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Risk Factors and Mechanisms of Injury in Female Youth Ice Hockey

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Risk Factors and Mechanisms of Injury in Female Youth Ice Hockey " submitted by Melissa D. Decloe in partial fulfillment of the requirements of the degree of Master of Science.

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Abstract

Objectives: 1) To examine the incidence of injury in female youth (ages 9-17) ice hockey, 2) To examine the type and severity of injury associated with female youth ice hockey participation 3) To examine mechanisms of injury in female youth ice hockey players and 4) To identify risk factors for injury in female youth ice hockey players.

Participants: Twenty-eight teams in the Girls Hockey Calgary Association (GHCA) including Atom, PeeWee, Bantam and Midget age groups.

Outcome Measure: Ice hockey injury, defined as any injury occurring in ice hockey during the 2008/09 season that required medical attention, and/or removal from a session, and/or missing a subsequent session.

Results: Twenty-eight teams (n=324) agreed to participate. A total of fifty three injuries were reported. The overall injury rate was 1.9 injuries / 1000 player hours (95% CI; 1.45-2.70). Previous injury, session type (games) and menstrual history (in PeeWee only) were identified as risk factors for injury.

Conclusions: This is the first cohort study of its kind, using prospective injury surveillance, to examine injury rates, mechanisms of injury and risk factors for injury in girls' youth ice hockey.

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Dedication

This thesis is dedicated to my parents, Dick and Debbie Decloe, who have supported me throughout my life in all my personal and academic endeavours.

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Chapter One: INTRODUCTION

Hockey is a sport of great national importance in Canada and throughout North America. In the 2007 / 2008 hockey season, 77,461 female players were registered with Hockey Canada.[32] This represents 15% of all registered hockey players.[32] There has been a 900% increase in female hockey registrants in the past 15 years and it is estimated that female hockey participation will continue to rise.[32] In Calgary and area, 8% of girls (ages 12-18) reported ice hockey to be one of their top three sports for participation.[23] In 2007, there were 600 girls participating on girls' teams (ages 7-16) as well as 180 girls (Registrar, Hockey Canada, personal communication, October 13, 2007) participating in the boys' competitive and recreational leagues in Calgary.[32] It is acknowledged that ice hockey participation has many benefits; however, ice hockey is a sport that is associated with a high rate of injury. [3] While there has been substantial research examining injury rates and risk factors in boys ice hockey, girls hockey has not been previously examined.[15] Research is needed to address this gap in the ice hockey literature.

1.1 The Problem of Injury

Injuries resulting from sport and recreation participation among children and adolescents are a significant and costly issue.[13, 56, 34.] In Canada, sport related injury has been found to be the leading cause of injury in adolescents and it is estimated that 1 in every 4 adolescents will require medical attention for a sport related injury yearly.[36] Other studies have reported that 35% of non-fatal injuries in children presenting to the emergency department in Denmark are sport-related.[56,55] In the United States, sport

related injuries were found to be the leading cause of non-fatal injuries to adolescents (aged 14-17) in a study based on the National Health Interview Survey (NHIS).[50] Given the high rates of sport related injury, it is evident that this issue has both individual and public health implications.[20]

Injuries that occur during childhood and adolescence are particularly troublesome. There is evidence that children and adolescents may be at an increased risk for injury due to rapid skeletal growth.[18,39] Moreover, certain types of injury are only possible in children and adolescents. For example, a fracture of a growth plate is not possible in adults but can have long term consequences for children with regards to the growth of the joint.[56,18]

Female athletes also produce some unique concerns and considerations. It has been shown that girls have similar injury rates when compared with boys, however, their injury patters differ.[39] For example in one study at the varsity level of play, males incurred more injuries in the severe category than females and males incurred more injuries during games than the females.[51] However, females incurred more injuries than males as a result of body contact and women were injured more frequently than males in the second period of game play.[51] It has been found that differences in body size, composition, shape, circulation, cardio-respiratory capacity, endocrinology and skeletal muscle strength are all factors that may contribute to the differences in injuries in females.[39] While these differences have been acknowledged in the literature, there is also an acknowledgement that epidemiological data on athletic injury in adolescent girls is limited.[39]

1.2 Ice Hockey

Girls' ice hockey registrations in Canada continue to rise yearly. Increases in girls ice hockey participation have been attributed to a number of factors; including the introduction of women's ice hockey as an Olympic sport in 1998 and the victory of the women's Canadian Olympic team in 2002.[15,32] Further, many benefits of ice hockey participation for girls have been acknowledged, such as the physical benefits of increasing activity levels and the social benefits of participation in a team sport. [30] A cross-sectional study by Theberge (2003) examined how ice hockey participation presents girls with the opportunity to challenge traditional gender ideologies and tradition which can benefit girls individually and collectively.[59] With these noted benefits and increases in popularity of girls and women's hockey, it is not surprising that participation has reached such high levels. However, as more girls become involved with hockey, it is necessary that research be conducted that examines the unique experiences and situations of girls in ice hockey, as well as negative outcomes such as injury.

There are some differences between female and male hockey that illustrate why male and female players need separate consideration. The main difference between the two games is that intentional body checking is not permitted in female ice hockey and it is permitted at certain levels of male ice hockey. While body contact and body checking are both individual defensive tactics, the rules of body contact do not permit hitting a player moving in the opposite direction.[32] Comparatively, body checking allows for intentional, deliberate and forceful extensions of the body of a player moving in the opposite direction of the puck carrier.[32] Despite these differences, female ice hockey remains a physical sport that requires attention in sport injury research.

1.3 Purpose

Given the different rules of play in some levels of female ice hockey compared with male ice hockey (i.e. body contact versus body checking), as well as physical differences, it is evident that female youth ice hockey injury rates and risk factors should be examined independently from boys. Further, males and females should be studied separately regardless of their participation in a female league or a male league. [51] As such, the purpose of this project is to examine the public health significance of injury and risk factors for injury in female youth ice hockey. These risk factors will include both extrinsic and intrinsic factors including social-behavioural characteristics previously found to be risk factors for injury in elite male youth ice hockey players.[43] Further, this project will be important for identifying target populations and injuries for future development and evaluation of interventions aimed at preventing injuries in female youth ice hockey.

1.4 Objectives

The specific objectives of this study are; 1) To examine the incidence of injury in female youth (ages 9-17) ice hockey, 2) To examine the type and severity of injury associated with female youth ice hockey participation 3) To examine mechanisms of injury in female youth ice hockey players and 4) To identify risk factors for injury in female youth ice hockey players (i.e. league of play, level of play, history of previous injury, hockey experience, physical activity level, weight, height, menstrual history and psychosocial characteristics such as attitudes towards body contact, levels of aggression and empathy).

1.5 Rationale and Relevance

Despite high participation rates in female youth ice hockey and reportedly high rates of injury at a varsity level of women's hockey, injury in female youth ice hockey has not been previously examined.[51] This cohort study will create a foundation for future research, including the development and evaluation of interventions to prevent injury in female youth ice hockey. A sound understanding of the female youth ice hockey population and the mechanisms and types of injuries they sustain, will allow for interventions that reduce the incidence and burden of ice hockey injury. By prospectively examining both physical and behavioural risk factors for injury in female youth ice hockey, this study will contribute to the field of injury prevention in youth sport and begin to address this public health issue.

1.6 Summary of Thesis Format

This thesis will include a systematic review of the existing literature examining injury rates, mechanisms and risk factors for injury in girls' and women's ice hockey (Chapter Two). This will be followed by a detailed description of the cohort study methodology (Chapter Three). Study results will be presented (Chapter Four), followed by a comprehensive interpretation and discussion (Chapter Five). A summary of the study findings, public health implications and recommendations for future research will be presented in the concluding chapter (Chapter Six).

Chapter Two: LITERATURE REVIEW

2.1 Introduction

Ice hockey is a fast paced contact sport associated with a high rate of injury.[3] Ice hockey injury has received substantial attention in the literature, but primarily in male populations.[1] Studies have been conducted that attempt to determine the rate of ice hockey injury in various populations. These studies, however, are difficult to compare due to the differing methodologies, study populations, and injury definitions.[3] In an analysis of ice hockey injuries in emergency departments in the United States, ice hockey injuries requiring medical attention were monitored using the National Electronic Injury Surveillance System.[33] It was estimated that 32,750 individuals were treated for ice hockey related injuries in 2001-2002 in the United States; including 18,000 players under the age of 18.[33] While this study is useful in that it makes national estimates of the burden of ice hockey injury, results must be interpreted with caution. This estimate likely underestimates the problem of ice hockey injury as it only considers those injuries that required emergent medical attention.[33]

Other studies have examined ice hockey injury specifically in male youth populations. A systematic review of the literature by Benson and Meeuwisse (2005) examined youth ice hockey injury rates and determinants of injury.[3] This review examined 14 studies in youth ice hockey players and found differing injury rates and risk factors partly attributed to by varying study designs, data collection procedures and the varying ways that injury rates were reported (i.e. per game, per 100 players, per 1000 hours or per athletic exposures).[3] For example, a prospective cohort study conducted in

the 2002-2003 hockey season in Ontario, Canada reported an injury rate of 1.9 injuries per 100 players per year across all age groups (4 to18) and injuries were reported using the Hockey Canada Injury Report. The injury rate differed by division of play and representative players in Atom and Bantam incurred the most injuries at 35.3 injuries per 100 players per year in both divisions.[63] A prospective cohort study conducted in Calgary, Alberta in the 2004-2005 hockey season reported an overall injury rate of 30.02 injuries per 100 players per season (95% CI 27.17 to 32.99) for players aged 9-16.[21] Studies among boys ice hockey players have also identified several risk factors for injury including: body checking and other intentional contact, higher divisions of play, age group, levels of aggression and empathy and physical characteristics such as body weight and height and fatigue in tournament play.[63,21,9,43,48] There is much to be gained from examining the boy's ice hockey literature; however, it is not clear whether injury rates and risk factors can be generalized to female populations.[15] As such, girls' ice hockey injuries must be examined independently from boys. The specific objectives of the following systematic review were to examine injury rates, injury types, mechanisms of injury, and risk factors for injury in female ice hockey.

2.2 Data Sources

Seven electronic databases were systematically searched using the terms listed in Table 2.1. Databases included: Medline (1950-present), EMBASE (1980-present), Health STAR (1966-preset), PubMed (1980-present), Sport Discus (1980-present), Dissertation Abstracts at Proquest and Safetylit (Injury Prevention Literature update – accessed Feb

2009). The American Society for Testing and Materials (ASTM) Safety in Ice Hockey, vol. 1-4 were also reviewed in their entirety.

Table 2.1 Medical Subject Headings and Text words

Medical subject headings (MeSH)	Text words
1. Hockey	9. Ice hockey
2. Wounds and injuries	10. Sport injury
3. Women	11. Girls
4. Female	12. Youth
5. Adolescent	
6. Child	
7. Risk Factors	
8. Athletic injuries	

2.3 Search Strategy

The following search terms were applied in each of the electronic database listed above.

a. Hockey or Ice hockey AND Wounds and Injuries or Athletic Injuries or Sport Injuries AND Female or Women or Girls (1 or 9 AND 2 or 8 or 10 AND 3 or 4 or 11).

b. Hockey or Ice hockey AND Wounds and Injuries or Athletic Injuries or Sport Injuries AND Female or Women or Girls AND Adolescent or Child or Youth (a AND 5 or 6 or 12).

c. Hockey or Ice hockey AND Wounds and Injuries or Athletic Injuries or Sport Injuries AND Female or Women or Girls AND Risk Factors (a AND 7).

2.4 Selection Criteria

Articles were scanned first for relevance by their title and then the abstracts were reviewed with the application of the following selection criteria:

1. The study population was female ice hockey players.
2. The main outcome measure was ice hockey injury (any injury sustained during ice hockey participation).
3. The article was peer reviewed.
4. The article was not a review
5. The article was published in English.

