Anatomical location was broken down into three parts: Lower body (which includes groin, hip, thigh, and lower appendages); Upper body (which includes chest, back, abdomen, and upper appendages); and Head (which also includes neck) (Figure 2.1 and 2.2). For example, if a player was injured by receiving a puck to the leg, the point of contact would be the lower body. Of the 35 observed injury events, 8 (22.86%) resulted from lower body contact, 5 (14.29%) resulted from upper body contact, and 22 (62.86%) resulted from head contact (Figure 2.2). That is to say, over 50% of the injuries occurred as a result of contact to the head/neck.



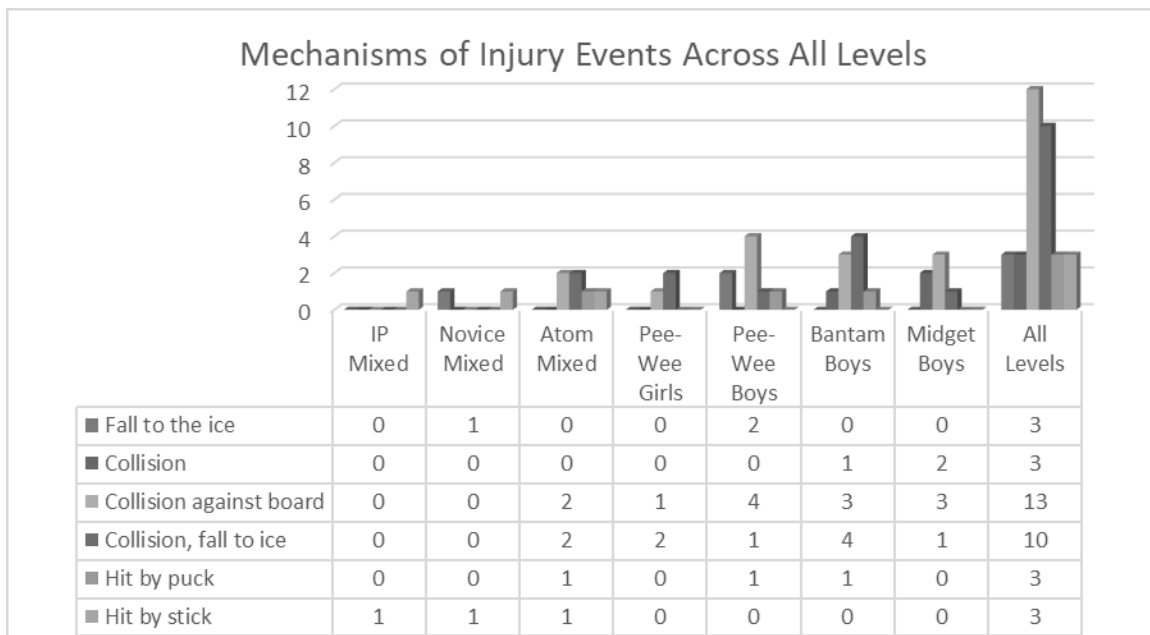
**Figure 2.1** Total number of injury events by point of contact (anatomical location) across all levels.



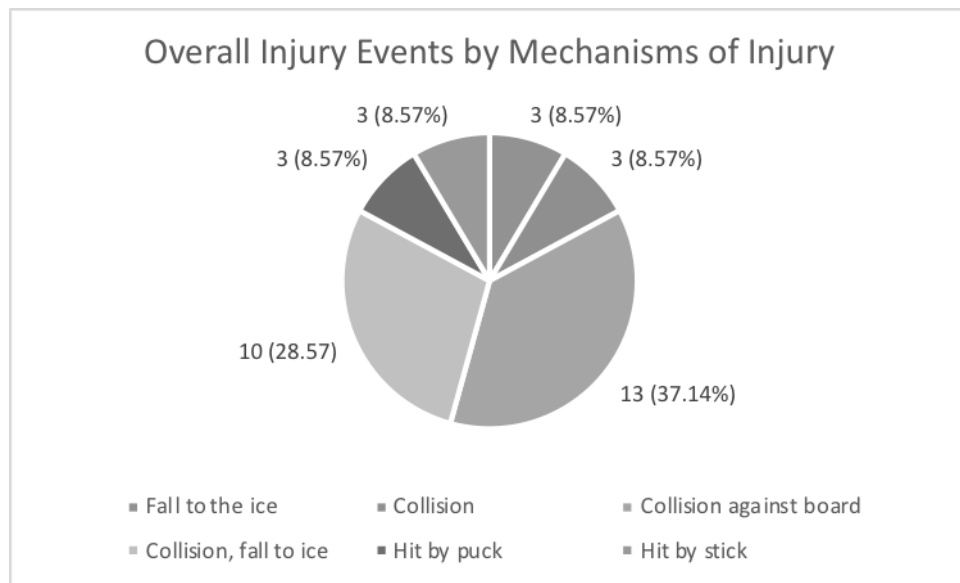
**Figure 2.2** Overall number of injury events by point of contact (anatomical location).

## Mechanisms of Injuries

Mechanisms of injury events were broken down into multiple in-game scenarios: fall to the ice; collision; collision against the boards; collision followed by a fall to the ice; hit by a puck; hit by a stick. Collision, collision against boards, and collision followed by a fall to the ice rose considerably at the pee-wee boys level and peaked at the bantam and midget level where body-checking is allowed (Figure 3.1). In total 13 (37.14%) injury events occurred as a result of a collision against boards, 10 (28.57%) from a collision followed by a fall to the ice, 3 (8.57%) from a fall to the ice, 3 (8.57%) from a collision, 3 (8.57%) from being hit by a puck, and finally 3 (8.57%) from being hit by a stick (Figure 3.2).



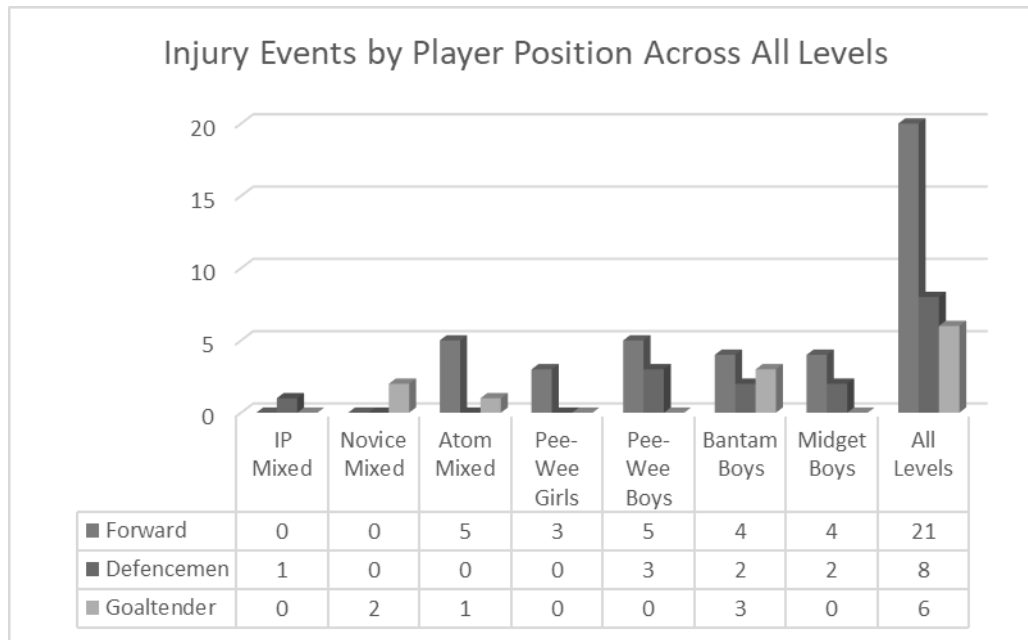
**Figure 3.1** Mechanisms of injury events across all levels.



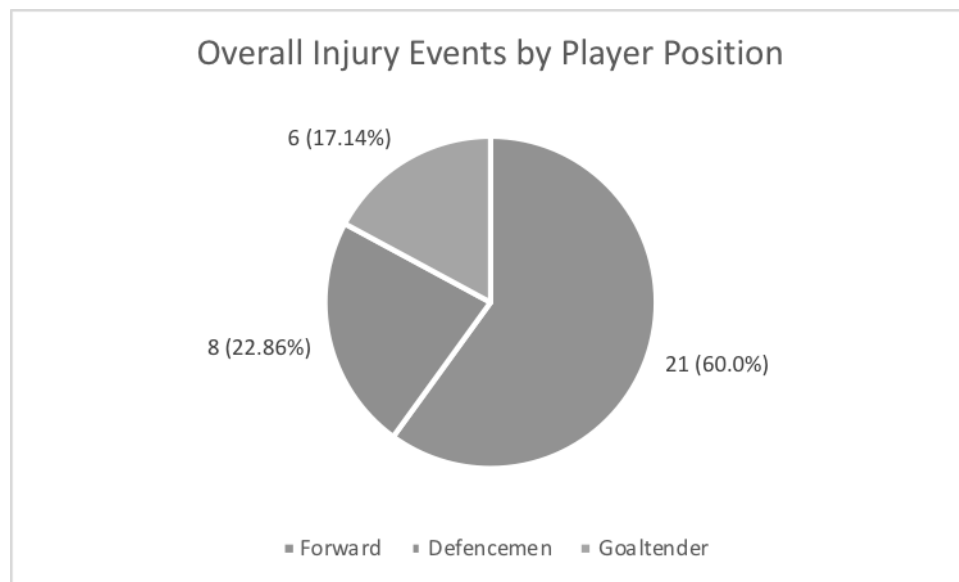
**Figure 3.2** Overall number of injury events by mechanism of injury.

### **Injury Event by Player Position**

A hockey team is composed of forwards, defensemen, and goalies. Forwards received the greatest number of injury, followed by defensemen, and then goalies. Only at the initiation program level did defensemen experience more injuries than forwards. At the novice, atom and bantam level, goalies experienced more injuries than defensemen (Figure 4.1). In total, 21 (60.0%) of the total injury events occurred to forwards, 8 (22.86%) to defensemen, and 6 (17.14%) to goalies (Figure 4.2).