Case studies, non-peer reviewed articles and studies that were not published in English were excluded from this review. Results of the search are summarized in Table 2.2.

2.5 Study Selection

In total, four unique articles (based on three unique studies) were identified from the systematic literature search that met the a priori inclusion criteria. A summary of the four articles is provided in Table 2.3.

2.6 Data Extraction

From each identified study, the study design, number of participants, injury definition, injury rates and risk factors were extracted. Injury rates were reported per 1000 player hours (or athlete exposures) and risk factors are reported with point estimates of an odds ratio (OR) or rate ratio (RR) depending on the study. Where available, 95% confidence intervals (CI) were also included. Each study was assessed using the Downs and Black (1998) instrument for validity with consideration of the study design, selected methodology, participants, selection and misclassification bias and whether the authors controlled for possible confounders.[14] Finally, external validity was assessed for each identified study.

Table 2.2 Results of Systematic Literature Search

Electronic Database	Search Strategy	Number of hits	Number of potentially relevant	# Selected (additional to previous searches)
Medline (1950-present)	a	56	4	4
	b	7	0	0
	c	15	2	0
	TOTAL	78	6	4
EMBASE (1980-present)	a	1	0	0
	b	0	0	0
	c	1	0	0
	TOTAL	2	0	0
Health STAR (1966-preset)	a	52	5	0
	b	8	0	0
	c	16	2	0
	TOTAL	76	7	0
PubMed (1980-present)	a	151	3	0
	b	101	3	0
	c	40	2	0
	TOTAL	292	8	0
Sport Discus (1980-present)	a	6	1	0
	b	2	0	0
	c	0	0	0
	TOTAL	8	1	0
Dissertation Abstracts at ProQuest	a	7	1	0
	b	0	0	0
	c	1	0	0
	TOTAL	8	1	0
ASTM Safety in Ice Hockey, vol. 1-4	a	N/A	1	0
	TOTAL	N/A	1	0
Safetylit	a	182	1	0
	TOTAL	182	1	0
			TOTAL	**4**

2.7 Data Synthesis

Table 2.2 provides a summary of the four selected articles including their study design, participants, injury definitions, injury rates and results. Discussion regarding the internal validity and the ability to compare these results is provided along with implications and directions for future research.

2.8 Results

There were no studies identified on risk factors and injury rates exclusively in female youth ice hockey players however four studies have been conducted with women's ice hockey players (that meet the Downs and Black criteria for reviewing observational studies)[14]. The first was a prospective cohort study examining the epidemiology of women's recreational ice hockey injuries (n=314,1997-1998, Edmonton, Alberta) reported an injury rate of 398 injuries/1000 players/season.[15] While the majority of this study sample were women (n=236), seventy eight Midget players were included in the analysis. When the data were stratified by level of play, players in Midget had the highest injury rate at 41 injuries/100 players/season. Injuries were more common in games than practices (65.6% of injuries occurred during games) and the most common mechanism of injury was player contact or body checking.[15] A second paper was published based on a secondary analysis of these data from the first study described above.[16] Risk factors identified in this secondary analysis included: previous sport injury in past year [(OR = 2.20) 95% CI 1.40 – 3.45, p=0.001], participation in additional strength training activities [(OR = 1.82) 95% CI; 1.08 – 3.07, p=0.024], player position (specifically left wing) [(OR = 1.68) 95% CI; 1.03 – 2.75, p=0.039], having greater than

five years of hockey experience [OR = 1.72 (95% CI; 1.10 – 2.70), p=0.018] and exposure level (greater than 50 games and practices in the season) [OR = 1.31 (95% CI; 1.05 – 1.64), p=0.016].[16] Overall, the observed injury rate in this study was lower than observed injury rates found in other studies in male populations, however, limitations such as the self reporting of injuries in this study make this comparison preliminary at best.[15]

The second study by Schick and Meeuwisse (2003) aimed to compare ice hockey injury rates in males and females using a prospective cohort design in varsity ice hockey players.[51] Baseline information about previous injury was collected at pre-season and injuries were tracked using an injury surveillance tool which team therapists completed, on six male teams, and six female teams. Overall, injury rates (per 1000 athlete-exposures) did not differ significantly between males and females [RR= 1.18 (95% CI; 0.89 -1.57), p=0.258].[51] However, differences in the severity of injury were found, as males incurred more injuries in the severe category than the females and males experienced more injury burden than females (based on time loss from injury of 1 day, 2-7 days, 8-14 days and >14 days).[51] This comparison of male and female injury rates and mechanisms of injury illustrates the need for females to be studied separately from males, particularly with respect to injury profiles.

Most recently, a study was published which examined four years of women's NCAA injuries using a national injury surveillance system.[1] This cohort study, conducted in the United States between 2000-2004 collected data on injury rates and risk factors for injury (n=1380). The injury rate in games was 12.6 per 1000 athlete-exposures (95% CI 11.1 - 14.1) and in practices was 2.5 per 1000 athlete-exposures (95% CI 2.1 - 2.9).[1]

Findings were consistent with previous research that found that injuries occurred five times more in games than in practices [RR= 5.0 (95% CI; 4.2 to 6.1)] and that player contact was the most common mechanism of injury.[1]

Table 2.3 Results of Literature Search and Summary of Findings

Author & Study Design	Participants	Injury Definition	Injury Rates	Risk Factors	Results
Dryden, D.M; Francescutti, B.H; Rowe, B.H; Spence, J.C; Voaklander, D.C. [15] Prospective Cohort, Canada (2000)	n = 314 on 33 Women's ice hockey teams during the 1997-1998 hockey season	"Any acute injury sustained playing women's ice hockey during any game or practice that required an individual missing the remainder of a game/practice, a subsequent game/practice and/or required an individual to consult a health professional".	7.5 /1000 player exposures	N/A	N/A
Dryden, Francescutti, L.H; Rowe, B.H; Spence, J.C; Voaklander, D.C.[16] Prospective Cohort, Canada (2000)	n = 295 on 33 Women's ice hockey teams during the 1997-1998 hockey season	"Any acute injury sustained playing women's ice hockey during any game or practice that required an individual missing the remainder of a game/practice, a subsequent game/practice and/or required an individual to consult a health professional".	7.5 /1000 player exposures	Injury in past year +5 yrs hockey experience High exposure	OR =1.57 OR=1.49 OR=1.41
Agel, J; Dick, R; Nelson, B; Marshall, S; Dompier, T.P [1] Prospective Cohort, U.S.A (2007)	n=1380 (63 women's hockey teams) in 2000-2001 season. n=1600 (69 women's hockey teams) in 2003-2004 season	"A reportable injury in the ISS was defined as one that (1) occurred as a result of participation in an organized intercollegiate practice or competition and (2) required medical attention by a team certified athletic trainer or physician and (3) resulted in restriction of the student-athlete's participation or performance for 1 or more calendar days beyond the day of injury".	Practices: 2.5/1000 athlete exposures Games: 12.6/1000 athlete exposures	Games vs. practices	RR=5.0 (95% CI; 4.2-6.1) p=<0.01
Schick, D.M and Meeuwisse, W.H.[51] Prospective Cohort, Canada (2003)	n=261 (6 male & 6 female hockey teams from Canada West) in the 1998-1999 hockey season	"Any event causing a subsequent time loss from participation in ice hockey"	♀7.77/1000 athlete exposures ♂9.19/1000 athlete exposures	Males vs. females	RR=1.18 (95% CI; 0.89-1.57) p=0.258

2.9 Discussion

2.9.1 Injury Rates

Estimated injury rates in women's ice hockey players ranged from 2.5 injuries per 1000 athlete exposures to 12.6 injuries per 1000 athlete exposures.[1] Findings from studies conducted with male youth ice hockey players found injury rates ranging from 11.7 injuries per 1000 player hours [44] to 34.4 injuries per 1000 players hours [58]. While it may appear that injury rates are higher in the male youth population, these injury rates can not be compared directly due to differing injury definitions and varying injury surveillance methods. Further there is no evidence to suggest that findings from studies with women's ice hockey players or with male youth ice hockey players can be generalized to female youth ice hockey players. As a result there is a gap in the ice hockey injury literature in this population and female youth ice hockey injury rates have yet to be determined.

2.9.2 Risk Factors

Identified risk factors for injury in female ice hockey players included: injury in the past year, more than five years of ice hockey experience, high exposure (classified as >50 games or practices in a season) and session type [16]. Risk factors identified in male youth ice hockey players to date include player age, [4, 19, 21, 44, 48, 58, 64] relative age, [61] session type, [8, 21, 26, 54] level of play, [21, 61, 62, 64] player position, [48, 58, 62] body weight and height, [8, 9, 26, 62] and body checking. [24, 29, 45, 49, 63] Despite the large number of studies examining risk factors for injury in male youth ice hockey, findings remain mixed. Studies examining risk factors in male youth hockey have used different methods and

injury definitions and therefore findings remain inconclusive and at times contradictory. It is also unclear whether these risk factors (excluding body checking) are also risk factors in women's or girl's ice hockey given many of these risk factors have not yet been examined in these populations. Further, discussion emerging from existing research in women's hockey highlights the problem associated with small numbers of female hockey players in some areas which results in large differences in skill levels, within teams and on opposing teams.[1,51] Therefore research examining risk factors in female ice hockey must consider these unique circumstances perhaps not encountered in male ice hockey.

2.9.3 Mechanisms of Injury

Player contact (contact with another player) was the leading mechanism of injury identified in this review.[1, 15, 51] Other contact (i.e. with the boards or pucks) was also reported as a common mechanism of injury.[1, 15] In boys youth ice hockey injury studies the main mechanisms of injury reported include body checking [4, 6, 9, 26, 29, 41, 45, 47, 49], contact with sticks[4, 6, 26, 44, 45, 48, 49, 58], contact with pucks[4, 6, 26, 44, 45, 48, 49, 58], contact with skates[48, 49, 58], contact with the boards[49], contact with the goal or goal post[49], falling[45], collision or body contact with another player[6, 9, 26, 29, 41, 44, 45, 48, 49, 58], fighting or roughing[9, 44] and overuse[58] Interestingly, while body checking is not permitted in women's hockey Dryden et al (2000) reported that body checking was the second most common mechanism of injury.[15] Body checking was not examined in the other studies as a possible mechanism of injury so this finding can not be compared. However, this finding highlights the importance of considering body checking in female ice hockey

studies despite the fact that it is not legal. Further, since it is not allowed in female ice hockey, players have likely not been given instruction with respect to how to receive a body check and could therefore be injured more seriously in the event of a body check (albeit illegally).

2.9.4 Injury Prevention

Of the four articles identified, none examined injury prevention strategies. This is likely due to a scarcity of studies examining female ice hockey injury and therefore more research will be required to determine target areas for future prevention interventions. Brunelle et al (2005) examined the Fair Play program in boys' ice hockey. [8] Findings estimate that the odds of injury in the league without the program were 2.43 times the odds of injury in the league that did have the program, however the result was not statistically significant [OR=2.43 (95% CI 0.68-9.05)].[8] Overall, more research is needed in all populations to determine the effect of various ice hockey injury prevention strategies.

2.10 Summary

Four articles based on three unique studies were included in this systematic review. Injury rates in women's ice hockey ranged from 2.5 to 12.6 injuries per 1000 player hours or athlete exposures. [1] Identified risk factors included injury in the past year[16], having greater than five years of hockey experience[16], high exposure [16] and game

play vs. practices.[1] It is unknown whether findings from this population can be generalized to female youth ice hockey players.

2.11 Conclusions

Injury rates and mechanisms of injury in women's hockey are varied due to differences in study design, injury definitions and injury reporting. Injury rates and mechanisms of injury in female youth ice hockey players remain unknown. More research is needed with these populations to determine who would benefit from future interventions aimed at preventing ice hockey injury.

Chapter Three: METHODS

3.1 Research Design

This study was a prospective cohort study which utilized a prospective Injury Surveillance System previously validated in minor hockey.[21]

3.2 Study Participants

The inclusive study sample consisted of female youth ice hockey players (ages 11-16) from the Girls Hockey Calgary Association in the 2008-2009 season.

3.3 Recruitment

Players were recruited from the Girls Hockey Calgary Association (GHCA) League across the Atom (ages 9-10), Pee Wee (ages 11-12), Bantam (ages 13-14) and Midget (ages 15-17) age groups. Calgary and the GHCA were approached in the spring of 2008 to request their participation in the study. Information regarding the study was first presented during the associations Annual General Meeting on June 5th 2008 where the GHCA consented to participation in the study. Coaches of each of the 33 teams in the GHCA were then approached at the mandatory coaches meeting on October 6th 2008 to request the participation of their team in the study. Teams were recruited from all levels of play for each age group. Each individual player and their parent or guardian, were asked to provide written consent to participate in the study (Appendix A). Individual

players who were members of a team that chose to participate were free to decline participation.

3.4 Sample Size

An a-priori sample size calculation estimated that 378 players (27 teams, 14 players per team) were required to achieve 80% power to detect a 0.20 difference of the proportion injured by age (with an adjustment for clusters and a potential drop out rate of 5%, two-sided test, $\alpha = 0.05$, $\beta = 0.20$) (Appendix B). Age was selected as the primary risk factor on which to power this study as it has consistently been shown to be a primary risk factor for injury in youth ice hockey, but has not yet been examined specifically in female youth ice hockey.

3.5 Inclusion/Exclusion Criteria

Players were included if 1) they were registered with Girls Hockey Calgary Association and were participating fully at the beginning of the 2008-2009 hockey season; 2) if they were in the Atom (ages 9-10), Pee Wee (ages 11-12), Bantam (ages 13-4) or Midget (ages 15-17) Divisions of play; 3) if they and their parent/guardian signed a consent form. Teams were included if 1) the head coach consented to participation and 2) a team designate was identified.

Players were excluded if they had an injury or chronic disease which was preventing full participation at the commencement of the 2008-2009 hockey season.

3.6 Procedures

A variety of validated tools were used to assess and measure risk factors and injury among female youth ice hockey players. The primary outcome variable was ice hockey injury defined as any injury occurring in the 2008/09 season (during the regular season, post-season play offs or tournaments) that required medical attention, removal from a session or missing a subsequent session.[21] The independent variables included: age group, division of play, session type (games versus practices), player position, height, weight, menstrual history, previous hockey experience (years), relative age, medical history (previous concussions), sport participation history and self reported views about body contact and self ratings of empathy and aggression. All independent variables were measured at baseline on the pre season questionnaire and with the Buss-Perry Aggression Questionnaire, the Empathy Index for Children and Adolescents and a Body Contact Questionnaire. Further, Follow-Up Questionnaires were obtained twice during the season; one following the holiday break (January 2009) and one at the end of the season (March 2008).

Each team was assigned a team therapist (i.e. physiotherapist, athletic therapist or athletic therapist candidate) who attended a session once every two weeks to assess all ice hockey related injuries (i.e. injuries fitting the above mentioned study definition) and collect study materials. Study therapists were trained by the study coordinator about the protocol of the study on October 15th, 2008 at the commencement of the 2008-2009 hockey season. Each team was also asked to assign a representative (team manager or team parent) who acted as the team designate. Team designates were trained by the study

therapist at the team's first session for the season. The role of the team designate was to record attendance on the Weekly Exposure Sheet (will be discussed in further detail below) and to act as a liaison between the team and the study therapist.

3.7 Data Collection Tools

3.7.1 Preseason Questionnaire

The Preseason Questionnaire (PSQ) (which was previously validated in boys ice hockey and boys and girls soccer)[21, 22] was used to collect baseline information regarding the participants' physical characteristics (self reported height, weight and menstrual history), demographics (age, date of birth, address and telephone number), level of play, sport participation (in hockey and other sports), previous injury, concussion and health history (Appendix C).

3.7.2 Follow-up Questionnaire

The Follow-Up Questionnaire was administered to all players following the holiday break (January 2009) and at the end of the season (March 2009). This instrument was used to collect updated information about the participants' physical characteristics (e.g., weight, height, menstrual history), sport participation (i.e., participation in hockey and in other sports) and type of equipment being worn (e.g., helmet age, type) (Appendix D).

3.7.3 Aggression and Empathy Questionnaires

Aggression and Empathy were measured as potential risk factors for injury using the Buss-Perry Aggression Questionnaire (Appendix E) and the Empathy Index for Children and Adolescents (Appendix F) [11,10]. Both the Empathy and Aggression questionnaires have been validated and have been shown to be reliable.[10, 11] The Empathy index was shown to have adequate reliability in first and fourth graders as measured by Pearson's correlation coefficient. For female students in grade one $r(26) = 0.76$ and for female students in grade four $r(38) = 0.83$.[10] The aggression questionnaire was first tested for reliability in an adult population and was also found to have adequate reliability. The authors reported a score of $r(372) = 0.80$.[11] Both scales were utilized by Emery et al (2009) in a cohort study in boys youth ice hockey players. Since aggression and empathy are not static, this measure was administered in the current study at baseline as well as at midseason (with follow-up one) and at the end of the season (with follow-up two).

3.7.4 Body Contact Questionnaire

A self-report Body Checking Questionnaire examining attitudes and perspectives toward body checking in boy's minor hockey players was adjusted and face validity examined to reflect the inclusion of body contact in female youth ice hockey (Appendix G). This measure was administered at baseline in the fall of 2008 and with each of the two follow-ups.

The validation process included face validation by experts to gauge whether the questions made sense and to determine if the audience could understand what was being asked.

Reliability of the body contact questionnaire was assessed by administering the test twice to the same group of hockey players, one week apart. A one week interval was selected in an attempt to ensure that no genuine changes would occur on any of the variables in that time period. It was also thought that one week would be long enough to minimize learning or memory effects.[46] In total, ten players from each age group were selected to complete the questionnaire again one week following the completion of the Pre-Season Questionnaire. To analyze test-retest reliability, the Kappa statistic for ordinal data was selected.[2] Landis and Koch (1977) describe arbitrary divisions to aid in the interpretation of the Kappa statistic by categorizing the strength of agreement (Table 3.1).[37] These categories of agreement will be presented along side the percent agreement and kappa values of each item from the body contact questionnaire. Finally, a Bland-Altman Limits of Agreement plot was generated to examine test-retest reliability for the total score on the body contact questionnaire.[46]

Table 3.1 Relative Strength of Agreement Labels [37]

Kappa Statistic	Strength of Agreement
<0.00	Poor
0.00-0.20	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-1.00	Almost Perfect

3.7.5 Injury Report Form

Injury Report Forms (IRF) were used to collect information regarding the time and date of the injury, mechanism of injury, injury type, player position and other injury related details. (Appendix H). The IRF was also previously validated in boys youth ice hockey.[21] The completion of the injury report form was initiated by the team designate at the time of the injury (when the study therapist was not present at the session). The study therapist visited the team once every two weeks to assess any injuries and complete the injury report form. Injury assessments included detailed information regarding the mechanism and circumstances of injury, injury assessment details and injury diagnosis. Injured players could be referred by the study therapist to a study physician (Sport Medicine Physician at the Sport Medicine Centre, University of Calgary) if the injury resulted in time loss from hockey, if a concussion was suspected or at the discretion of the study therapist. This physician or any other attending family physician, specialist or other health practitioner (i.e. community physiotherapist, chiropractor, athletic therapist, nurse) involved in the care of the injured player was asked to complete a short diagnosis

and treatment plan form at the end of the Injury Report Form. In cases where the injury report form was missing information (i.e. time loss from injury), telephone follow-up was completed by the research coordinator following the end of the season.

3.7.6 Sport Concussion Assessment Tool

A baseline assessment of concussion status was collected for each participant using the Sport Concussion Assessment Tool. This standardized assessment tool was designed to evaluate athletes after a concussion in sport.[42] Each player was asked to complete an assessment of their everyday status (with the help of a parent / guardian) (Side one – See Appendix I). The study physiotherapist, athletic therapist or athletic therapist candidate completed the second half of the assessment in the first few visits of the 2008-2009 hockey season. (Side two – See Appendix J).

3.7.7 Weekly Exposure Sheet

Daily hockey participation was recorded by the team designate on the weekly exposure sheet (WES) that documented whether each player participated in a game or practice and whether the player participated fully (≥75% of the session), partially (<75% of the session) or not at all (0% of the session). If the player was not participating fully in the session, the team designate was asked to report a reason based on the codes on the WES. When the reason for partial participation was due to an ice hockey injury, the corresponding Injury Report Form number was included in the WES. The information from the WES was used to calculate exposure to risk and to verify time loss from hockey

as a result of an injury. (Appendix K). In cases where weekly exposure information was missing or incomplete an attempt was made to recover the missing information from the team designate. Where missing information still existed for individuals the data was imputed based on the individual or team average for number of games, number of practices and hours of games and practices. Data was imputed for single players when an individual was missing exposure data for one week or more. Data was imputed for teams when a team did not begin reporting weekly exposure data until after the start of the regular season (October 1, 2008), were missing a full week of data (excluding over the Christmas break- December 22nd 2008 – December 28th 2008) or if a team did not collect any weekly exposure data all season. To impute a week or more of data for an entire team, the total number of games, practices, game hours and practice hours were divided by the number of weeks the team had WES data for and these became the values for the missing weeks for the entire team. Where a team did not collect any weekly exposure data, the average for all of the teams in that age group was taken and used for that team's entire season.

3.8 Data Management:

Study materials were collected by the study therapist on an ongoing basis and checked for completeness prior to submitting them to the study coordinator. The study coordinator entered all materials received in a data collection record (in Microsoft Excel) to ensure all study materials were received and up to date. Data screening was an ongoing process beginning when the first study forms were returned. Forms were checked for

completeness and when missing information was identified, the therapist was asked to collect this information as quickly as possible. If the information could not be obtained or the participant did not want to disclose the information then the data was coded as missing. When all the data had been collected and entered, an accuracy check was conducted. This included checking the data for outliers. Where outliers were identified, the original study forms were consulted to rule out the possibility of data entry error. If data entry error did not occur, clarification was sought from the participant or the participant's parent or guardian. In order to enter, manage and store study-related data, StudyTRAX research software by ScienceTRAX was used.[52]

3.9 Analysis:

There were four specific objectives of this study and the following sections outline the analysis completed for each objective. All statistical analyses were completed using STATA Intercooled statistical software, version 9.0.[57]

3.9.1 Cluster Analysis

This study recruited individuals at the team level and therefore all analyses were adjusted for cluster. Killip, Mahfoud and Pearce (2004) note that "similarities among subjects in clusters can reduce the variability of responses from a cluster compared with those expected from a simple random sample" (pg 204).[35] As such, the intracluster correlation coefficient (ρ) was used to measure the relatedness of data within clusters (teams) by using the variance within clusters and between clusters. Intracluster

correlation coefficient values range from 0.0 to 1.0. If the value is close to 1.0 the responses within a cluster are more similar than between subjects in different clusters. Similarly, as the value gets closer to 0.0 the between cluster and within cluster variance is equal.[35]

3.9.2 Objective One

The first objective was to examine the incidence of injury in female youth ice hockey. To achieve this, injury rates with 95% confidence intervals (based on total injuries out of total participants and adjusted for cluster) were calculated per 100 players and per 1000 player hours. These analyses were also conducted using a Poisson regression model (with significance set at 5%) as to see the effects of cluster on the results. This model was selected because some players reported multiple injuries throughout the course of the season and the Poisson regression model allows for these multiple outcomes and is the appropriate probability model for count data. Assumptions of the Poisson regression model are that injuries are independent events and that the probability of injuries is the same in equal time intervals. All analyses using Poisson regression models were checked for accuracy (i.e. had similar point estimates and confidence intervals) using classical stratified analysis.