**Figure 4.1** Total injury events by player position across all levels.

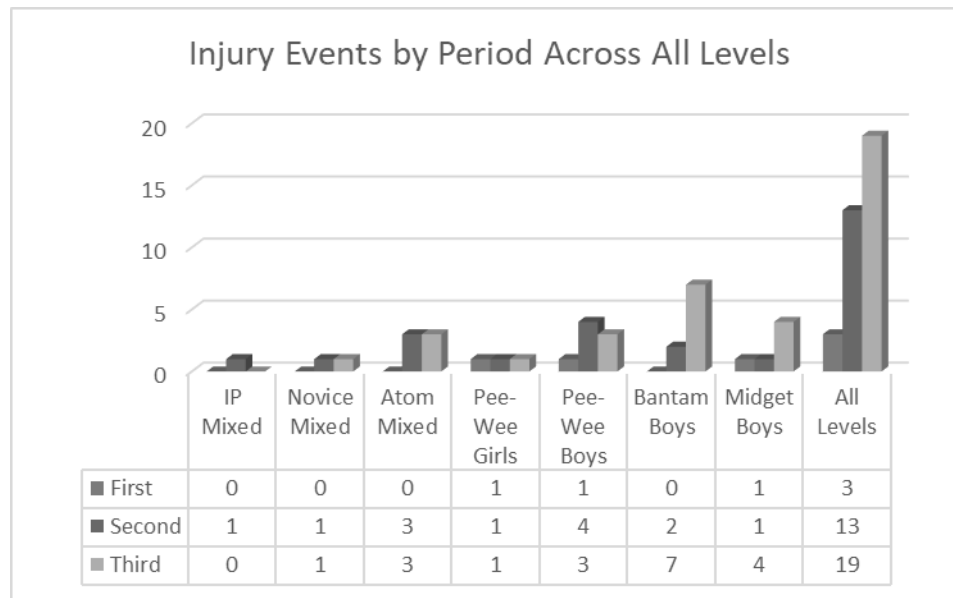


**Figure 4.2** Overall number of injury events by player position.

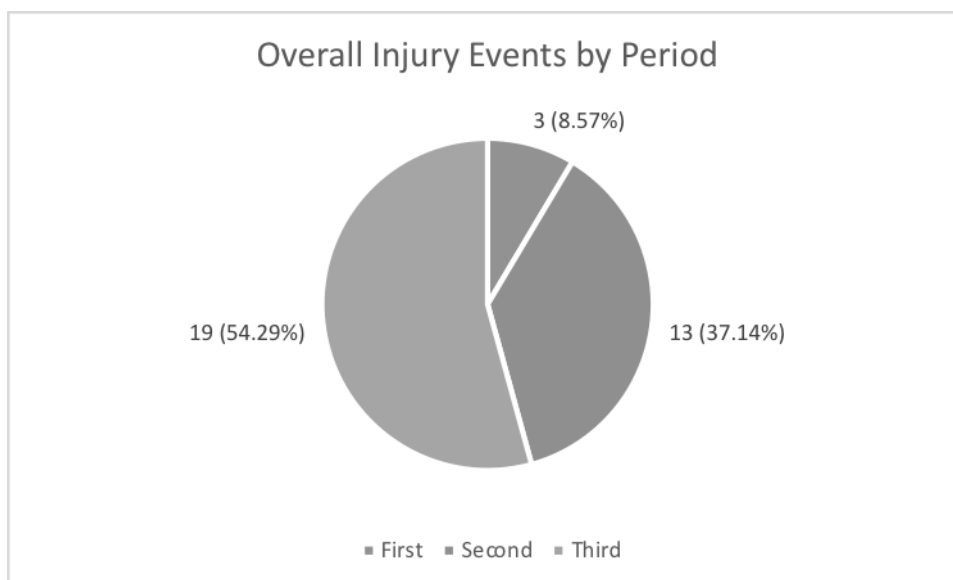
### **Injury Event by Period**

The time of game in which injury events occurred was also observed, with more injuries occurring in the third period compared to first and second periods (Figure 5.1).

Only 3 (8.57%) injuries occurred in the first period, 13 (37.14%) in the second, and 19 (54.29%) in the third (Figure 5.2). Injuries in the third period represent more than a six fold increase compared to the first period. Overall, more than half of the injury events occurred in the third period.



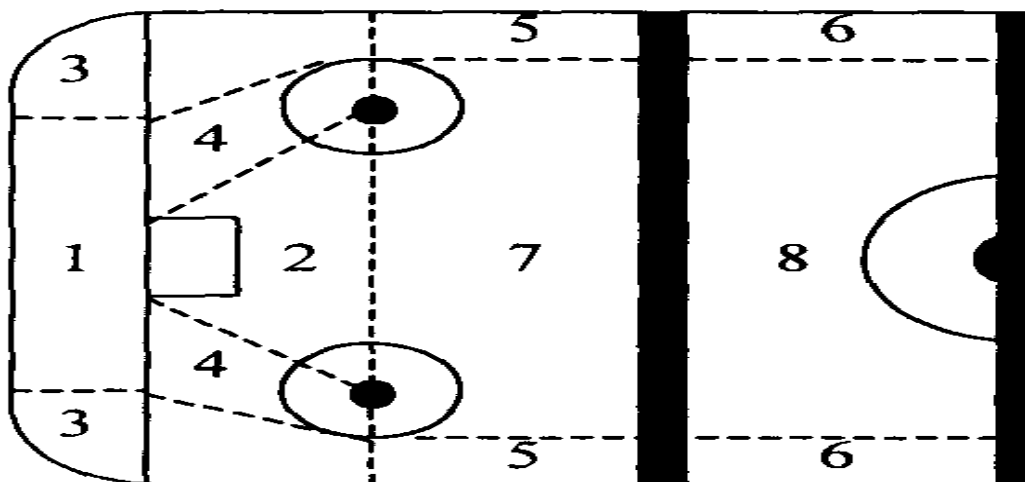
**Figure 5.1** Total injury events by period across all levels.



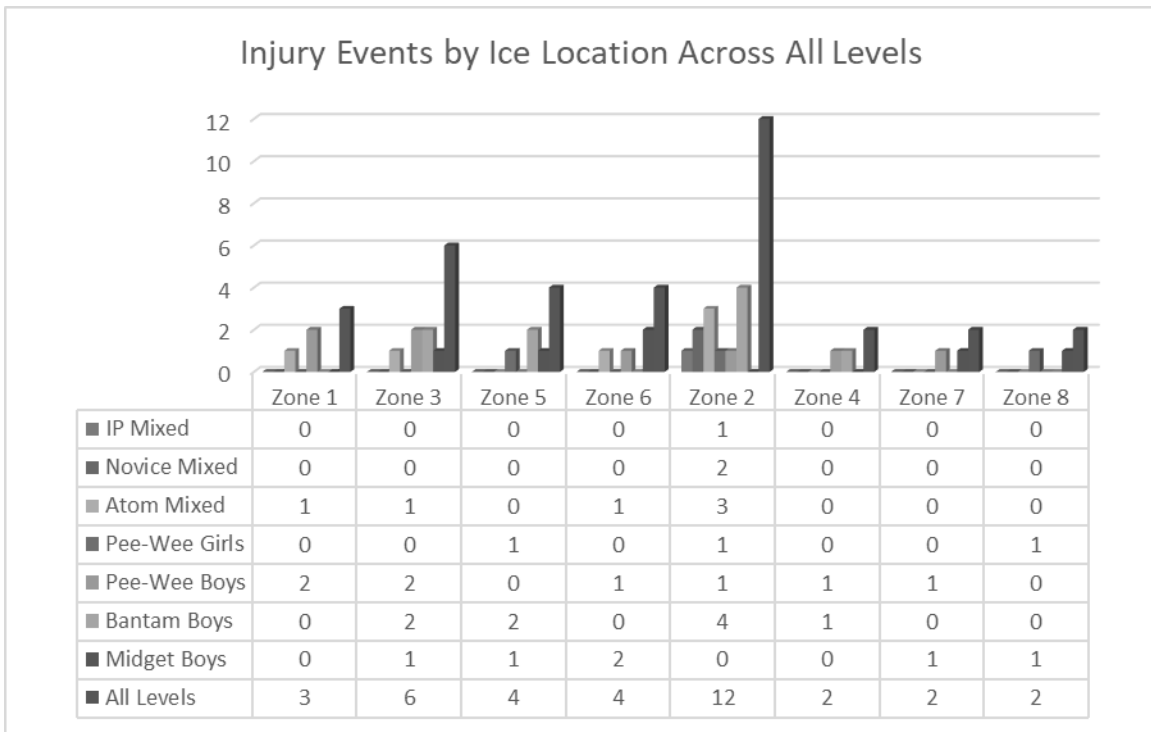
**Figure 5.2** Overall number of injury events by period.

### Injury by Ice Location

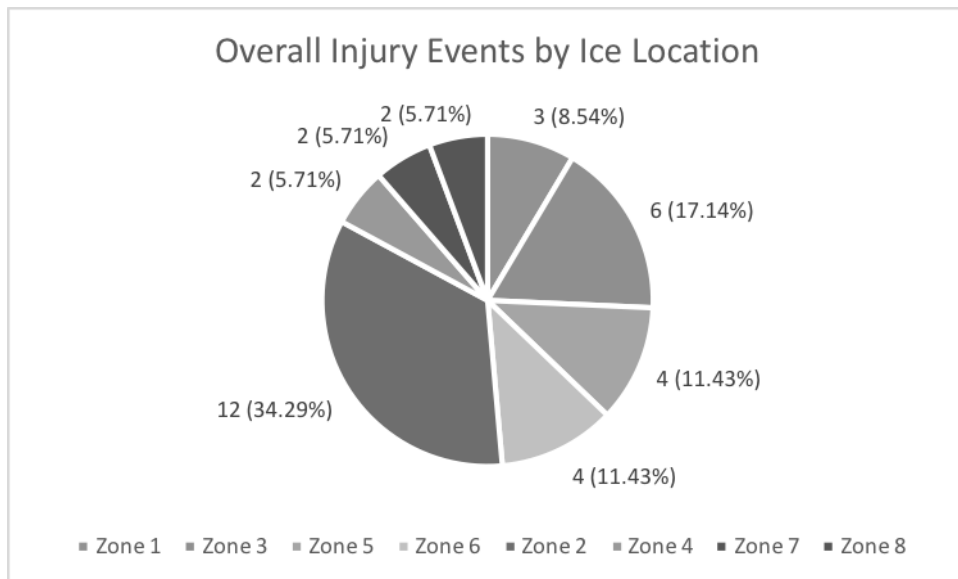
To determine what part of the ice surface had the highest frequency of injury, injury locations were identified on a map of an ice surface divided into eight specific regions (Figure 6.1). These eight areas are part of two major sections: the perimeter (zone 1, 3, 5, and 6 on the map); and open ice areas (zone 2, 4, 7, and 8 on the map). Out of the 35 injury events, the events were equally split into the two major sections with 17(48.57%) occurring to the perimeter and 18 (51.43%) occurring to the open ice areas. 3 (8.54%) injury events occurred in zone 1, 6 (17.14%) in zone 3, 4 (11.43%) in zone 5, and 4 (11.43%) in zone 6 which represent all the injury events that occurred in the perimeter areas. For the open ice areas, 12 (34.29%) injury events occurred in zone 2, 2 (5.71%) in zone 4, 2 (5.71%) in zone 7, and 2 (5.71%) in zone 8 (Figure 6.2). Zone 2, which represents the area in front of the net had the most injury events with 12 (34.29%) (Figure 6.3).



**Figure 6.1** Map of ice with eight specific regions.



**Figure 6.2** Total injury events by specific ice area across all levels.



**Figure 6.3** Overall injury events by specific ice area.

## DISCUSSION

The purpose of this study was to compare, through an observational research design, injury events in minor hockey to determine rates of injury and injury contextual factors by age level. The overall injury events rate combining all levels was 5.72 injury events per 1000 AE, and in general, the injury rate increased by age. These findings are consistent with other studies (Agel et al., 2007; Powell & Barber-Foss, 1999; Turbeville et al., 2003), however, the injury definition utilized in this study had a much lower threshold of injury compared to what is used in traditional injury reporting. Unlike other injury reporting that requires a player to miss the game/practice following the injury event to be considered an injury, this study determined a player to be injured if s/he did not return in that particular game. For example, if a player was hurt in the last two minutes of a game and did not return, that was considered an injury. Of the 35 observed injuries, 10 injury events occurred with under 5 minutes to play, accounting for 28.57% of total injuries. This is an important consideration when looking at overall injury rate, as we were unable to confirm if the players actually suffered an injury or if they simply did not get a chance to get back out on the ice before the game finished. Of these 10 injury events, 3 occurred at the atom level which represents half of the injury events (50%) recorded at this level. Removing these injury events would give a rate of injury of 3.48/1000 AE, rather than surprising high rate of 6.95/1000 AE. The remaining 7 occurred at the pee-wee boys, bantam and midget levels and it was unclear if the players remained on the bench as a result of coach selection or if they were injured. Whatever the case, these 7 injury events accounted for 20.0% of total injuries. And while it cannot be verified if in any of these cases players would have returned to play if there was more

time remaining, it does suggest that the injury total might have been even lower if this minimal time loss definition was not in place. Considering this low injury definitional threshold, and the fact that injury rates reported here were consistent with other studies, the overall frequency of injury is lower than what was expected.

The most common form of contact that led to players being injured, was head contact. Contact to the head represented 62.86% of the injury events observed over the two year period. Contact with the lower body represented 22.86% of the injuries, and upper body contact represented 14.29% of injuries. When examining point of contact and injury across age levels, contact with the head was the highest across all levels except for the initiation program and novice. Injury as a result of head contact also increased by age level, with 14 out of the total 22 head injury events occurring at the pee-wee boys, bantam and midget levels (body-checking starts at the bantam level). While it cannot be confirmed if any of these players received concussions as a result of the head contact, there is cause for concern that head injury is the most common injury. Steps to reduce head contact through rule/game modifications and educating players about head safety are already being implemented, but it is clear that further work needs to be done, in particular at levels where body checking is allowed.

Through observational analysis, it is not only possible to document injury rates, but also the manner in which injuries are occurring. In this study, collisions (collision; collision against the boards; collision followed by a fall to the ice) were the leading mechanism of injury, representing 26 of the total 35 injury events (74.29%). The observations provided a more nuanced understanding of injury by collision, however, as collisions involved three distinct factors: 1) collisions might involve body to body contact

that causes the injury; 2) collisions might involve a secondary point of contact with the boards which is the source of injury; and 3) collisions might result in a fall to the ice which causes injury. Similar to what is found in Agel et al. (2007), this study identified that contact with another player against the boards (37.14% ) was the highest mechanism of injury, followed by contact with another player and hitting the ice at 28.57% of injuries, and contact with another player at 8.57% . Outside of collisions, getting hit by a stick represented 8.57% of injuries, hit by puck 8.57% of injuries, and a simple fall to the ice 8.57%. The fact that players were receiving most injuries as a result of contact with the boards should not come as a surprise considering the speeds at which players are travelling, and the hard immovable forces that surround them while playing. In non-body checking hockey, it was observed that players generally play along the boards with a degree of caution, and avoid collisions whenever possible. This may be due to the rules that are in place that aggressively penalize contact along the boards, or perhaps the ongoing education regarding safe play, which includes hitting from behind and contact along the boards. Collisions and injury events at this level were typically accidental, with players colliding as they strived to get the puck. At the bantam and midget level, where body-checking is legal, contact along the boards is much more frequent. Injuries as a result of collision and contact with the boards was the result of deliberate contact and assertive play. The injuries were not the result of reckless or aggressive play, but still purposive in that players intentionally hit players into the boards which ultimately leads to higher injury rates compared to non-body checking hockey

The different positions players play in hockey also seemed to be a determining factor in injury. Different positions have different roles and subsequently different travel

trajectories. For example, the centre position typically covers more ice than wingers and defense, since the position requires the player to travel lower in the defensive zone to help the defense, but then transition quickly to open ice to receive outlet passes from the wing positions. In Hutchison's study (2011) analyzing concussion rates by position in the National Hockey League, he expected to see the distribution of concussion by the proportional representation of player position, with 50% forwards, 33% defensemen, and 17% goalies. What his study revealed, however, was that 65% of the documented concussions were incurred by forwards, 32% by defensemen, and only 3% by goalies. In our study, 21 (60.0%) injuries were forwards, 8 (22.86%) were defensemen and 6 (14.14%) were goalies. What was impossible to determine, however, was if centres or wingers received more injury. This was because players would often switch from playing wing to centre within games, and without knowing opponent teams (those teams that served as the opposition to the teams recruited for the study), player position was at times difficult to verify. The comparison to Hutchinson's NHL study is interesting as it appears to indicate that the forward position carries with it a higher risk of being injured than defense and goaltenders.

Finally, when considering at what point in the game players are more likely to be injured, it appears that more injuries occur in the latter stages of the game. 54.29% of all the injury events happened in the third period, decreased in the second (37.14 %), and were even more infrequent in the first (8.57 %). This trend was consistent across all levels, but was even more pronounced at the bantam and midget level. As stated earlier, these results may be partially skewed due to the time loss injury definition. Some of the events may not have been documented as injuries if there was more time in the game for

players to return. Taking this into consideration, there might be other factors that contribute to a higher injury rate in the third period. For example, as players get more tired as the game progresses, they might be more vulnerable to injury, either in terms of protecting themselves against falls or collisions. Fatigue may also play a role in decision making; as players fatigue they might be prone to taking more risks when making plays, and risking their own and opponents' safety in the process. Another factor might be a heightened level of competition that often occurs towards the end of close games and players battle to determine the outcome of the game. The play typically intensifies which might compromise safety, making players more susceptible to injury. In combination, fatigue and increased competitiveness are likely factors contributing to an increased rate of injury in the final period of play.

## **LIMITATIONS**

There are certain limitations to this study that must be acknowledged. Because of the observational research design, the sample size is smaller than other secondary injury reporting studies. The smaller observational design, however, allowed researchers to observe injury events as they occur in situ which larger secondary injury reporting studies are not able to provide. Second, a team approach to data collection was required to cover the amount of games observed in this study, which did lead to inconsistencies when documenting injury. To help reduce bias, all game video footage was reviewed by an independent viewer to confirm whether injuries did or did not occur. A third limitation was not being able to get information about the injuries, both in terms of diagnostics and time lost. Using the minimum threshold of injury as not returning to play for that particular athletic did provide consistency in injury reporting, but more information about

the actual injuries would have been beneficial. Finally, only one level of female hockey was observed over the two years, making comparisons between male and female hockey difficult. Only so many games could be covered with the number of researchers on our research team, but it is clear more observational research is required to compare injury between the predominantly male minor hockey leagues and female hockey, and between levels of play in female hockey.

## CONCLUSION

Concerns about safety in youth hockey have been openly expressed in public and in academic circles. Sport injury literature continue to report that the prevalence of injury in hockey remains high at both the grassroots and elite levels. Much of this injury reporting, however, utilize injury reporting methods that provide very little about how and why these injuries are occurring. Retrospective secondary reporting conducted by accessing emergency department and insurance claim records have lacked contextual details surrounding injury. Prospective voluntary reporting has improved on this by providing limited descriptive details, but without actually being in the field observing the injuries in context, the impact of this research is limited. Similarly, voluntary reporting practices do little in the way of providing information about what is causing injury, let alone providing accurate data about injury rates due to the tendency for underreporting. Studies with large sample sizes are generally privileged in scientific research, yet these studies are unable to provide the micro-analysis available in smaller quantitative *and* qualitative studies, as was conducted here.

The comprehensive prospective observational approach utilized in this study proved to be effective in understanding injury frequency, but also how and why injuries

are taking place. Based on the observations from this study, hockey is not the violent/dangerous sport it is often portrayed to be, and injuries are not occurring as a result of violent or aggressive play. In fact, very few injury events occurred throughout the two years of data collection. The study accounted for only 35 injuries for 6122 athletic exposures and 204 games across all levels from the initiation program level to the midget level. Despite the relatively limited amount of injury documented over the two period, it is disconcerting that 22 (62.86%) of all the injury events occurred as a result of head contact. Considering what is known about the devastating effects of brain trauma, in particular on the developing (children and youth) brain, increased efforts are necessary to reduce head contact. More research documenting the frequency and types of head contact in minor hockey needs to be conducted if appropriate steps are to be taken to help mitigate this contact from occurring.

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## CHAPTER V

### **Observational Analysis of Head Contact Events Across Minor Ice Hockey in Ontario and Québec (Canada)**

#### **INTRODUCTION**

The issue of safety in hockey is an ongoing, yet intensifying, source of contention for those involved in the sport (Adams, Mason, & Robidoux, 2015). Head injuries in elite and youth sport have garnered growing public attention in part because of high profile cases of professional athletes suffering career ending/threatening concussions, and because of the increase in medical studies identifying how repeated concussive events can lead to long term health problems, most notably degenerative brain disease (De Beaumont, Theoret, Mongeon, et al., 2009; Guskiewicz, Marshall, Bailes, et al., 2005). Sport leagues and organizations are finding themselves under increased pressure to introduce concussion awareness and prevention strategies to ensure the safety of their constituents, but also to maintain participatory and/or fan interest (Benson, McIntosh, Maddocks, et al., 2013; Donaldson, Asbridge, & Cusimano, 2013; Ellenbogen, Berger, & Batjer, 2010; Johnson, 2011; Saffary, Chin, & Cantu, 2012; Wiebe, Comstock, & Nance, 2011). Body checking and other collisions are particularly dangerous in youth hockey given the disparities in body size and strength that are common in minor hockey. Multiple studies have shown that body contact, including legal body checks, account for up to 86% of injuries during games amongst youth players aged 9 to 15 years (Agel, Dompier, Dick, & Marshal, 2007; Marchie & Cusimano, 2003; Tegner & Lorentzon, 1991). What is even more alarming is that from these injuries, 23% were injuries to the

head and neck according to a statement from the American Academy of Pediatrics (2000).

Given the potential long-term consequences and the predictable frequency with which head trauma occur in hockey, it is a priority of all stakeholders to develop strategies for prevention. However, in order to implement effective preventive strategies, an understanding of the situational context in which head contact events occur is necessary. Unfortunately, the mechanism of head trauma is often difficult to discern; eyewitness accounts- especially if these are based on injured players' memories of events- can be extremely unreliable (Hutchison, 2011). The Neurotrauma Impact Science Laboratory (P.I, Dr. Blaine Hoshizaki) and the Sociocultural Sport Injury Laboratory (P.I., Dr. Michael Robidoux) of the University of Ottawa alongside CCM Hockey and the National Science and Engineering Research Council have teamed up to respond to this issue. The overall goal of this observational study is to provide information to CCM Hockey in order for them to develop a helmet best suited for the types of contact players receive while playing hockey. Working from existing injury studies and implementing an observational research design, this article will provide critical details about the frequency, type, and situational factors of head contact events from all levels of minor hockey (initiation program level to midget level) from both male and female leagues in Ontario and Quebec.

## **BACKGROUND**

Historically, injury rates in hockey have been amongst the highest in North American sport, prompting hockey organizations to implement measures to reduce the risk of injury (Hutchison, 2011). In the 1960s, the majority of severe injuries in hockey

occurred as a result of head contact, mainly attributable to a lack of quality protective equipment and regulations to protect the head and face. In Canada, it was not until 1978 that amateur hockey players were required to wear helmets approved by a technical standards committee (Hutchison, 2011). The enforced use of a helmet and face mask was remarkably successful, virtually eliminating facial lacerations and skull fractures. However, reports of injuries involving youth and adult hockey players show that, despite advances in equipment design, the number of concussions are increasing and remain a major problem in the sport today (Marchie & Cusimano, 2003).

It has been estimated in the United States that between 1.6 and 3.8 million mild traumatic brain injuries (mTBI) result from sports each year (Mihalik et al., 2010). These injuries cost the American health care system approximately 56.3 billion dollars annually in direct and indirect costs and make mTBI among the most expensive conditions to treat in children (Mihalik et al., 2010). This occurrence of mTBI exists for all sports but is even more prevalent in contact sports like hockey. In fact, a study from Covassin, Swanik, and Sachs (2003) states that approximately 20% of hockey players sustain a concussion during their playing career. Also, King and Leblanc (2006) stated that the reporting of injuries in hockey “is likely the tip of the iceberg, since many injuries, particularly concussions, which may have long-term consequences on the developing brain, are underreported” (p. 163). One explanation of this underreporting is offered by Juhn et al. (2002): “it is likely that players under-report concussion, as most concussions do not involve loss of consciousness, and players are concerned that they will be removed from practice or games” (p. 47). Perhaps even more alarming is the fact that sport-related concussion are being reported with increased frequency among children and adolescents

(Bramley, Kroft, Polk, Newberry, & Silvis, 2012). Each season, around 10-12% of minor league hockey players aged 9-17 who are injured report a head injury, most commonly a concussion (Bramley, Kroft, Polk, Newberry, & Silvis, 2012; Marchie & Cusimano, 2003). These numbers are disturbing for parents whose sons/daughters are participating in sport especially at a young age where the developing brain is at an even higher risk of injury (Marchie & Cusimano, 2003). Pre-adolescent youth with an mTBI may never fully develop the social and cognitive skills characteristics of adults and maybe more violent than those without such an injury (Marchie & Cusimano, 2003). Moreover, repeated concussions may lead to permanent learning disabilities and other neurological and psychiatric problems (Marchie & Cusimano, 2003).