3.9.3 Objective Two

The second objective was to examine the type and severity of injury associated with female youth ice hockey participation. The type of injury was categorized into one

of seven groups, as per Emery et al, 2006): ligament sprain, contusion, concussion, muscle strain, fracture, dislocation, joint swelling or other. Further, the location of injury was categorized by body region including: head / teeth, shoulder / collarbone, knee, wrist / hand / forearm, groin / pelvis / upper leg, lower leg / ankle / foot, back, chest / ribs / abdomen and neck / throat and proportions were calculated.[21] Severity of injury was quantified based on time loss from hockey as reported on the injury report form. Based on consensus guidelines for reporting sport injury, time loss was categorized into slight (0–1 days), minimal (2–3 days), mild (4–7 days), moderate (8–28 days) and severe (>28 days).[28] A total measure of time loss was calculated by examining the proportion of injuries out of all the total injuries that resulted in time loss from hockey. Time loss from injury was examined using a Poisson regression model with 95% confidence intervals and with relative risk as the main measure of effect. Injury severity was also examined descriptively with proportions of the Injury Severity Scores as reported on the Injury Report Form (1= unable to perform any normal daily activities, 2= unable to participate (i.e. practice) in sport, 3= able to practice but unable to compete in sport, 4=able to compete but performance is impaired and 5= fully able to compete as if there was never an injury).

3.9.4 Objective Three

The mechanism of injury was examined descriptively by calculating proportions with 95% confidence intervals. Mechanism of injury was categorized into intentional contact with another player (elbowing, tripping, slashing, roughing, cross checking, body

checking), incidental contact with another player, contact with the environment (puck, boards, net), no contact and unknown mechanisms.

3.9.5 Objective Four

The fourth objective was to identify risk factors for injury in female ice hockey players. Risk factors included age group, level of play, history of previous injury, hockey experience, physical activity level, weight, height, position of play menstrual history and characteristics such as aggression and empathy and attitudes towards body contact. To examine the relationship between the above stated risk factors (with varying exposure times) and the outcome of injury, a Poisson regression model was fit with significance set at 5%.

3.9.6 Definitions

The following table outlines the variables examined as risk factors and defines how they were dichotomized (Table 3.2). Cut-off points were selected to examine those hypothesized to have the greatest injury risk (i.e. the 25^{th} percentile and above) compared with the referent group (i.e. those at lesser risk) for each age group. Height and weight were examined with the hypothesis that the smaller players (i.e. lighter, shorter) would be at an increased risk of injury than the larger players. It was hypothesised that players who had begun to menstruate would be at an increased risk of injury when compared with those who had not begun to menstruate. For levels of aggression it was hypothesized that players with higher aggression ratings would be at an increased risk of injury compared

with players with lower aggression ratings. Alternatively, for empathy it was hypothesized that players with lower ratings of empathy would be at an increased risk of injury compared with players with higher levels of empathy. Physical activity was examined by comparing those players with lower levels of preseason physical activity to those players with higher levels of physical activity with the hypothesis that lack of preseason physical activity is a risk factor for injury. When examining hockey experience and relative age it was hypothesized that having fewer years of ice hockey experience and being in the first year of eligibility for each age group would increase the risk of injury. Finally, previous injury was examined with the hypothesis that those players who reported a previous injury would be at an increased risk for injury.

Table 3.2 Dichotomized Risk Factor Variable Definitions

Variable	Description
Height	For each age group, the lowest 25th percentile of reported heights versus the remaining 75% of players.
Weight	For each age group, the lowest 25th percentile of reported weights versus the remaining 75% of players.
Menstrual History	For each age group, players who had begun to menstruate versus players who had no begun to menstruate.
Physical Activity Level	For each age group, the lowest 25th percentile of reported physical activity levels in the past week versus the remaining 75% of players.
Position	Position of play at time as reported on Preseason Questionnaire. (forward, defence and goalie)
Aggression	The highest 25th percentile (high aggression) versus the remaining 75% of players (low aggression).
Empathy	The lowest 25th percentile (high empathy) versus the remaining 75% of players (high empathy).
Attitudes towards Body Contact	The highest 25th percentile (positive attitudes) versus the remaining 75% of players (negative attitudes).
Hockey Experience	Atom: Greater than or equal to three years of hockey experience versus those with less than two years of playing experience PeeWee: Greater than or equal to five years of hockey experience versus those with less than four years of playing experience Bantam: Greater than or equal to seven years of hockey experience versus those with less than six years of playing experience Midget: Greater than or equal to nine years of hockey experience versus those with less than eight years of playing experience
Previous Injury	All players reporting a previous injury in the past year on the Pre Season Questionnaire versus all players reporting no previous injury in the past year.
Relative Age	For Atom, PeeWee and Bantam: players in their first year of eligibility versus second year of eligibility. For Midget: players in their first year of eligibility versus players in their second or third year of eligibility.

3.9.7 Exploratory Analysis

In this study an exploratory analysis was conducted to consider changes in selected baseline variables such as height, weight, menstrual history, physical activity level, aggression, empathy and attitudes towards body contact. Changes in each of these variables were first examined descriptively. Further exploratory analysis using a Poisson regression model was done to examine risk factors for injury in the second half of the season where a significant change was found by paired t-tests. In addition, a nested case-control analysis was done to examine injury in ice hockey during the season as a potential risk factor for changes in aggression and empathy between baseline and follow-up two. An exploratory analysis using independent t-tests was used to examine whether these changes differ between those that have sustained an injury (cases) and those that have not (controls) over the study period. It is worth noting here that limitations are acknowledged with this approach given that it is not known when these changes may have occurred (i.e. pre or post injury). However, these analyses are exploratory and will not be used to draw conclusions.

3.10 Ethical Considerations:

Each participant and their parent/guardian had to consent to the study in writing using a consent form that outlined the study to ensure informed consent (Appendix A). There were no anticipated risks to players for participating in this study as they went about their hockey season in the usual fashion. Further, there was an opportunity for the players to benefit from participation as they did not usually have the opportunity to be

assessed by a therapist following a hockey related injury. Confidentiality was ensured as all study forms were assigned unique subject identification numbers and all data entry occurred using these project specific ID's. All study materials were stored in locked filing cabinets in KNB 3300A. This research was conducted on a paediatric population and therefore ethics approval was sought and granted through both the Child Health Research Office as well as the Office of Medical Bioethics (Appendix L and M).

Chapter Four: RESULTS

4.1 Participants

In total, 28 female youth ice hockey teams out of the 33 that were approached (84.85%) agreed to participate in the study. Of the teams that chose not to participate, four made the decision in the pre-season and all reported it was due to feelings of lack of support from team parents to take on study roles (i.e., team designate). One team agreed to participate in the pre-season but the team designate did not collect any study materials and officially dropped out in February. Of the 28 teams that participated in the study, four were in the Atom age group (which does not have any divisions), six were in PeeWee (three from division A and three from division B), nine were in Bantam (5 from division A and 4 from division B) and nine were in Midget (four from division A, two from division B and three from AAA). In total, 324 (of an estimated 476) players consented to participate in the study (68.07%) and participation on teams ranged from four to 17 players. All participants were female. Baseline characteristics of the study participants are presented in table 4.1.

Table 4.1 Baseline Characteristics of Study Sample

Baseline Characteristic	Atom (n=41, N=4 teams)	PeeWee (n=51, N=6 teams)	Bantam (n=117, N=9 teams)	Midget (n=115, N=9 teams)
Age (Median with range)	10 (range 9-10)	12 (range 11-12)	13.5 (range 13-14)	16 (range 15-17)
Proportion of players in 1st 2nd or 3rd year of eligibility	19/40 = 47.5% (31.8-63.2) 21/40 = 52.5% (36.8-68.2)	23/48 = 47.9% (33.6-62.3) 25/48 = 52.1% (.37.7-66.4)	53/106 = 50.0% (40.4-59.6) 53/106 = 50.0% (40.4-59.6)	45/111 = 40.5% (31.3-49.7) 33 /111 = 29.7% (21.2-38.3) 33/111 = 29.7% (21.2-38.3)
Height (cm) (Mean with 95% CI)	142 (95% CI; 138-146)	152 (95% CI; 150-154)	162 (95% CI; 161-163)	166 (95% CI; 165-167)
Weight (lbs) (Mean with 95% CI)	75 (95% CI; 69-80)	96 (95% CI; 90-103)	117 (95% CI; 113-122)	133 (95% CI: 128-137)
Division: (Proportion)				
B	n/a	16/51=31.4% (18.5-44.3)	52/117=44.4% (35.4-53.5)	22/115=19.2% (11.9-26.4)
A	n/a	35/51=68.6% (55.7-81.5)	65/117=55.6% (46.5-64.6)	52/115=45.2% (36.0-54.3)
AAA	n/a	n/a	n/a	41/115=35.6% (26.8-44.5)
Position: (Proportion)				
Forward	17/30 = 56.7% (38.6 - 74.8)	30/50 = 60.0% (46.2 - 73.8)	65/114 = 57.0% (47.9 - 66.2)	63/111 = 56.78% (47.5- 66.1)
Defence	9/30 = 30% (13.3 - 46.7)	16/50 = 32.0% (18.9 - 45.1)	40/114 = 35.1% (26.3 - 43.9)	34/111 = .35.1% (26.3 - 43.9)
Goalie	4/30 = 13.3% (.91 - 25.8)	4/50 = 8.0% (.37.4 - 15.6)	9/114 = 7.9% (2.9 - 12.9)	31/111 = .12.6% (6.4 - 18.8)
Years of girls hockey (Median with range)	1 (range 0-4)	2 (range 0-7)	3 (range 0-8)	5 (range 0-10)
Years of boys hockey (Median with range)	0 (range 0-4)	2 (range 0-8)	2 (range 0-10)	2 (range 0-10)
Total Years (Median with range)	2 (range 0- 5)	4 (range 0-11)	5 (range 0-13)	8 (range 0-15)

Table 4.1 Continued

Baseline Characteristic	Atom (n=41, N=4 teams)	PeeWee (n=51, N=6 teams)	Bantam (n=117, N=9 teams)	Midget (n=115, N=9 teams)
Previous Injury (Past Six weeks)	4/41=9.76% (0.27 - 19.24)	3/49=6.12% (-0.84 -13.08)	9/111=8.12% (2.95 – 13.27)	7/109=6.42% (1.75 – 11.1)
Previous Injury (Past One Year)	5/38= 13.16% (2.22 – 24.09)	6/47=12.77% (2.86 – 22.67)	31/110=28.18% (19.64 – 36.72)	33/110=30% (21.30 - 38.7)
Previous Concussion	1/39=2.56% (-2.63 – 7.75)	1/48=2.08% (-2.11 – 6.27)	15/105=14.29% (7.48 - 21.09)	38/108=35.19% (26.03 - 44.34)

4.2 Completeness of Reporting

Of the 324 players who consented to be in the study, 318 (98.1%) returned their Preseason Questionnaires which included the baseline medical history, the Aggression and Empathy Questionnaires and the Body Contact Questionnaire. Both follow-up one and follow-up two included a shorter version of the baseline questionnaire as well as the Aggression and Empathy Questionnaires and the Body Contact Questionnaire again. Follow-up one was distributed the week of January 12 2009 and follow-up two was distributed the week of February 23 2009. Given the short amount of time between follow-up one and follow-up two, only 130 players (40.12%) completed the first follow-up during the designated follow-up one time period. All forms completed after this time (at the end of January 2009) were considered as follow-up two for which 282 participants (87.04%) returned their forms. In total, 65 Injury Report Forms were submitted and 53 were included once they were screened to ensure they met the injury definition.