Adding to the debate about safety in youth hockey is the controversial role body-checking plays. The National Hockey League (NHL) held lengthy General Managers meetings in the 2009/2010 hockey season to address the issue of high velocity body-checks that impact the head and that have resulted in numerous concussions. This concern about body-checking is not only happening at the elite/professional levels, but also at the minor hockey levels. Within this debate, the only constant has been the mounting evidence demonstrating that body-checking or player-to-player contact in hockey is the leading cause of injury (Agel, Dompier, Dick, & Marshal, 2007; Marchie & Cusimano, 2003; Tegner & Lorentzon, 1991) accounting for up to 86% of injuries during game amongst youth players aged 9 to 15 years. Laflamme and Robidoux's study (at press) documented injury events across all minor hockey levels from the Ottawa and Gatineau regions and they discovered that 62.86% of the possible injuries were due to contact to the head. From this 62.86% (n=35), 74.29% (n=26) resulted from some sort of

collision—collision with another player, collision against the boards, or collision followed by a fall to the ice. Body checking and other collisions are particularly dangerous in youth hockey given the disparities in body size and strength that are common among children of the same age. The head should be protected, especially at these younger ages, and rules and regulations should be implemented that will reduce contact to the head.

## **METHODS**

In response to this concern about head injuries, this study was designed to document head contact events experienced in different minor hockey age categories. This study took a closer look at the situational factors surrounding head contact events in leagues where body-checking is allowed and not allowed. For the purpose of this study, a head contact event was described as any clear observable contact to a player's head that occurred as a result of participation in organized game play, by way of person to person contact, head to boards, head to ice, stick to head, puck to head, or any combination of these factors. This research was made possible through extensive observations and recording of minor hockey games in the Ottawa and Gatineau regions. The hockey teams recruited were from all categories of minor hockey from the initiation program (IP) level to the midget level from both male and female leagues in the Ottawa (Ontario, Canada) and Gatineau (Quebec, Canada) regions. By covering this range of age levels it offers a wide variety of rules and styles of hockey that were suspected to influence the types of head contacts observed.

The observational data for this paper covers games that occurred over the course of the 2016-17 and the 2017-18 seasons. A total of 204 games (6122 athletic exposures)

were observed across all levels of play: 20 IP (5-6 years old) games (557 athletic exposures); 20 novice (7-8 years old) games (511 athletic exposures); 29 atom (9-10 years old) games (863 athletic exposures); 43 pee-wee girls (11-12 years old) games (1290 athletic exposures); 42 pee-wee boys (11-12 years old) games (1288 athletic exposures); 31 bantam boys (13-14 years old) games (996 athletic exposures); and 19 midget boys (15-17 years old) games (617 athletic exposures). The teams recruited were all part of competitive leagues. The number of players from each team differed so a player count was done before each game was observed. Each organization that was approached to participate in the study consented, meaning that the only selection bias was geographical—meaning that organizations within the closest proximity to the research team was recruited. The parameters of this study were approved by the University of Ottawa's Health Sciences and Science Research Ethics Board.

### **Field Observations**

In observational studies, the ability of just one researcher to collect all data in all places is virtually impossible, thus a team approach to data collection was necessary, similar to that what was conducted by Dumas & Laforest (2003). The team of volunteers in charge of the data collection was made up of 30 undergraduate students from the University of Ottawa's School of Human Kinetics. A team composed of three researchers attended each game to provide detailed notes pertaining to all aspects of head contact events, filled out observation grids (Appendix A) to properly categorize head contact events, and video recorded game-play for further use by the Neurotrauma Impact Science Laboratory. The camera was stationed in the middle of the ice at the top of the stands to most effectively capture the zone of the ice where the play was happening. The camera

was located on a tripod to facilitate the movement of the camera and stabilize the filming. Video footage was then downloaded into *VLC Media Player Software*<sup>®</sup> where all head contact events were subjected to frame-by-frame analysis. By reviewing the video with multiple observers, researchers could minimize bias and verify if head contact occurred or not. Only the head contact events matching both the live observation and the video footage analysis were kept for further analysis. Data collection ended at the conclusion of the second hockey season. The video recording from this study was also used for another study led by the Neurotrauma Impact Science Laboratory, which used the video footage in order to determine the velocity and force of each of the head contact events. The combination of *in situ* observation and impact measurements provides a novel way of examining head injury in sport.

### **Observation Grid**

To systematically observe the multifaceted events that transpire over the course of a hockey game, this study implemented an observation grid (Appendix A) to document all observed head contact events. The observation grid has been informed by previous observational studies (Boyer, 2011; Hutchison, 2011; Stuart, Smith, Nieva, & Rock, 1995). To categorize situational factors leading to head contact events, the study drew from previous epidemiological studies, which identified the following mechanisms: contact with another player/collision (Agel, Dompier, Dick, & Marshal, 2007; Marchie & Cusimano, 2003); contact with stick or puck (Agel, Dompier, Dick, & Marshal, 2007; Stuart et al., 1995); contact with ice/fall on ice (Smith, Stuart, Wiese-Bjornstal, & Gunnon, 1997); and contact with boards (Boden & Jarvis, 2009; Juhn et al., 2002). Moreover, by gathering this information, we were able to categorize the head contact

events experienced to systematically determine primary causes of head contact events, and to discover any head contact events trends that might be evident at each level of hockey.

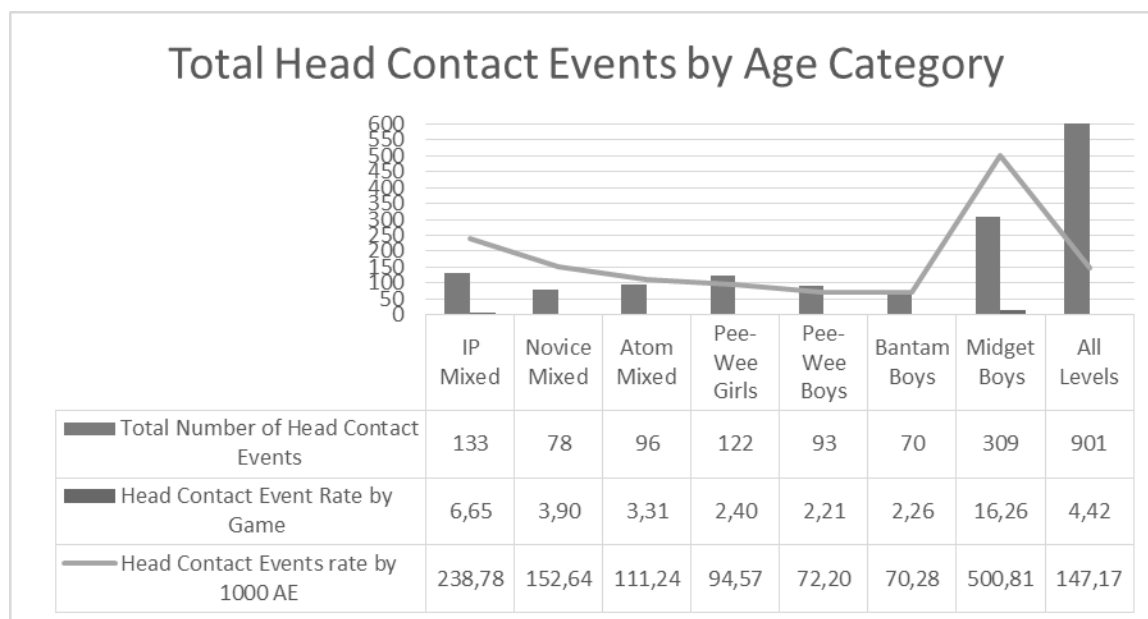
### **Data Analyses**

The rate of head contact events was compared by way of Athletic Exposures (AE). Borrowing from Dick, Agel and Marshall (2007), athletic exposure is defined as a player participating in one practice or competition where they are exposed to the “possibility of athletic injury regardless of the time associated with that participation” (p. 174). For the purposes of this study, only events that occurred during games were documented. The number of head contact events for each level was divided by the number of AE for that particular level, which is informed by previous studies (Agel, Dompier, Dick, & Marshal, 2007; Powell & Barber-Foss, 1999; Turbeville, Cowan, Owen, Asal & Anderson, 2003). Each individual head contact was considered as an independent event. The rate of head contact events was also compared by way of Games Played (GP). The number of head contact events for each level was divided by the number of GP for that particular level. Comparisons of rates and characteristics between levels were performed using descriptive statistics. All statistical analyses were performed using *Microsoft Excel 2016 Software*<sup>®</sup>. In order to complement the rates of head contact events, descriptive analysis of the contextual factors surrounding the events was also performed.

## RESULTS

### Head Contact Events by Level of Play

The level of play had a significant role in the number of head contact events documented. At the IP level, there was a much higher rate of head contact than expected with 238.78 head contact events/1000 AE (Figure 1). This rate then sharply decreases to 152.64 head contact events/1000 AE at the novice level, and continues to decline to bantam (Figure 1). The rate then dramatically peaks at midget, which is the highest age level of minor hockey, with a rate of 500.81 head contact events/1000 AE (Figure 1).