4.3 WES Imputation

Overall, 71.43% of teams had incomplete WES data. One team (3.57%) had the full season of WES missing, while fourteen teams (50.00%) had five or less weeks of missing WES data. The remaining five teams (17.86%) had between seven and nine weeks of missing WES data. Imputation of WES data for missing weeks was based on mean hours of participation for all teams playing at the same level. No imputation was done on an individual level as WES data was complete or missing at the team level.

4.4 Behavioural Variables

Feelings of aggression, empathy and attitudes towards body contact were measured as possible behavioural influences on injury. Overall, three hundred and three players completed the baseline aggression and empathy questionnaires and three hundred and seventeen completed the body contact questionnaire. The results of these baseline behavioural characteristics are summarized in Figures 4.1 - 4.3. The overall mean score of the aggression questionnaire was 59.62 (95% CI; 57.97 - 61.27) out of a possible total of 145. The overall mean score on the baseline empathy questionnaire was -6.12 (95% CI; -8.38 to -3.85) out of a possible total range of -88 to 88. Finally for the body contact questionnaire, the mean score was 24.22 (95% CI; 23.56 - 24.88) out of a possible total of 50. Mean scores of each questionnaire were also examined by age group and are presented in Table 4.2.

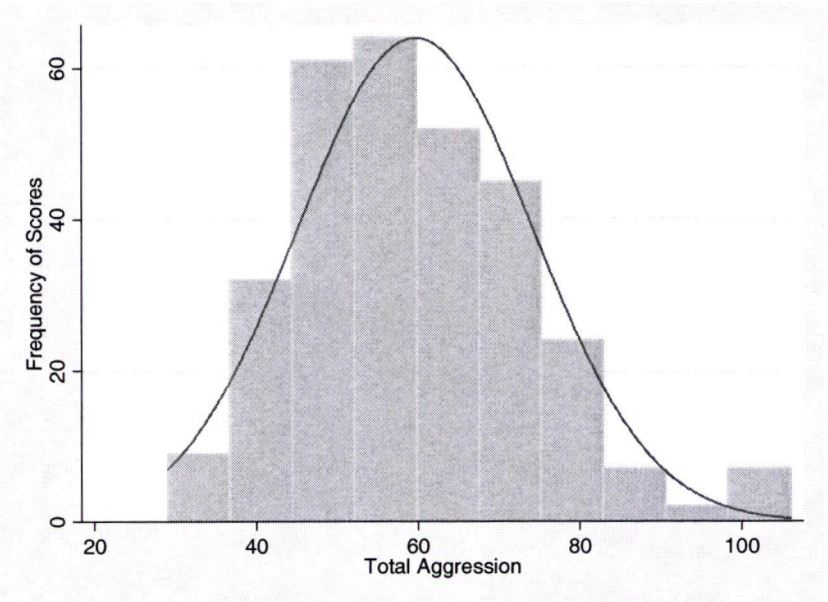

Figure 4.1 Distribution of Total Aggression Scores

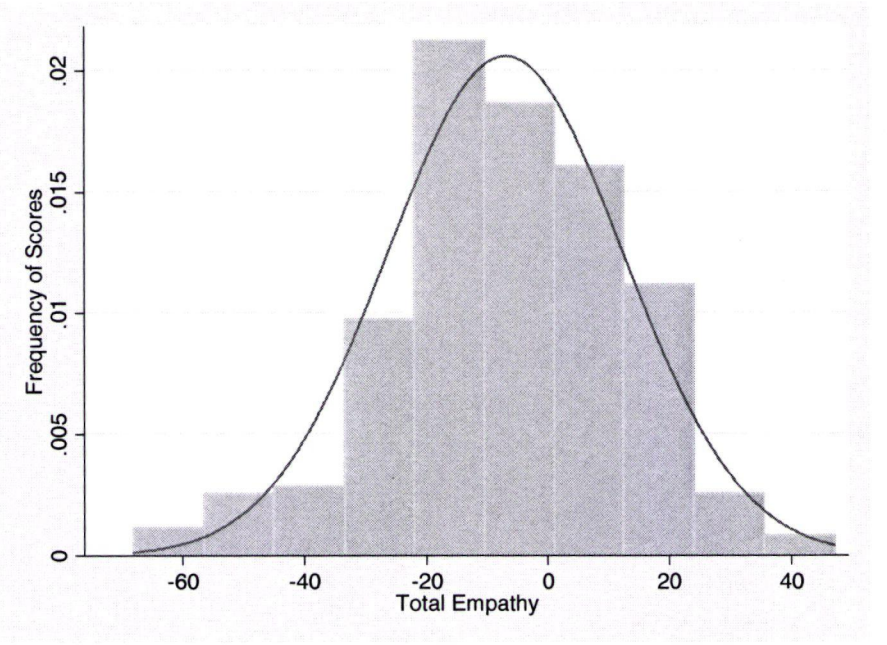

Figure 4.2 Distribution of Total Empathy Scores

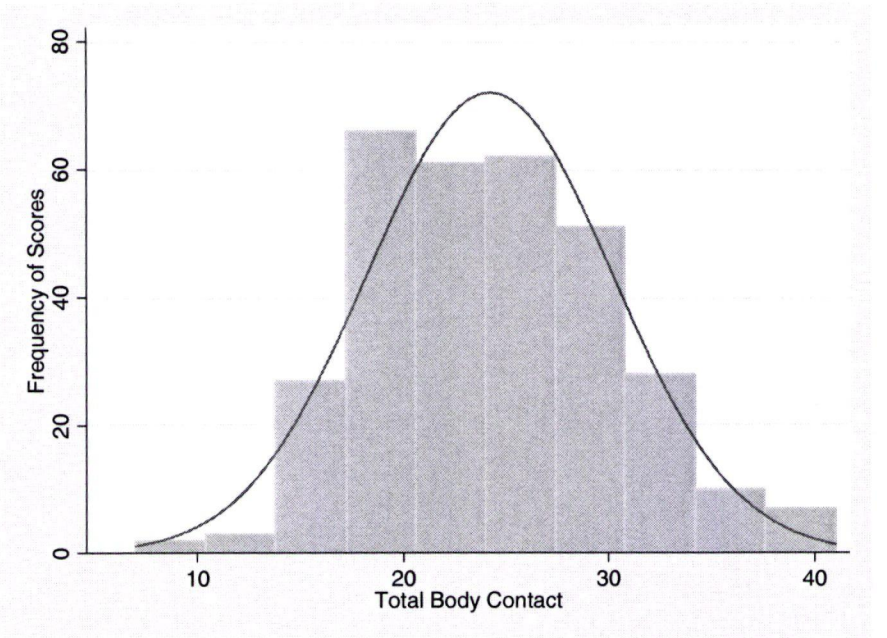

Figure 4.3 Distribution of Total Body Contact Scores

Table 4.2 Mean Scores by Age Group (with 95% Confidence Intervals)

	Atom	PeeWee	Bantam	Midget
Aggression	53.41 (49.08 - 57.74)	55.18 (51.78 - 58.58)	60.84 (57.93 - 63.75)	62.11 (59.52 - 64.69)
Empathy	-7.85 (-16.04 to -0.35)	-6.17 (-13.08 to - 0.74)	-5.35 (-8.89 to -1.80)	-6.28 (-9.71 to -2.86)
Body Contact	20.13 (18.36 - 21.90)	21.16 (19.80 - 22.52)	24.74 (23.74 - 25.74)	26.46 (25.38 - 27.54)

4.5 Test – Retest of Body Contact Questionnaire

The reliability of the Body Contact Questionnaire was assessed using Kappa values for each individual item and a Bland and Altman Limits of Agreement plot for total score (50). For each item, the percent agreement is reported along side the Kappa statistic and the relative strength of the findings as defined by Landis and Koch (1977).[37] The results of the item reliability analysis can be found in Table 4.3. Overall each item on the Body Contact Questionnaire was found to have "fair" reliability (or a Kappa statistic between 0.21 – 0.40) with the exception of question nine ("I would try to harm an opponent with body contact if it would increase my teams chance of winning") which was categorized as having "moderate" reliability (or a Kappa statistic between 0.41 – 0.60). To assess total reliability a histogram was generated which examined the distribution of the difference in total score between time one and time two of the reliability testing and is presented in Figure 4.4. Finally the Bland-Altman Limits of

Agreement Plot was generated and the mean difference was -1.53 (95% CI; -3.06 to 0.005) with an upper limit of agreement of 7.8 and a lower limit of agreement of -10.9 (Figure 4.5).

Table 4.3 Body Contact Questionnaire Test-Retest Reliability Scores For Each Item

Question	% Agreement	Kappa Statistic	Relative Strength
1. I like body contact	50.0%	0.38	Fair
2. I like when body contact is used on me	51.35%	0.25	Fair
3. My coach encourages me to use body contact	42.11%	0.25	Fair
4. My parents encourage me to use body contact	43.24%	0.26	Fair
5. My team mates encourage me to use body contact	52.63%	0.38	Fair
6. I could be seriously injured by body contact	47.37%	0.32	Fair
7. I could seriously injure someone else with body contact	52.63%	0.38	Fair
8. I think body contact increases my teams chance of winning	52.63%	0.34	Fair
9. I would try to harm an opponent with body contact if it would increase my teams chance of winning	73.68%	0.48	Moderate
10. I would use body contact against another player even if I knew it would injure them	78.95%	0.39	Fair
TOTAL SCORE	78.95%	0.49	Moderate

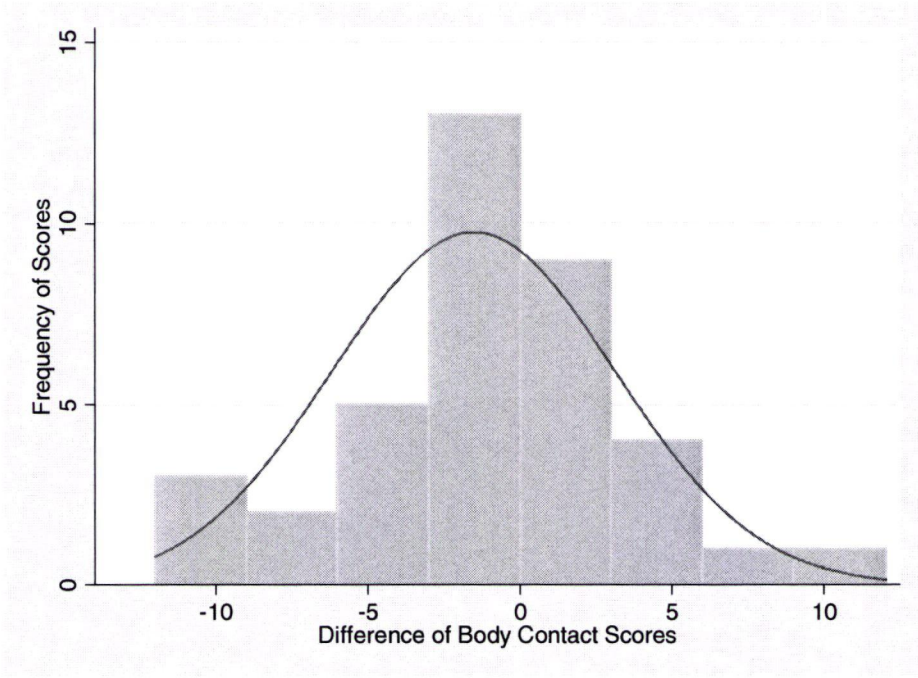

Figure 4.4 Distribution of the Difference in Body Contact Scores (Reliability Testing)

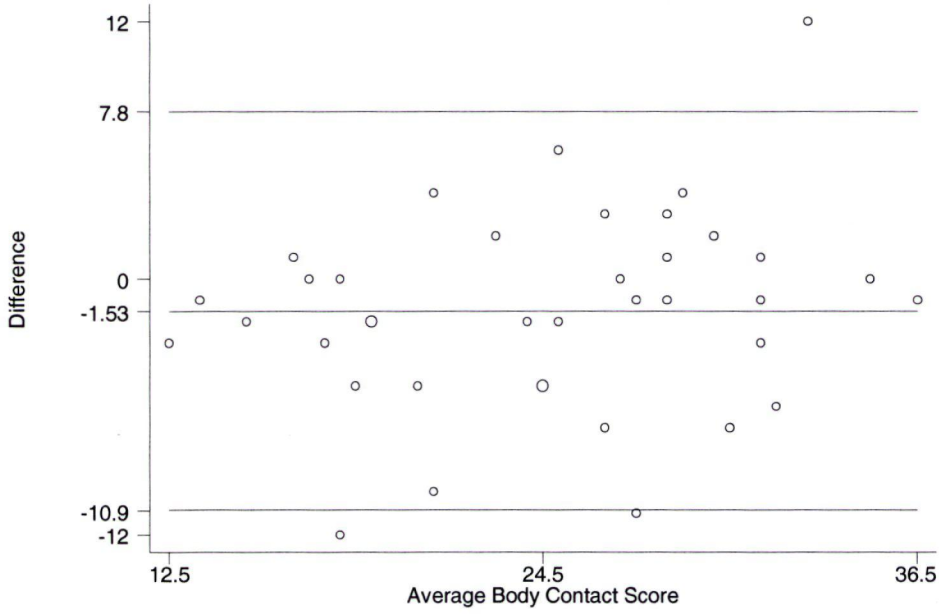

Figure 4.5 Bland Altman Limits of Agreement Plot

4.6 Adjusting for Cluster

Since recruitment was done by teams, all incidence rates presented below have been adjusted for cluster to account for increased similarities with in teams. The Intracluster Correlation Coefficient (ρ) was calculated and stratified by age group (ρ = 0.05) based on 28 clusters with a median cluster size of 12 players per team (range 4 – 17).

4.7 Injury Rates

The overall incidence rate was 1.9 injuries / 1000 player hours (95% CI; 1.45-2.70) or 16.35 injuries / 100 players (95% CI; 10.75 – 24.90). When stratified by age group, incidence rates ranged from 1.01 injuries / 1000 exposure hours (95% CI; 0.33 - 3.09) in Atom to 2.80 per 1000/ exposure hours (95% CI; 1.82 – 4.30) in Midget (Table 4.4). There was no statistically significant increase in risk of injury by age group. There was also no significant increase in risk by division of play. Incidence rates were higher in games than in practices in Midget where the practice incidence rate was 1.55 (95% CI; 0.61 – 3.97) and the game incidence rate was 3.53 (95% CI; 2.18 – 5.74) (Table 4.5). Overall there is no evidence of confounding by age group when examining session type and therefore the overall rate can be used. Overall there was a significant increase in risk in games versus practices [IRR = 2.06 (95% CI; 1.08 - 4.22), p=0.01].

Table 4.4 Incidence Rates by Age Group and Division of Play (Adjusted for Cluster)

Age Group / Division	Athlete Exposure Hours	Number of Injuries*	Injury Rate: Number of injuries/1000 player hours	Injury Rate: 95% Confidence Interval	Division of Play: Incidence Rate Ratio	Division of Play: 95% Confidence Interval	Division of Play: p (Fisher's exact test)	Age Group: Incidence Rate Ratio	Age Group: 95% Confidence Interval	Age Group: p (Fisher's exact test)
Atom										
All	2956	3	1.01	0.33 -3.09	n/a	n/a	n/a	1	-	-
PeeWee										
B	1070	1	0.93	0.28 – 4.05	1	-	-			
A	2164	4	1.85	0.40- 8.52	1.98	0.30 - 13.07	0.48			
All	3234	5	1.55	0.47-5.05				1.52	0.35 - 6.67	0.58
Bantam										
B	3603	1	0.28	0.05 – 1.61	1	-	-			
A	5078	8	1.58	0.86 – 2.90	5.68	0.96 - 33.48	0.06			
All	8681	9	1.04	0.57 – 1.89				1.02	0.33 - 3.19	0.97
Midget										
B	1591	9	5.57	4.51-7.10	1	-	-			
A	4376	7	1.60	0.78 – 3.28	0.28	0.14 - 0.56	<0.00005†			
AAA	6906	20	2.90	1.68 – 4.98	0.51	0.29 - 0.92	0.02†			
All	12873	36	2.80	1.82 – 4.30				2.76	0.95 – 8.01	0.06
TOTAL	27744	53	1.91	1.45- 2.70						

* Total Injuries reported including multiple injuries in the same player
† Denotes statistical significance (p=<0.05), Fishers Exact Test

Table 4.5 Incidence Rates for Games vs. Practices

Age Group	Athlete Exposure Hours	Number of Injuries	Number of Injuries / 1000 player Hours w/ 95% CI (Adjusted for Cluster)	Incidence Rate Ratio	p (Fishers exact test)
Atom					
Practice	1348	1	0.74 (0.13 – 4.31)	1	-
Game	1608	2	1.24 (0.39 – 3.99)	1.68 (0.09 - 98.92)	0.36
PeeWee					
Practice	1249	1	0.80 (0.11 – 5.68)	1	-
Game	1986	4	2.01 (0.43 – 9.46)	2.52 (0.25 - 123.89)	0.22
Bantam					
Practice	3524	3	0.85 (0.23 – 3.14)	1	-
Game	5157	6	1.16 (0.71 – 1.91)	1.37 (0.29 - 8.45)	0.34
Midget					
Practice	5154	8	1.55 (0.61 – 3.97)	1	-
Game	7630	27	3.53 (2.18 – 5.74)	2.30 (1.01 - 5.81)	0.02†
Overall					
Practice	11274	13	1.15 (0.61 – 2.19)	1	-
Game	16381	39	2.38 (1.59 – 3.56)	2.06 (1.08 - 4.22)	0.01†

† Denotes statistical significance (p=<0.05), Fishers Exact Test

4.8 Mechanism of Injury

Mechanisms of injury are summarized in Table 4.6. Intentional contact with another player was the most commonly reported mechanism of injury (39.62%) and contact with the environment was the least reported known mechanism of injury (15.10%). Table 4.6 summarizes the reported mechanisms of injury. For 7/53 reported injuries penalties resulted [(13.21%) 95%CI; 2.76 – 23.65]. Figure 4.3 illustrates all reported mechanisms of injury by age group.

Table 4.6 Reported Mechanism of Injury

Mechanism of Injury	Frequency	Proportion with 95% Confidence Interval
Intentional Contact with another player	21	39.62 (25.76 - 53.48)
Elbowing	2	3.77 (0 – 8.76)
Tripping	2	3.77 (0 – 8.76)
Slashing	0	-
Roughing	0	-
Cross checking	4	9.43 (1.87 - 17.00)
Body checking	11	20.75 (10.02- 31.49)
Incidental Contact with another player	10	18.87 (8.56 - 29.18)
Environment (puck / boards)	8	15.10 (5.51 – 24.68)
No Contact	11	20.75 (5.51 – 24.68)
Unknown Mechanism	3	5.66 (0 - 11.86

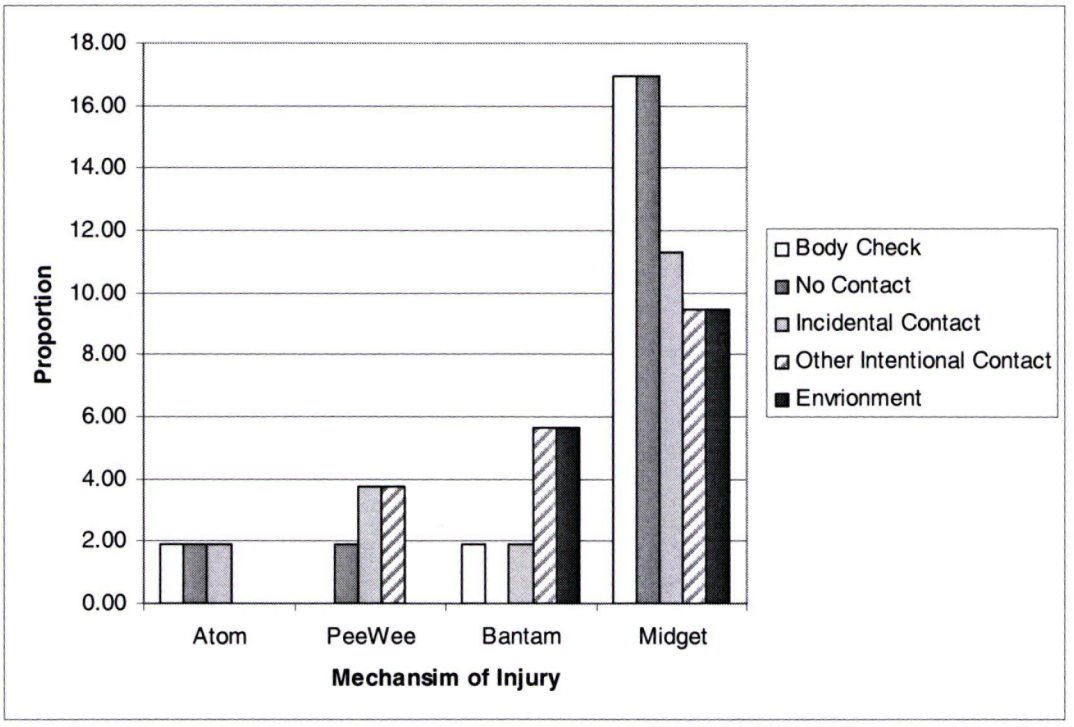

Figure 4.6 Proportion of Injuries by Mechanism of Injury and Age Group

4.9 Severity of Injury

Severity of injury was examined in two ways. First severity was categorized by time loss from hockey, as reported on the Injury Report Form, and classified according to the Consensus Guidelines for reporting sport injury by time loss.[27] Second severity scores, as reported on the Injury Report Form, were used to examine injury severity. When examined by time loss, 44/53 injuries resulted in at least one day of time loss (83.01%). Incidence rates by time loss categories and age group are presented in Table 4.7. The majority of injuries resulted in less than one week of time loss (69.8%) and there were no injuries in the moderate or severe category (8 – 28 or >28 days time loss) incurred by players in the Atom age group and no severe (>28 days time loss) injuries

reported in PeeWee. As such Atom and PeeWee were collapsed into one group and injuries were compared that resulted in less than one week of time loss and greater than one week of time loss [IRR = 1.54 (95% CI; 1.28 – 1.85), p=0.004]. (Figure 4.7). When severity of injury was examined by the injury severity score, in the majority of injuries (71.7%) the injury severity score was less than or equal to 3 (i.e., able to practice but unable to compete in sport) on the five point scale. An injury severity score of 1 is the most severe (unable to perform any normal daily activities) while a score of 5 is the least severe (fully able to compete as if there was never an injury). Figure 4.8 illustrates the severity scores at the time of injury.