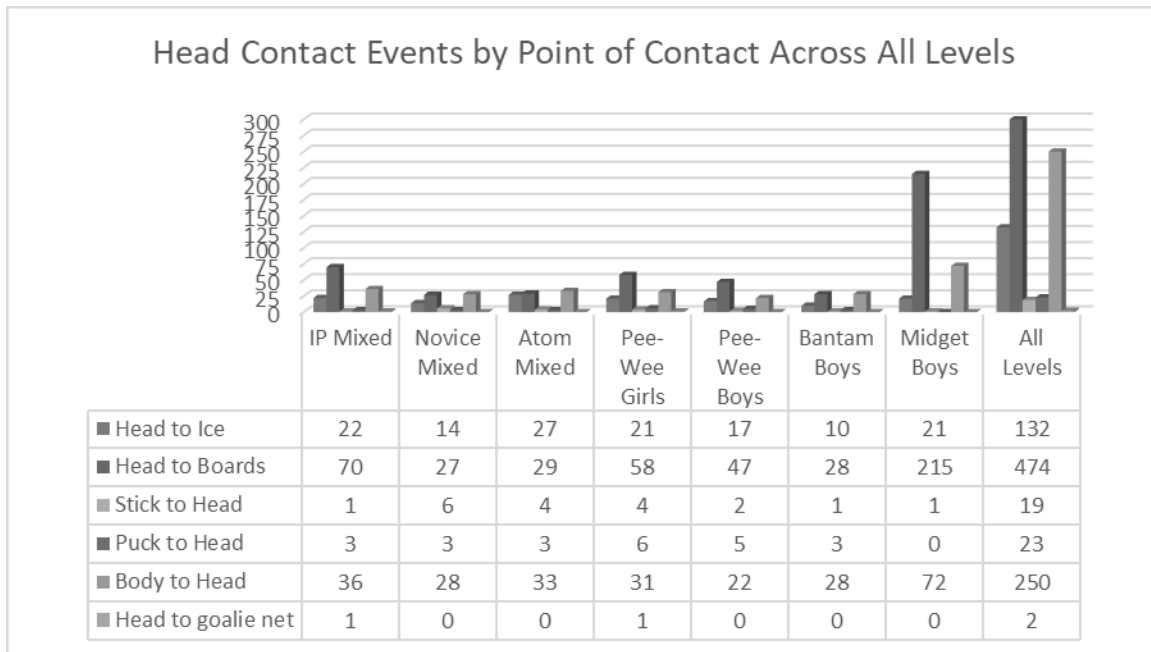


**Figure 1.** Head contact events rate across all levels.

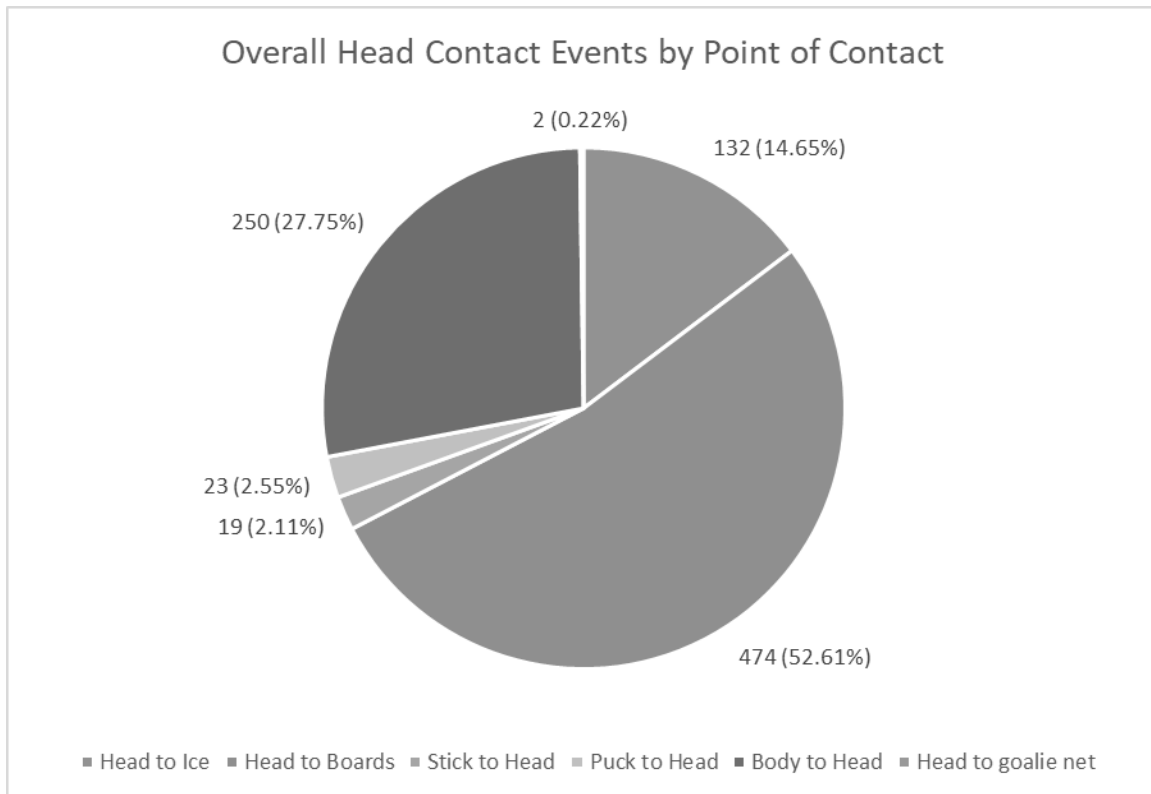
### Point of Contact

Head contact with the boards was the most frequent point of contact in almost every level except for the novice and atom levels where body to the head was the most frequent point of contact (Figure 2.1). 474 (52.61%) of the 901 total events occurred as a result of head contact with the boards, which represents more than half the total events

(Figure 2.2). The second most frequent point of contact was body to head with 250 (27.75%) total events, followed by head to the ice with 132 (14.65%) events. Stick to the head, puck to the head, and head to goalpost (net) represented a total of 44 (4.88%) events combined.



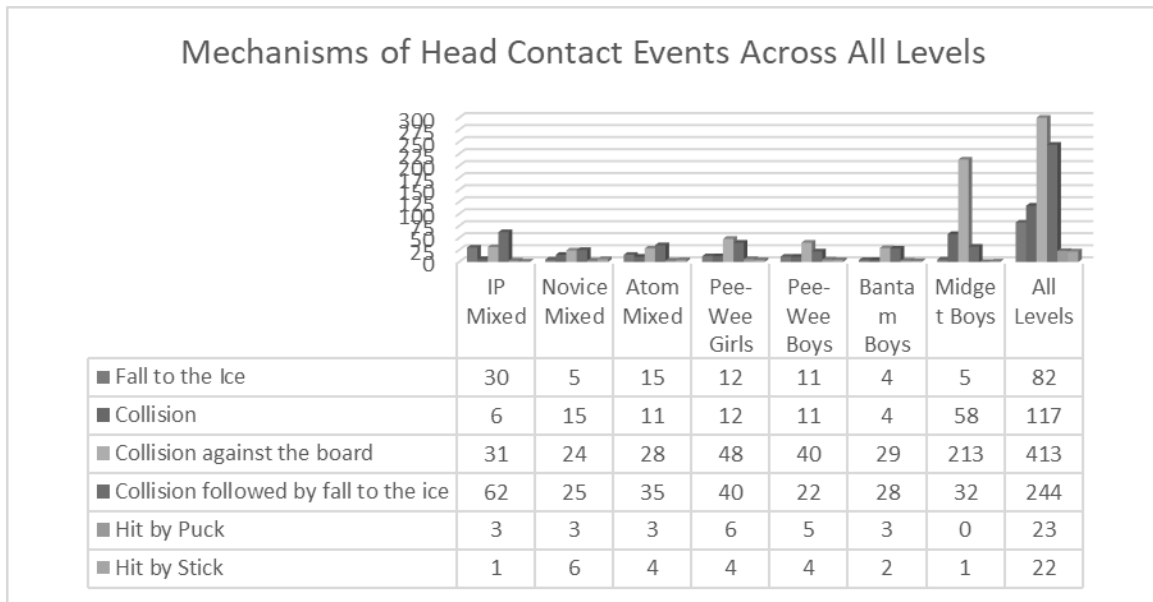
**Figure 2.1** Total number of head contact events by point of contact across all levels.



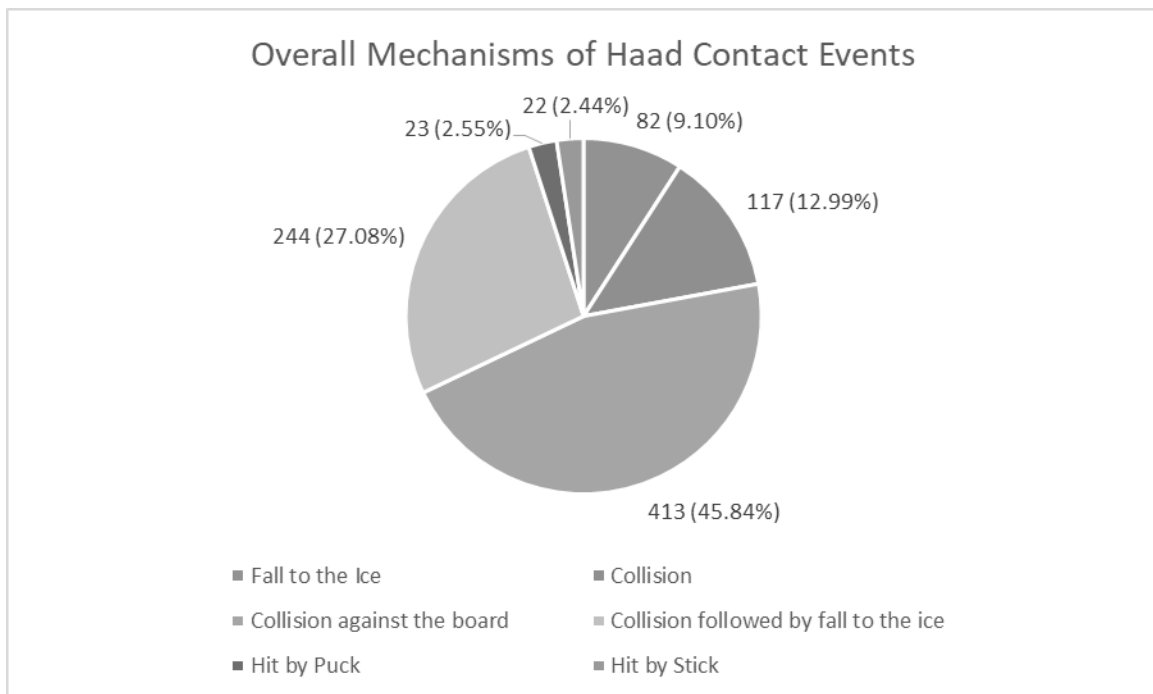
**Figure 2.2** Overall number of head contact events by point of contact.

### **Mechanisms of Head Contact Events**

The three type of collisions (collision; collision against the bards; collision followed by fall to the ice) were most frequent, representing 85.90% of the total events documented over the course of the study (Figure 3.2). Collisions against the boards and collisions followed by a fall to the ice were the two highest mechanisms of head contact at every level except midget where collision with another player was the second highest type of collision (Figure 3.1). Falls to the ice spiked at the IP level, but diminished as age level increased (Figure 3.1). Hit by a stick and hit by a puck were fairly low across all levels accounting for only 2.55% and 2.44% of head contacts (Figure 3.2).



**Figure 3.1** Mechanisms of head contact events by level of play.



**Figure 3.2** Overall mechanisms of head contact events.

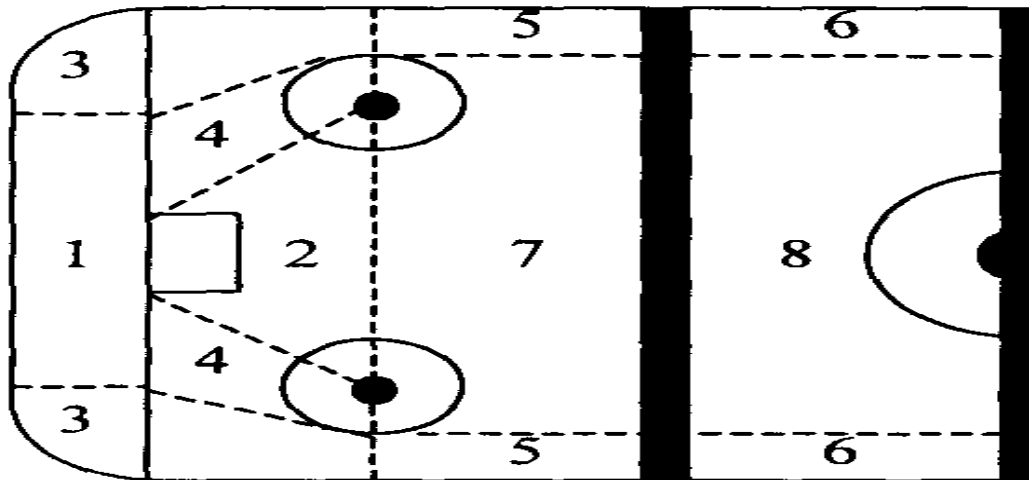
## DISCUSSION

The purpose of this study was to understand and compare, through an observational research design, how head contact events occur over the course of a hockey game across all minor hockey age categories. The overall rate of head contact was 147.17 head contact events per 1000 AE and/or 4.42 head contact events per game. These findings are considerably lower than studies using electronic sensors that record any contact to the head. For example, in a study done by Reed et al., (2010), they recorded 2989 head impacts over the course of 27 games which breaks down to 110.70 head contact events per game. However, from these impacts, only 1281 head impacts were above the sensor threshold set by the user and then used for the analysis. Even with this higher threshold, the number is three times higher than what was recorded at the highest level (midget level) in our study. Furthermore, in that study, on average 140 head impacts were recorded for each player over the course of the season and each player sustained 5.19 head impacts per game (Reed et al., 2010). It is not clear if the sensors pick up more contact than what is discernable by in person/video documentation, or if there was simply more contact in the Reed et al. In the study done here, only clear observable head contact events were documented which eliminated several low impacts or impacts not observable from our vantage point. It is possible that the different definitions and methods used in these two studied would create the variance in total head contacts detected.

One of the major findings from this study was understanding how head contact was occurring at the different age levels. The most frequent form of head contact was contact with the boards, with head to boards accounting for 474 (52.61%) of the 901 events. Similar to what is found in Agel, Dompier, Dick, & Marshal (2007), this study

identified contact with another player against the boards to be the highest mechanism of head contact events (45.84%), followed by contact with another player and hitting the ice (27.08%), and contact with another player without coming into any other surface (12.99%). Outside of collisions, falls to the ice represented 9.1% of all the head contact events, getting hit by a puck 2.55%, and lastly getting hit by a stick at 2.44%. The fact that players were receiving most head contact events as a result of contact with the boards points to higher risk areas on the ice which prompted us to explore further where along the boards players were experiencing the highest rate of head contact. The ice surface was divided into two major areas: the perimeter (zone 1, 3, 5, and 6 on the figure) and the open ice area (zone 2, 4, 7, and 8 on the figure). The perimeter is comprised of the side boards, corners, end boards, and side of net. Side boards refer to the boards and glass and three feet of the ice surface from the boards towards the middle of the rink, spanning all three zones. The corners refer to the rounded portion of the boards and glass connecting the side boards and end boards, including three feet toward the middle of the rink. Of all the 8 specific zones, the 4 zones representing the perimeter came with the highest frequency of head contact. Zone 5 which represents the side of the zone on each side was the most common area for hit to head with 220 (24.42%) of the 901 head contact events. This is the area where most players try to enter the offensive zone or get the puck out. This explains why so many contacts are happening in this specific zone. Zone 3 which represents the corners came second with 183, zone 1 (behind the net) with 130, and zone 6 (side of the neutral zone) with 102 head contacts events followed to conclude the perimeter. Zone 1 and 3 were also very common as they are zones where a lot of puck battles are created. The remaining zones represented the open ice areas (zone 2, 4, 7, and

8). Altogether, a total of 266 (29.52%) head contact events took place in these open ice areas, which is roughly the same amount that occurred in zone 5 alone.



**Figure 4.** Map of ice with eight specific regions.

In non-body checking hockey, it was observed that players generally play along the boards with a degree of caution, and avoid collisions whenever possible. This may be due to the rules that are in place that penalize contact along the boards, or perhaps the ongoing education regarding safe play, which includes hitting from behind and contact along the boards. Collisions resulting in contact to the head in non-body checking leagues were most often accidental, even though some of them resulted in an injury, with players colliding as they strived to get the puck. However, at the bantam and midget level, where body-checking is legal, contact along the boards is much more frequent. Head contact events and injury events obtained over the course of the study caused by a collision and contact with the boards were the result of deliberate contact and assertive play. The head contact events and injury events were not the result of reckless or aggressive play, but

still purposive in that players intentionally hit players into the boards which ultimately leads to higher head contact event rates compared to non-body checking hockey.

Another important finding in this study was the considerable number of head contacts happening at the initiation program (IP) level. This higher than expected head contact occurrence is likely due to the fact that players are only beginning to learn the game. Most of the players at this level are not proficient skaters, do not understand positional play and tend to chase the puck wherever it is on the ice, which leads to collisions. When collisions do occur, their weaker balance and body control appears to make the players more vulnerable, which also contributes to the higher rate of head contact. That is to say, when players either fall on their own or fall as a result of colliding with another player, the fall often leads to the head hitting the ice. In the case of collisions, head contact was often twofold, with head to body contact, followed by head to ice or head to boards contact. In this cohort, there were 30 head contact events that occurred as a result of children simply falling to the ice, which was the highest among all levels observed. The second most frequent mechanism of head contact was collision against the boards. As in the other divisions, these collisions were mostly due to a loss of balance or unintentional contact with an opponent against the boards. In other words, head contact was not the result of aggressive or violent play. As age level increases (up until midget), the number of head contact events diminishes, which is likely because playing styles are more organized, with less collisions occurring. Similarly, players are more proficient skaters and have greater control over their bodies preparing them for collisions when they do occur, falling less and being better prepared to manage falls.

What was perhaps most unexpected in this study was the low level of contact that occurred at the bantam level, despite this being the first year where body-checking is introduced. These results are inconsistent with other studies looking at injuries at bantam, where injury rates typically increase (including head related injury) as a result of body-checking being introduced (American Academy of Pediatrics, 2000; Boyer, 2011; Donaldson, Asbridge, & Cusimano, 2013; Johnson, 2011; Juhn et al., 2002; King & LeBlanc, 2006; Marchie, A., & Cusimano, 2003; Smith, Stuart, Wiese-Bjornstal, & Gunnon, 1997; Stuart, Smith, Nieva, & Rock, 1995; Tegner & Lorentzon, 1991). There could be many reasons for this discrepancy in our study, such as the level of competition of the teams that were observed, or coaching styles that do not emphasize body checking. While this study only focused on competitive hockey (not house league) there is a wide range of competitive levels, starting at competitive B and working its way up to AAA. The level of physicality—use of the body to defend or gain possession of the puck—seems to increase with the level of competition. Again, there are many factors that might contribute to this, such as the level of intensity on the ice, increased speed and skill, or more competitive coaching styles that demand players use the body whenever possible. Most of the teams recruited in the study were part of the lower end of competitive hockey, which might have affected the data and explains the lower number of head impacts.

One other factor to consider in regard to the lower level of head contact at the bantam level, is the potential that players are not yet familiar with body checking and do not automatically seek out physical contact. This again might be explained by the level of the teams recruited, but also by the fact that players prefer to play a faster and more

skilled game. Whether it was a matter of coaching style or education around body checking, there appeared to be less emphasis on body-checking and more emphasis on positional play and stick checking. After two years of observing this level of play, it was obvious that some of the players enjoyed the physical aspect of the sport, but more players opted to stick check opponents rather than deliver body-checks. Perhaps this is also a reflection of the apparent culture shift in hockey, where physical intimidation is becoming less and less a part of the game. Instead, the emphasis is being placed more on speed and skill, creating more opportunities for smaller players that were once overlooked for bigger more physical players.

Lastly, from the total 901 head contact events recorded in the study, only 22 resulted in players getting noticeably injured (0 at the initiation program, 1 at the novice, 4 at the atom, 3 at the pee-wee girls, 6 at the pee-wee boys, 4 at the bantam, and 4 at the midget level). These 22 events represent more than half (62.86%) of all the injury events recorded in Laflamme and Robidoux (at press). In other words, from what was observed over this two year period, players are generally engaging in the sport safely and avoid contact whenever possible, not in the aggressive/dangerous style it is often characterized as. These observations are not dissimilar to what Mihalik et al. (2010) found in their study examining head impacts and penalties. Of the 665 collision related head impacts that were observed, 82.7% of them were deemed to be legal body collisions (Mihalik et al., 2010). Based on these observations hockey is not necessarily the high risk sport it is often portrayed as in the media, with a relatively low rate of head contact events, and what head contact is occurring, rarely leads to injury. Out of the 901 head contact events that were observed, only 22 led to injury (2.44%). With this said, however, the Laflamme

& Robidoux study reported a total of 35 injuries over the course of their study and 22 (62.86%) involved some form of head contact (Laflamme & Robidoux, at press).

Therefore, efforts to reduce the level of head contact are still necessary, despite their relatively low occurrence as observed in this study.

The observational approach utilized in this study does provide critical information about how and why head contact is occurring, which does provide insight into possible steps to be taken to reduce head contact even further. As evidenced in this research, the type of head contact being experienced differs according to age level, which means measures to reduce head contact must be targeted at specific age levels. At the IP level collision and/or falls to the ice were the primary mechanism of head contact due to players just learning how to skate and where to be on the ice. Even though collisions and falls are inevitable at the IP level, IP players should limit their time playing formal games and rather focusing on practicing their skills such as skating, turning, balancing, stickhandling, passing, and shooting. Introducing skills should still emphasize 'play' in order for the children to have fun while getting better at the sport. Intra squad games where no officials, no score keeping, limited ice surface, is believed to encourage safe and fun competition which we believe would result in fewer contacts. By playing less formal games, this would limit the opportunity for collisions and/or falls to happen. This would also better prepare them to be able to react to all the upcoming stimuli/hazards that are in place over the course of a hockey game. This emphasis on individual skills would also better suit the intent of the level which is to initiate the players to hockey.

As the level of play increases, the players have greater skill, and the type of head contact changes, with more contact along the boards. This is even more prominent when

body-checking is allowed. Learning how to body-check is difficult and special consideration needs to be taken when delivering and receiving a check along the boards. As body checking is introduced, it would be advisable to eliminate checking within a specific distance to the boards. Our suggestion is to introduce a “no contact along the boards” rule where even accidental collisions against the boards would be penalized. This rule could even be introduced in non-body checking hockey to ensure players understand safe play around the boards. After two years of playing body checking, players would enter midget and enter full body checking where contact along the boards would be permissible. In addition to introducing this graduated body checking system, players approaching the bantam level should receive multiple body checking clinics prior to starting body checking hockey. This would prepare them not only to give a proper body-check, with the correct intent of separating the opponent from the puck, but also how to receive a body-check in order to reduce the risk of injury. Coaches and officials would be critical in supporting these rule changes, as coaches teach players proper technique and officials strictly call all on ice infractions. If board contact can be minimized, there will be a considerable drop in overall head contact rates.

## **LIMITATIONS**

There are certain limitations to this study that must be acknowledged. Because of the observational research design, a team approach to data collection was required to cover the amount of games observed in this study, which did lead to inconsistencies when documenting head contact events. To help reduce bias, all game video footage was reviewed by an independent viewer to confirm whether injuries did or did not occur. Another limitation was caused by the discrepancy by the teams recruited in the study. All

the teams recruited in the study were teams that played in the Ottawa and Gatineau regions and that were all playing in competitive leagues. However, it was noted a huge difference of skill level across teams playing competitive B for example, versus teams playing competitive AA. The level of competition may have played into the data, especially at the higher levels like bantam and midget. Finally, only one level of female hockey was observed over the two years, making comparisons between male and female hockey difficult. There were only so many student volunteers that could be recruited to assist with the data collection, so there was a limit in the amount of games could be covered. What is certain is that more observational research is required to compare head contact events between the predominantly male minor hockey leagues and female hockey, and between levels of play in female hockey.

## **CONCLUSION**

Concerns about safety in youth hockey have been openly expressed in public and in academic circles. This is even more present when talking about concussions since the population in general is more aware of this misunderstood injury. Most of the studies done on head contact events in hockey tend to only referred to sensors located on the players' helmet which provide limited descriptive details. However, without actually being in the field observing the head contact events in context, the impact of this research is limited. The comprehensive prospective observational approach utilized in this study proved to be effective in understanding the frequency of head contact events, but also how and why head contact events are taking place. Based on the observations from this study, hockey is not the violent/dangerous sport it is often portrayed to be, and head contact events are not occurring as a result of violent or aggressive play. In fact, very few

head contact events occurred throughout the two years of data collection. The study accounted for only 901 head contact events for 6122 athletic exposures and 204 games played across all levels from the IP level to the midget level. What is disconcerting is that 22 potential injury events occurred over the course of the study caused by head contact events. Considering what is known about the devastating effects of brain trauma, in particular on the developing (children and youth) brain, increased efforts are necessary to find ways to eliminate head contact events.

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## CHAPTER VI

### CONCLUSION

Concerns about safety, especially about head injuries, in youth hockey have been increasingly and openly expressed in public and academic circles over the past two decades. The comprehensive prospective observational approach utilized in this study proved most effective in understanding not only injury events and head contact events, but how and why they are taking place throughout the course of a hockey game. Knowing the contextual factors surrounding such events are important in building injury prevention strategies and to minimize all types of head contact. The importance of reducing head impact is becoming increasingly clear as repeated head impacts, even at lower levels, is having negative neurological consequences on the developing (children and youth) brain (De Beaumont, Theoret, Mongeon, et al., 2009; Guskiewicz, Marshall, Bailes, et al., 2005).

With hockey being such a fast paced game, it is often difficult to observe and document injury events effectively. The use of our centered video camera system proved to be invaluable as it allowed us to break down injury events and head contact events and discover what exactly led to the event through slow motion analysis. The observational research design in combination of a quantitative and qualitative analysis enabled a review of the observation grid assessments to ensure accuracy in reporting. This layered approach enabled better documentation of the amount of injury events and head contact events and the context surrounding the event.