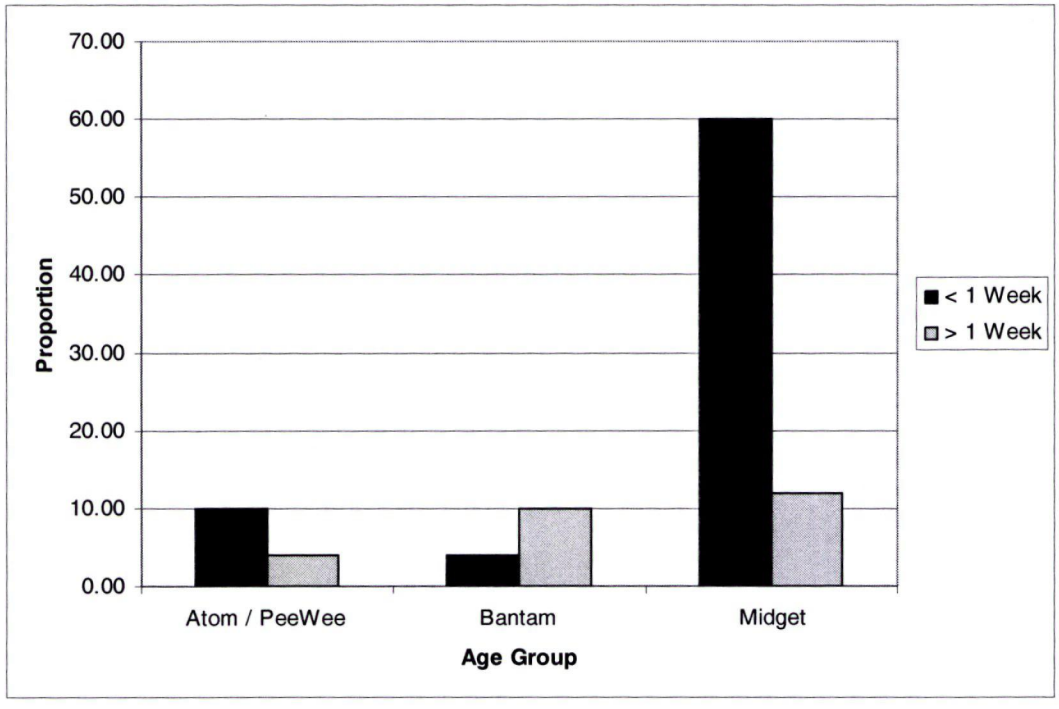

Figure 4.7 Proportion of Injuries Resulting in Time Loss Less Than and Greater Than One Week

Table 4.7 Incidence Rates by Time Loss Categories and Age Group (Adjusted for Cluster)

Age Group	Athlete Exp. Hours	No. of Injuries	# of Injuries / 1000 player Hrs	95% Confidence Interval	Incidence Rate Ratio	p*
Slight						
0-1 days						
Atom	2956	1	0.34	0.06 – 1.87	1	-
PeeWee	3234	1	0.31	0.06 – 1.55	0.91 (0.11 - 7.67)	0.93
Bantam	8681	0	-	-	-	-
Midget	12874	11	0.85	0.27 – 2.73	2.53 (0.39 - 16.53)	0.33
Minimal						
2-3 days						
Atom	2956	1	0.34	0.04 – 2.96	1	-
PeeWee	3234	0	-	-	-	-
Bantam	8681	1	0.12	0.02 – 0.85	0.34 (0.02 - 5.12)	0.44
Midget	12874	8	0.62	0.31 – 1.25	1.84 (0.24 - 13.95)	0.56
Mild						
4-7 days						
Atom	2956	1	0.34	0.06 – 1.87	1	
PeeWee	3234	1	0.31	0.06 – 1.55	0.91 (0.11 - 7.66)	0.93
Bantam	8681	1	0.06	0.02 – 0.77	0.34 (0.03 - 3.63)	0.37
Midget	12874	11	0.85	0.61 – 1.19	2.52 (0.54 -11.81)	0.23
Moderate						
8-28 days						
Atom	2956	0	-	-	-	-
PeeWee	3234	2	0.62	0.12 – 3.09	1	-
Bantam	8681	2	0.23	0.03 – 1.34	0.37 (.03 - 3.97)	0.41
Midget	12874	5	0.39	0.23 – 0.66	0.63 (0.13 - 3.06)	0.57
Severe						
>28 days						
Atom	2956	0	-	-	-	-
PeeWee	3234	0	-	-	-	-
Bantam	8681	3	0.35	0.34 – 0.86	1	-
Midget	12874	1	0.08	0.01 – 0.56	0.22 (0.03 - 1.86)	0.17

* Fishers Exact Test

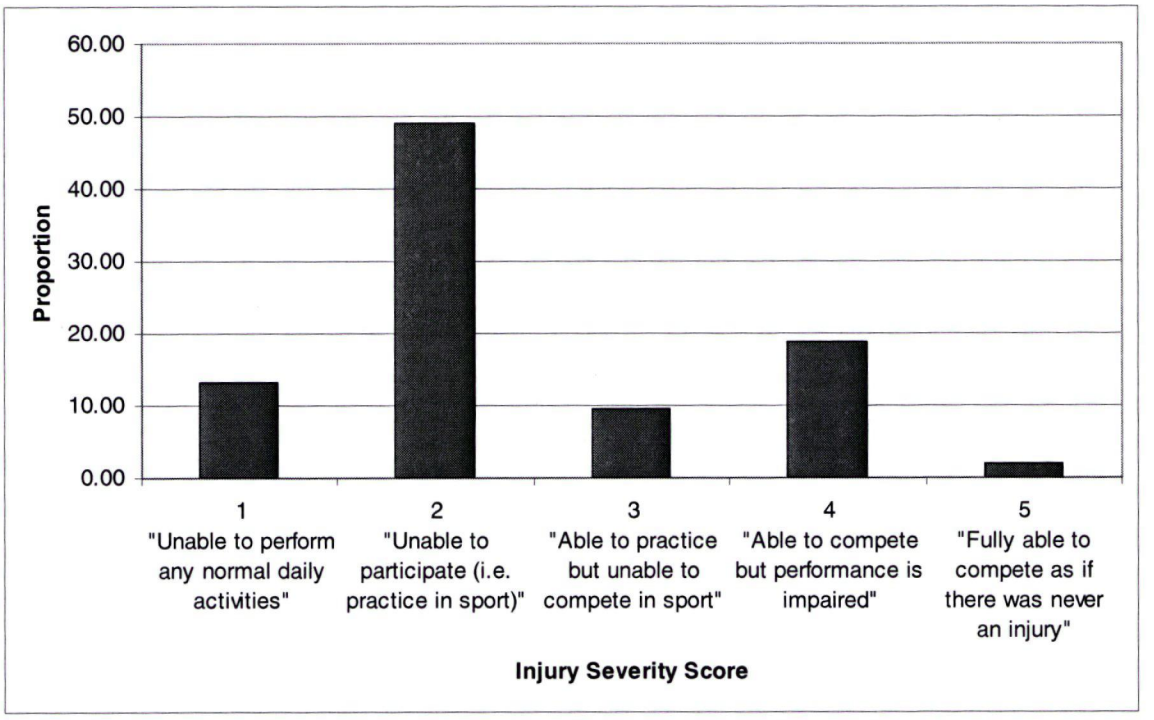

Figure 4.8 Proportion of Injuries by Injury Severity

4.10 Injury Type

Figure 4.9 summarizes the type of injuries reported during the study period. Muscle strain was the most commonly reported type of injury followed by ligament sprain, contusion, concussion, joint swelling, dislocation and fracture. Figure 4.10 illustrates the reported injuries by location of injury. The head / teeth were the most commonly reported injury locations followed by shoulder / collarbone, knee, hand / wrist / forearm, groin / pelvis / upper leg, lower leg / ankle / foot, back, chest / ribs / abdomen and neck.

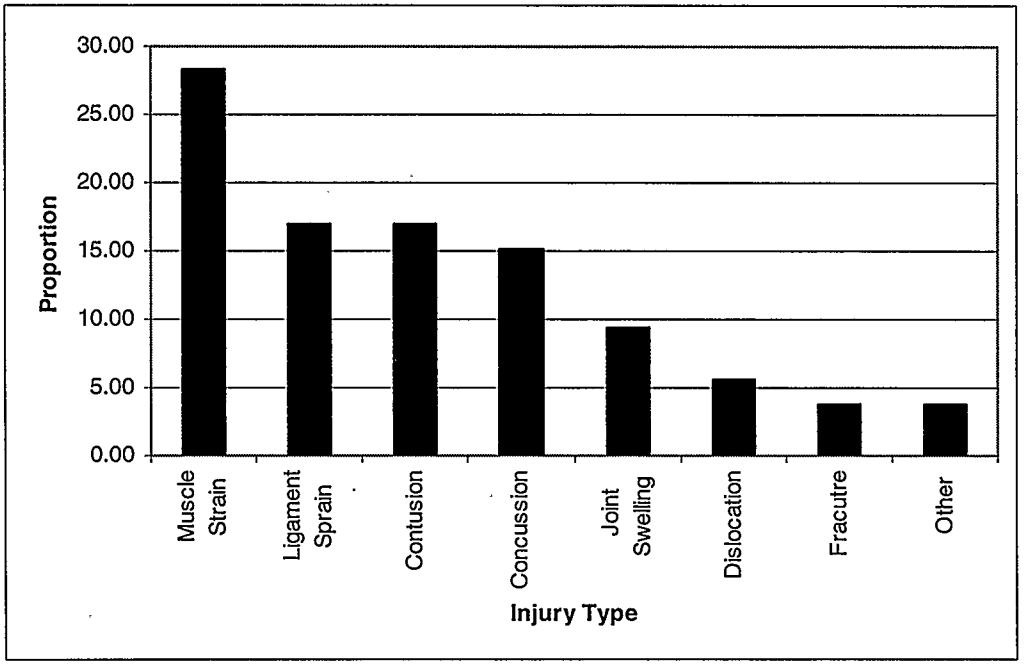

Figure 4.9 Injury Type

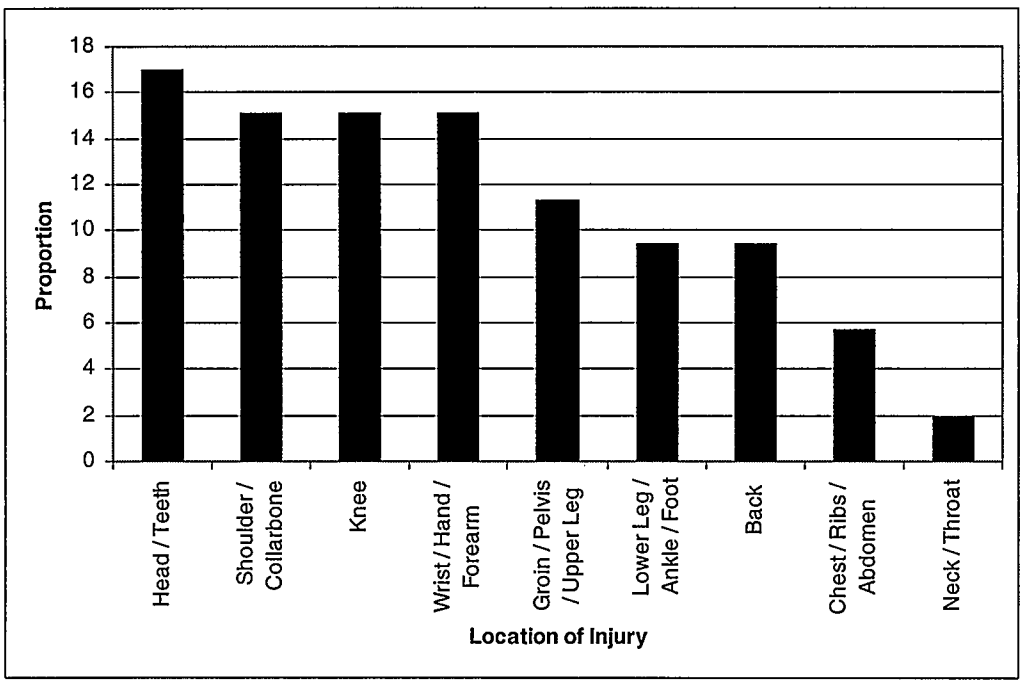

Figure 4.10 Location of Injury

4.11 Concussion

Eight concussions (in six players) were reported throughout the study period. Of the eight reported concussions, one was categorized as slight (0-1 days of time loss), two were categorized as mild (4-7 days of time loss), one as moderate (8-28 days of time loss) and two were categorized as severe (>28 days of time loss). Two of the reported concussions were missing information regarding time loss. Where SCAT data was available post concussion (for five of the eight concussions), players reported having between 1 and 20 positive symptoms (i.e. headaches, dizziness, nausea, irritability etc). SCAT data regarding memory loss was only completed for two of the eight concussions, and no memory loss was reported for either. No concussions were reported in PeeWee. Four concussions were reported in the Bantam age group, three in Midget and one in Atom. Concussion rates ranged from 0.23 concussions per 1000 player hours (95% CI; 0.03 – 1.69) in Midget to 0.46 concussions per 1000 player hours (95%CI; 0.21-1.01) in Bantam. The overall rate of concussion was 0.29 concussions per 1000 player hours (95% CI; 0.12 – 0.68). There was no statistically significant increase in risk of concussion by age group. Concussion rates are summarized in Table 4.8.