Such methods have led us to determine that while injury events are occurring and will continue to occur, there were fewer than expected injury events recorded, and very

few were considered to be serious—the majority of injured players returned to play the next game. Throughout the two years of data collection, 204 games and 6122 athletic exposures have been observed across all age categories: initiation program level (20 games, 557 athletic exposures, 1 injury events, 133 head contact events), novice level (20 games, 511 athletic exposures, 2 injury events – 1 due to head contact, 78 head contact events), atom level (29 games, 863 athletic exposures, 6 injury events – 4 due to head contact, 96 head contact events), girls pee-wee level (43 games, 1290 athletic exposures, 3 injury events – 3 due to head contact, 122 head contact events), boys pee-wee level (42 games, 1288 athletic exposures, 8 injury events – 6 due to head contact, 93 head contact events), boys bantam level (31 games, 996 athletic exposures, 9 injury events – 4 due to head contact, 70 head contact events), and finally boys midget level (19 games, 617 athletic exposures, 6 injury events – 4 due to head contact, 309 head contact events). This represents an overall injury events rate of 5.72 injury events /1000 athletic exposures and an overall head contact events rate of 147.17 head contact events /1000 athletic exposures and/or 4.42 head contact events per game. Out of the 35 injuries 10 of them occurred in the last 5 minutes of the game which we marked as injury events, but we were not sure if the players left the game or simply did not have time to go back and play. This is something that could be verified in future studies by conducting post game follow ups with coaches or training staff to verify if players did not return as a result of injury. Of all injuries requiring the player to miss the remaining of the game, the head was injured more often than any other body part (head 62.86%, lower body 22.86%, and upper body 14.29%). A total of 35 injury events were recorded, 22 of them occurred as a result of contact to the head. Most of the injury events and head contact events were caused by

some sort of collisions (body to body contact, body to the board contact, and body to body contact followed by a fall to the ice). The combined contact of player and boards was the leading mechanisms of injury. Other information like players' position, period of play, and ice area location were documented for the injury events. Forwards received the highest rate of injury at 60%, which is similar to previous studies (Echlin et al, 2010; Emery, Hagel, Decloe, & Carly, 2010; Flik, Lyman, & Marx, 2005; Hutchison, 2011). It seems logical that forwards would receive the brunt of the injuries since there are more forwards than defense on a team and they tend to cover more ice which would put them more at risk. Forwards tend to cover the entire ice whereas defense typically do not enter the offensive zone, unless pursuing a scoring opportunity. 54.29% of all the injuries happened in the third period of the game. As it was presented in other studies this might be due to the fact that as players get more tired as the game progresses, they might be more vulnerable to injury, either in terms of protecting themselves against falls or collisions. Fatigue may also play a role in decision making; as players fatigue they might be prone to taking more risks when making plays, and risking their own and opponents' safety in the process. Another factor might be a heightened level of competition that often occurs towards the end of close games and players battle to determine the outcome of the game. The play typically intensifies which might compromise safety, making players more susceptible to injury. In combination, fatigue and increased competitiveness are likely factors contributing to an increased rate of injury in the final period of play. Finally, to put injuries into context, injuries were mapped out to determine what part of the ice surface had the highest frequency of injury. Injury locations were mapped out into eight specific regions. These eight areas are part of two major sections: the perimeter

(zone 1, 3, 5, and 6 on the map); and open ice areas (zone 2, 4, 7, and 8 on the map). The perimeter is comprised of the side boards, corners, end boards, and side of net. Side boards refer to the boards and glass and three feet of the ice surface from the boards towards the middle of the rink, spanning all three zones. The corners refer to the rounded portion of the boards and glass connecting the side boards and end boards, including three feet toward the middle of the rink. Out of the 35 injury events, the events were equally split into the two major sections with 17(48.57%) occurring at the perimeter and 18 (51.43%) occurring to the open ice areas. 3 (8.54%) injury events occurred in zone 1, 6 (17.14%) in zone 3, 4 (11.43%) in zone 5, and 4 (11.43%) in zone 6, which represent all the injury events that occurred in the perimeter areas. For the open ice areas, 12 (34.29%) injury events occurred in zone 2, 2 (5.71%) in zone 4, 2 (5.71%) in zone 7, and 2 (5.71%) in zone 8 (Figure 6.2). Zone 2, which represents the area in front of the net had the most injury events with 12 (34.29%) (Figure 6.3). This high frequency in zone 2 is mostly explained by the fact that 6 of them occurred to goaltenders and goaltenders can only be hurt in this specific zone. However, when looking at where the head contact events occurred, the perimeter accounted for 70.47% of all events. This is to say that the perimeter is the location where most battles for the puck are happening which create more collisions and more contact to the head.

Popular opinion and previous literature have shown hockey to be a highly violent and aggressive sport. However, the current analysis of youth hockey did not live up to these assumptions. Observations and analysis provided an enlightened vision of the misconstrued environment of youth hockey. By breaking down the misconception that violence and aggression were responsible for the high injury rates in youth hockey, our

research provides alternative readings. Players are, for the most part, conducting themselves within the informal and formal rules of the sport. The majority of injury events and head contact events that were documented were deemed accidental and were not acts of aggression or violence. The observational approach utilized in this study does provide critical information about how and why head contact is occurring, which does provide insight into possible steps to be taken to reduce head contact even further. As evidenced in this research, the type of head contact being experienced differs according to age level, which means measures to reduce head contact must be targeted at specific age levels. At the IP level collision and/or falls to the ice were the primary mechanism of head contact due to players just learning how to skate and where to be on the ice. Even though collisions and falls are inevitable at the IP level, IP players should limit their time playing formal games – limiting the competitiveness aspect (e.g., no referees, smaller ice surface, no opponent – intra squad instead) - and instead focus more on practicing their skills such as skating, turning, balancing, stickhandling, passing, and shooting. By playing less formal games, this would limit the opportunity for collisions and/or falls to happen. This would also better prepare them to be able to react to all the upcoming stimuli/hazards that are in place over the course of a hockey game. This emphasis on individual skills would also better suit the intent of the level which is to initiate the players to hockey.

As the level increases, the players skill levels rise and the mechanism of head contact changes with more contact with boards. This is even more prominent when body-checking is allowed. In 2009-10, the National Hockey League (NHL) acknowledged that current rules are not sufficiently protecting professional players, calling into question

how these same rules effectively protect youth playing minor hockey. In response the NHL made rules changes to prevent any contact to the head (NHL Rules, 2010). Players in minor hockey have not developed the balance, coordination or timing to allow for full body-checking. Learning body-checking is and has been shown to be a difficult process, and the addition of allowing body-checking along the boards adds more complexity. We then recommend eliminating body-checking within a specific distance to the boards at least within the first years of introducing body checking. Our suggestion is to introduce a “no contact at all cost along the board” rule where even accidental collisions against the boards would be penalized. Over and above this rule, there should be mandatory body checking clinics for players approaching the bantam level. This would prepare players not only to give proper body-checking with the right intent of separating the opponent from the puck, but also how to receive a body-check properly in order to reduce the risk of injury. At the bantam level, a gradual body-checking rule should be put in place. These suggestions are based on two years of observational analysis, which would undoubtedly reduce the number of hits to the head and the overall rate of injury.

These are only a few examples of how youth hockey can eliminate/reduce head contact events. However, it is important to stress that our study found very limited occasions of aggressive and/or violent play. Hockey is currently seeing a major shift where physicality and aggressiveness is being replaced by speed and skill. Leagues (amateur and elite) are constantly looking at ways in order to improve the game and making it safer. For example, the National Hockey League (NHL) introduced a discipline committee that reviews all risky forms of contact that occur throughout a game and fines/suspends players if the act is deemed dangerous/wreckless even if the player did not

receive a penalty on the play. The Canadian Hockey League (CHL), which is Canada's elite Junior league, has attempted to reduce fighting in the league with the introduction of a five fight limit per player per year. While even more can be done, these steps being taken are an indication that leagues are taking player safety serious and the sport and the participants are benefitting from it.

Injury in youth sport continues to be an important issue that parents and sport organizers continue to face as they strive to ensure the safety of participants and encourage sport registration. While injury reporting is an important means of monitoring rates of injury, the results from this observational research study indicate that the situational factors surrounding injury and head contact events must be effectively understood if injury prevention strategies are going to be put into place. What this study revealed is that injury across all levels of minor hockey are primarily the result of incidental or instrumental contact depending on the level of play, with players either colliding into one another, or colliding with subsequent contact with a hard surface, such as boards or ice. For the most part, these events are occurring not as a result of aggressive or violent play, but rather as players simply attempt to execute on ice plays. These findings are important as they illustrate that the sport of hockey is not necessarily the violent and dangerous sport it is often characterized as. I argue that these observations are indicative of a culture shift in the sport, where physicality and aggressiveness are being less emphasized, and a greater focus is being placed on speed and skill. Given the amount of head contact that was documented, at both ends of the age category spectrum, it does warrant further monitoring of the sport for two primary reasons: 1) to ascertain the extent to which head trauma is impacting player brain development; and 2) to strive further in

eliminating head contact all together. With this, this study has provided important contextual details about how injury and head contact is occurring across all levels of minor hockey, and provides important first steps for efficacious injury prevention strategies to be implemented.

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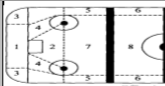
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## APPENDICES

### APPENDIX A

#### Observation grid

CCM YOUTH STUDY																			
Team's name:										Level:									
Date of the game:										Covered by:									
Player	Player's position	Period	time of period	head contact				Contact with Body			Injury Situational Factor				Severity	Zone	Location	comments	
				Head to ice	Head to boards	Stick to head	Puck to head	Body to head	Lower-Body	Arm/hand	Torso	Fall to ice	Collision	Collision against boards	Collision, fall to ice	hit by puck	Hit by stick		(0=kept playing; 1=left OFF, DEF, NEU)



## APPENDIX B

*Informed consent form: English and French*



Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé  
École des sciences de l'activité physique

Faculty of Health Sciences  
School of Human Kinetics

### INFORMED CONSENT

#### **TITLE OF THE STUDY:**

Documenting and Reconstructing Mechanisms of Head Contact in Youth Non-Bodychecking Ice Hockey

#### **INVESTIGATORS:**

Dr. Blaine Hoshizaki, Professor, School of Human Kinetics (SHK), University of Ottawa  
Dr. Michael Robidoux, Professor, School of Human Kinetics (SHK), University of Ottawa

#### **COMMUNITY PARTNERS:**

Reebok - CCM Hockey, Inc., Hockey Canada, Hockey Eastern Ontario Minor

#### **PURPOSE OF THE RESEARCH**

This observational study will identify and analyze the events contributing to the risk of head contact in pre-body checking ice hockey amongst boys and girls at different age levels. The data collected will be used to conduct laboratory reconstructions of head contact events to determine the speed and force of events and their potential impact on the brain. This data will be essential to helmet manufactures to guide the development and innovation of helmet designs that will prove effective in mitigating the risk of head injuries for youth hockey players.

#### **PARTICIPATION IN THE STUDY**

This study is an observational study where researchers will observe and record on ice play of league hockey games. Participation in the study involves coaches/trainers providing the height, weight of all players, along with their helmet model and size to enable laboratory reconstructions.

It is important to note that video recordings of the games will be stored in locked filing cabinets in Dr. Hoshizaki's office at the University of Ottawa for a period of 10 years. The recordings will only be accessible to the members of the research team. Recordings will be destroyed after 10 years. **BENEFITS**

The primary benefit of this study is that the results will provide hockey manufactures the information they need to develop a youth specific helmet designed to perform under the unique impact characteristics experienced by youth hockey players of both genders.

### **CONFIDENTIALITY AND ANONYMITY**

All participants will remain anonymous. Research participants will be categorized by a number with only Researchers and Research Assistants knowing what number corresponds to whom. All video documentation will be altered via digital editing software to avoid identification.

### **VOLUNTARY PARTICIPATION**

Participation in this study is entirely voluntary and teams can withdraw from the study at any time without suffering any negative consequences.

### **RIGHTS OF THE PARTICIPANTS**

The researchers guarantee that:

- Participants can withdraw from the project at any time.
- The confidentiality of the information gathered as well as the anonymity of all participants will be rigorously protected as indicated above.

### **COMMUNICATION OF RESULTS**

At the conclusion of the study, research results will be presented via a written plain language summary to the study partners, Hockey Canada, Hockey Eastern Ontario Minor and CCM. Research will also be presented in scholarly journals and academic presentations. The information may also be used in University of Ottawa graduate theses.

Any information about your rights as a research participant may be addressed to the Protocol Officer for Ethics in Research, 550 Cumberland Street, Room 154, Ottawa, ON K1N 6N5. Tel. 613-562-5387 or email: [ethics@uottawa.ca](mailto:ethics@uottawa.ca) .

There are two copies of the consent form, one of which you may keep.

If you have any questions about the conduct of the research project, you may contact Dr. Michael Robidoux at (613) 562-5800 ext. 4227, Dr. Blaine Hoshizaki at 613-562-5800 ext. 5851, or toll free at 1-877-868-8292.

School of Human Kinetics

### **CONSENT:**

I the undersigned, agree to participate in the above research study. The study has been explained to me, I have had the opportunity to ask questions about my child's involvement and to receive additional details that I wanted to know about the study. I understand that by accepting to participate, I am in no way waiving my right to withdraw from the study at any time.  
I have been given a copy of this form.

Parent/Legal Guardian's signature: \_\_\_\_\_

Date:

\_\_\_\_\_  
Signature of Researcher: \_\_\_\_\_

Date:

\_\_\_\_\_



## Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé      Faculty of Health Sciences  
École des sciences de l'activité physique      School of Human Kinetics

### FORMULAIRE DE CONSENTEMENT

#### **TITRE DU PROJET:**

Documenter et reconstruire les mécanismes de contacts à la tête dans le hockey mineur sur glace sans mises en échec

#### **CHERCHEURS:**

Blaine Hoshizaki, Ph.D., professeur titulaire, École des sciences de l'activité physique (ÉSAP), Université d'Ottawa

Michael Robidoux, Ph.D., professeur titulaire, École des sciences de l'activité physique (ÉSAP), Université d'Ottawa

#### **PARTENAIRES COMMUNAUTAIRES:**

Reebok - CCM Hockey, Inc., Hockey Canada, *Hockey Eastern Ontario Minor*

#### **BUT DE LA RECHERCHE**

Cette étude observationnelle permettra d'identifier et d'analyser les événements qui contribuent au risque de contacts à la tête dans le cadre du hockey mineur sans mises en échec pour les garçons et les filles de différents niveaux et groupes d'âges. Les données recueillies seront utilisées pour effectuer des reconstructions d'événements en laboratoire de contacts à la tête afin de déterminer la vitesse et la force des événements et leur impact potentiel sur le cerveau. Ces données seront essentielles pour le développement et l'innovation de modèles de casques qui se révéleront efficaces afin d'atténuer le risque de blessures à la tête pour les jeunes joueurs de hockey.

#### **PARTICIPATION À L'ÉTUDE**

Cette étude est une étude observationnelle où les chercheurs observeront et enregistreront les événements sur glace qui contribuent aux contacts à la tête. La participation dans cette étude comprend l'implication des entraîneurs/thérapeutes qui fourniront la taille, le poids de tous les joueurs, ainsi que les modèles et les grandeurs des casques afin de permettre les reconstructions en laboratoire.

Il est important de noter que les enregistrements vidéo des parties seront conservés dans des classeurs verrouillés dans le bureau du Professeur Hoshizaki à l'Université d'Ottawa pour une période de dix (10) ans. Les enregistrements seront seulement accessibles aux membres de l'équipe de recherche. Les enregistrements seront détruits après dix ans.

## **AVANTAGES**

L'avantage principal de cette étude est que les résultats fourniront aux fabricants d'équipement d'hockey l'information dont ils ont besoin pour développer un casque spécifique aux jeunes conçu pour performer sous les caractéristiques d'impacts uniques aux joueurs de hockey mineur des deux sexes.

## **CONFIDENTIALITÉ ET ANONYMAT**

L'anonymat est garanti pour tous les participants. Les participants de cette recherche seront catégorisés par un numéro dont seulement les chercheurs et assistants-chercheurs connaîtront l'identité correspondante à chaque numéro respectif. Toute documentation vidéo sera altérée à l'aide d'un logiciel spécialisé afin d'éviter que les participants puissent être identifiés.

## **PARTICIPATION VOLONTAIRE**

La participation dans cette étude est entièrement volontaire et les participants peuvent se retirer de cette étude à tout moment sans subir de conséquences négatives.

## **DROITS DES PARTICIPANTS**

Les chercheurs garantissent que:

- les participants peuvent se retirer de l'étude en tout temps;
- la confidentialité des informations recueillies et l'anonymat de tous les participants seront rigoureusement protégés tel qu'indiqué ci-dessus.

## **COMMUNICATION DES RÉSULTATS**

À la fin de cette étude, les résultats de la recherche seront présentés par l'entremise d'un résumé en langage clair écrit aux partenaires de recherche, Reebok - CCM Hockey, Inc., Hockey Canada, *Hockey Eastern Ontario* Minor. La recherche sera également présentée dans des revues scientifiques et des présentations académiques. De plus, l'information peut être utilisée dans les thèses des étudiants en études supérieures à l'Université d'Ottawa.

Toutes questions concernant vos droits en tant que participant de cette recherche peuvent être adressées au Bureau de l'éthique en recherche de l'Université d'Ottawa, 550, rue Cumberland, pièce 154, Ottawa (Ontario) K1N 6N5. Tél.: 613-562-5387; courriel: [ethics@uottawa.ca](mailto:ethics@uottawa.ca)

Il existe deux copies de ce formulaire de consentement, dont une que vous pouvez conserver.

Pour toutes questions sur la conduite de ce projet de recherche, veuillez contacter le Professeur Michael Robidoux au 613 562-5800, poste 4227, Dr. Blaine Hoshizaki au poste 613-562-5800 ext. 5851, ou sans frais au 1-877-868-8292.

## **CONSENTEMENT**

Je, soussigné, consens à participer dans l'étude de recherche décrite ci-dessus. Cette étude m'a été expliquée et j'ai eu l'occasion de poser des questions concernant

l'implication de mon enfant et de recevoir des détails additionnels concernant cette étude. Je comprends qu'en consentant à participer à la présente étude, je ne renonce pas à mon droit de me retirer de cette étude en tout temps.

J'ai reçu une copie de ce formulaire.

Signature du parent/ gardien: \_\_\_\_\_

Date:

\_\_\_\_\_  
Signature du chercheur: \_\_\_\_\_

Date:

*Nota: L'utilisation du masculin sert uniquement à alléger le texte et désigne autant les hommes que les femmes.*

## Recruitment Text



Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé  
École des sciences de l'activité physique

Faculty of Health Sciences  
School of Human Kinetics

Wayne Ahronson  
Executive Assistant  
Hockey Eastern Ontario Minor  
Richcraft Sensplex, Suite 201  
813 Shefford Rd  
Ottawa, ON  
K1J 8H9

Dear Mrs. Ahronson:

We are approaching you at this time as professors at the University of Ottawa conducting research on the development of hockey through innovative research strategies aiming to optimize playing experiences for male and female players of all abilities and skill levels. One of the targeted areas of research is injury prevention and in partnership with Hockey Canada we are constructing a research program to properly monitor and understand injury in youth hockey. Our intention is to form a partnership with the Ottawa District Minor Hockey Association in order to gather observational data about head contact in youth hockey.

The general aim of this study is to optimize participants' hockey experiences. Through this study we intend to observe and videotape all league games to:

- A. record all on ice behaviour that either leads to head contact;
- B. provide contextual details about head contact situations to better understand how and why these events are occurring.

Prior to any fieldwork we would like to meet you to discuss the possibility of doing our research with your organization. If this initiative appears to be of interest to you, we would then like to meet and discuss this with teams and coaches who might be interested in the study. We will then hold a meeting with potential coaches. Moreover, during training camp or after team selection, we would meet with coaches, parents, and players following a practice of their convenience. At that point we will explain what is involved in the study, what participation would consist of, the benefits of the study, potential risks, proposed outcomes, and any other questions they may have. We will also provide our contact information if they wish to contact us privately. It is our aims to make everyone

involved feel as comfortable as possible and to take any measure we can to ensure such goals are met.

It is important to note that participation is voluntary and they can withdraw at anytime. Furthermore, all participants of this research will be guaranteed complete anonymity and confidentiality and any information collected will not be shared directly with anyone else in the hockey organization. If you have any questions at any point, please contact Michael Robidoux or the Office of Research Services, University of Ottawa Phone: 613-562-5387 or by e-mail [ethics@uottawa.ca](mailto:ethics@uottawa.ca)].

Sincerely,

Michael Robidoux, Ph.D.  
Professor, School of Human Kinetics  
University of Ottawa  
Tel: (613) 562-5800 ext. 4227  
[robidoux@uottawa.ca](mailto:robidoux@uottawa.ca)  
Fax: (613) 562-5497

and

Blaine Hoshizaki  
School of Human Kinetics  
University of Ottawa  
613-562-5800 ext. 5851  
[thoshiza@uottawa.ca](mailto:thoshiza@uottawa.ca)

## APPENDIX C

*Youth assent form: English and French*



Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé    Faculty of Health Sciences  
École des sciences de l'activité physique    School of Human Kinetics

### YOUTH ASSENT FORM

**Title:** Documenting and Reconstructing Mechanisms of Head Contact in Youth Non-Bodychecking Ice Hockey

This form may have some words that you do not know. Please ask the researcher to explain any words that you do not know.

**What is this study about:** To learn about how often head contact occurs in hockey and to understand why head contact might be happening.

**What happens to me if I choose to be in this study?**

Our research team will watch and video tape your hockey games to see if any head contact occurred. Your height, weight and helmet type and size will be recorded so researchers can determine how fast players are travelling on the ice and the force behind head contact.

**What will happen with the information I give you?**

When discussing or writing about this research, we will never use your name. The information you give us will not be shared with anyone outside of the training staff, your parents and us, the researchers.

**What if I do not feel like participating in the study?**

You do not have to participate and can refuse to answer any questions at any point of the study. You will not be penalized for not taking part in our study.

**Questions?**

If you have any questions about being in this study, you can call or have your parent(s) call: Michael Robidoux at 613-562-5800 ext 4227.

**Consent:**

I have read this form and I understand the information about this study. I am willing to be in this study.



Université d'Ottawa • University of Ottawa

Faculté des sciences de la santé  
École des sciences de l'activité physique

Faculty of Health Sciences  
School of Human Kinetics

## FORMULAIRE DE SANCTION

**Titre du Projet:** Documenter et reconstruire les mécanismes de contacts à la tête dans le hockey mineur sur glace sans mises en échec

Ce formulaire pourrait contenir certains termes que vous ne connaissez pas. Veuillez s'il vous plaît demander aux chercheurs de vous expliquer tous les termes que vous ne connaissez pas.

### **Sujet de l'étude:**

Pour identifier les événements qui contribuent au risque de contacts à la tête dans le cadre du hockey mineur et de comprendre pourquoi certains événements surviennent.

### **Qu'advient-il de moi si je choisis d'être dans cette étude?**

Notre équipe de recherche va regarder et enregistrer vos parties de hockey avec des cassettes vidéo pour voir les événements qui contribuent au risque de contacts à la tête. Votre taille, votre poids et le type de casque ainsi que sa grandeur seront enregistrés afin de permettre aux chercheurs de déterminer la vitesse des joueurs sur la glace ainsi que la force du contact à la tête.

### **Qu'allez-vous faire avec l'information que je vous donne?**

En discutant ou en écrivant au sujet de cette recherche, nous n'utiliserons jamais votre nom. Les informations que vous allez nous donner ne seront pas partagés avec personne en dehors de la formation du personnel, de vos parents et nous, les chercheurs.

### **Que faire si je ne veux pas participer à l'étude?**

Vous n'avez pas à participer et vous pouvez refuser de répondre aux questions à tout point de l'étude. Vous ne serez pas pénalisé pour ne pas prendre part à notre étude.

### **Questions?**

Si vous avez des questions par rapport à votre participation à l'étude, vous ou votre parent/gardien pouvez communiquer avec Michael Robidoux, au 613-562-5800 poste 4227.

### **Consentement:**

J'ai lu ce formulaire et je comprends les informations au sujet de l'étude. J'accepte de prendre part à cette étude.