Table 4.8 - Concussion Rates by Age Group (Adjusted for Cluster)

Age Group	Exp. Hours	Number of injuries	No. of Injuries / 1000 player Hrs	95% CI	IRR	95% CI	p (Fishers Exact Test)
Atom	2956	1	0.34	0.06 – 2.03	1	-	-
PeeWee	3234	0	-	-	-	-	-
Bantam	8681	4	0.46	0.21 – 1.01	1.36	0.25 - 7.35	0.72
Midget	12874	3	0.23	0.03 – 1.69	0.69	0.06 - 7.81	0.77
Total	27746	8	0.29	0.12 – 0.68	-	-	-

4.12 Risk factors for Injury

Beyond the variables assessed as risk factors discussed above (i.e., age group, division of play, game vs. practices) several other potential risk factors were examined. Physical risk factors included height, weight and menstrual history. Behavioural risk factors included physical activity levels, player position levels of aggression and empathy and attitudes towards body contact – all as reported on the Pre-season Questionnaire. Other risk factors included injury in the past year, years of hockey experience and relative age. All potential risk factors are summarized in Table 4.9.

4.12.1 Physical Risk Factors

Low height and low weight (by age group) were both examined as potential risk factors for injury and no increase in risk was detected for either. At the PeeWee level only, menarche was found to be a significant risk factor for injury. Those players who

had already began menstruation at preseason had 4.17 times the risk of incurring an injury than those who had not (IR = 4.17, 95% CI; 1.03-16.88). In Atom, only one player had started to menstruate and did not incur an injury so a comparison with those who had not was not possible. In Bantam and Midget, the majority of players (i.e. 82.88% and 99.12% respectively) had begun to menstruate and no injuries were incurred in the groups that had not, so again, a comparison was not possible

Table 4.9 Risk Factors for Injury (Adjusted for Cluster)

	Athlete Exposure Hours	Number of Injuries	Number of Injuries / 1000 player Hours	95% Confidence Interval	IRR 95% Confidence Interval	p (Fishers exact test)
Height >25th percentile	16431	31	1.89	1.67 – 3.05	1	-
Height < 25th percentile	5785	9	1.56	0.97 – 2.51	0.82 (0.43 - 1.59)	0.56
Weight >25th percentile	17613.	32	1.82	1.23 – 2.67	1	-
Weight < 25th percentile	5842	12	2.05	1.11 – 3.81	1.13 (0.62 - 2.05)	0.69
Pre Menarche - PeeWee	2705	3	1.11	0.43 – 2.88	1	-
Post Menarche - PeeWee	432	2	4.63	0.40 – 53.23	4.17 (1.03 -16.88)	0.045†
PA level >25th percentile	17393	32	1.84	1.14 – 2.96	1	-
PA level <25th percentile	7095	10	1.41	0.69 – 2.89	0.77 (0.35 - 1.69)	0.51
Defense	8198	14	1.71	0.89 – 3.28	1	-
Forward	15059	26	1.73	1.10 – 2.71	1.01 (0.50 - 2.06)	0.98
Goalie	3022	8	2.65	1.45 – 4.82	1.55 (0.63 - 3.82)	0.34
Low Aggression <75th percentile	18574	35	1.88	1.12 – 2.83	1	-
High Aggression >75th percentile	7520	13	1.73	1.17 – 2.56	0.91 (0.55 - 1.52)	0.74
High Empathy >25th percentile	19055	28	2.71	1.43 – 5.1	1	-
Low Empathy <25th percentile	7390	20	1.47	1.04 – 2.09	0.54 (0.26 - 1.13	0.10
Negative BC* Attitudes	19395	30	1.56	0.94 – 2.59	1	-
Positive BC* Attitudes	8030	18	2.24	1.41 – 3.56	1.44 (0.69 - 3.01)	0.34

* Body Contact
† Denotes statistical significance (p=<0.05), Fishers Exact Test

Table 4.9 Continued

	Athlete Exposure Hours	Number of Injuries	Number of Injuries / 1000 player Hours	95% Confidence Interval	IRR 95% Confidence Interval	p (Fishers exact test)
High Hockey Experience	11664	21	1.80	1.16 – 2.80	1	-
Low Hockey Experience	16080	32	1.99	1.15 – 3.45	1.11 (0.52 - 2.36)	0.80
No Previous Injury-1 year	19415	23	1.18	0.83 – 1.70	1	-
Yes Previous Injury-1 year	6851	22	3.21	2.08 – 4.95	2.71 (1.70 - 4.33)	<0.01†
Relative Age – 2nd / 3rd year	10205	19	1.86	1.17 – 2.97	1	-
Relative Age – 1st year	16187	30	1.85	1.18 – 2.91	1.0 (0.59 - 1.69)	0.99

† Denotes statistical significance (p=<0.05), Fishers Exact Test
* Body Contact

4.12.2 Behavioural Risk Factors

Overall, no behavioural factors measured in this study were found to be significant risk factors for injury. Player position was examined as a potential risk factor for injury and there was no difference in risk for goalies [IR = 2.65 (95% CI; 1.45 – 4.82)] forwards [IR = 1.71 (95% CI; 1.10 – 2.71)] or players in a defensive position [IR = 1.73 (95% CI; 0.89 – 3.28)]. Physical activity within the six weeks prior to completing the preseason questionnaire was also examined as a potential risk factor and no difference was found between the active [IR = 1.84 (95% CI; 1.14 – 2.96)] and less active [IR = 1.41 (95% CI; 0.69 – 2.89)] groups. Aggression was then examined and no differences were detected between those who were rated as having high aggression [IR = 1.73 (95% CI; 1.17 – 2.56)] and those who were rated as having low levels of aggression [IR = 1.88 (95% CI; 1.12 – 2.83)]. Similarly, no differences were found between the high empathy [IR = 2.71 (95% CI; 1.43 – 5.10)] and low empathy groups [IR = 1.47 (95% CI; 1.04 – 2.09)]. Finally attitudes towards body contact were examined and no difference was detected between the positive and negative attitude groups [IR = 2.24 (95% CI; 1.41 – 3.56)], [IR = 1.56 (95% CI; 0.94 – 2.59)].

4.12.3 Other Risk Factors

Total years of hockey experience and relative age were not found to be significant risk factors for injury in this analysis. Having an injury in the past year was found to increase risk of injury [IR = 2.71 (95% CI; 2.08 – 4.95)] when compared with those players who did not have an injury in the previous year [IR = 1.18 (95% CI; 0.83 – 1.70)].

4.13 Exploratory Analysis One: Change in Selected Baseline Variables

Selected baseline variables were examined descriptively to determine if any significant changes occurred between pre-season (October 2009) and follow-up two (February 2009). Using a paired t-test to examine the difference in means for each variable, it was determined that aggression and height had statistically significant changes (p=<0.001 and 0.0004) respectively. Weight was not shown to change markedly throughout the season nor did attitudes towards body contact. Results of the t-tests are summarized in Table 4.10.

Table 4.10 Change in Selected Variables Between Preseason and Follow-up Two

Variable	Mean Baseline with 95% CI	Mean Follow up 2 with 95% CI	t	p
Weight (lbs)	118.12 (114.36 - 121.87)	119.34 (115.61 - 123.07)	-1.86	0.06
Height (cm)	161.30 (159.96 - 162.64)	162.246 (160.95 - 163.54)	-3.57	0.0004†
Aggression	59.57 (57.89 - 61.24)	63.78 (61.76 - 65.81)	-4.63	<0.001†
Empathy	-6.30 (-8.82 to -3.78)	-7.47 (-10.13 to-0.81)	1.97	0.36
Attitudes towards BC*	24.38 (23.68 - 25.07)	24.36 (23.59 - 25.14)	0.03	0.98

† Denotes statistical significance (p=<0.05)
* BC = body contact

Since no significant changes in weight, empathy or attitudes towards body contact were detected, these change variables were not included in the exploratory analysis of potential risk factors. Aggression and height were examined at baseline and were not found to be significant risk factors. However, given that these variables do not appear to be static, changes in this variable were considered as potential risk factors using a Poisson Regression model. Results of the Poisson Regression indicate that changes in aggression or height are not statistically significant risk factors for injury (Table 4.11).

Table 4.11 Changes in Aggression and Height as Risk Factors for Injury (Adjusted for Cluster)

	Athlete Exposure Hours	Number of Injuries	Number of Injuries / 1000 player Hours w/ 95% CI	Incidence Rate Ratio w/95% CI	p (Fishers exact test)
No change / Decrease in aggression	18982	37	1.95 (1.34 – 2.95)	1	-
Increase in Aggression	5138	10	1.95 (0.88 – 4.29)	1.0 (0.42 - 2.40)	0.99
No change in height	18250	33	1.81 (1.13 – 2.90)	1	-
Increase in height	2417	7	2.90 (1.32 – 6.36)	1.60 (0.60 - 4.27)	0.35

4.14 Exploratory Analysis Two: Nested Case Control Analysis

A nested case control analysis was undertaken to examine if changes in aggression differ between those that have sustained an injury (cases) and those that have not (controls). Results of the independent t-test (Table 4.12) did not reveal any significant differences between those who had been injured and those who had not in terms of changes in aggression (p=0.06).

Table 4.12 Comparison of Injured vs. Non-Injured Players in Changes of Aggression

	Mean Non Injured Players (Controls) with 95% CI	**Mean Injured Players (Cases) with 95% CI**	**t**	**p**
Aggression	-3.51 (-5.3 to -1.70)	-8.28 (-14.51 to -2.04)	1.87	0.06

Chapter Five: DISCUSSION

This is the first study of its kind to examine female youth ice hockey injury. This study utilized prospective injury surveillance methods and recorded hours of player participation. Overall this study with a large sample size had high participation rates as well as high proportions of completed data. Injury rates, mechanisms of injury, injury severity and risk factors were all examined and adjusted for cluster providing the most conservative estimates possible. This study contributes to the ice hockey injury literature in that female youth ice hockey injury rates and risk factors were previously unknown.

5.1 Body Contact Questionnaire

The Body Contact Questionnaire was examined for test-retest reliability and was found to have "fair" or "moderate" reliability for each item. However, since the total score of the Body Contact Questionnaire was of interest in this study, the Bland-Altman plot was generated to examine total score reliability. The mean difference in scores was -1.53 (95% CI; -3.06 to 0.005) between time one and time two indicating very little difference in scores (i.e. where the total score is 50). However, the upper limit of agreement was 7.8 and the lower limit of agreement was -10.9 indicating that the intra-rater (within child) scores changed up to 9.37 points (higher or lower) from the first administration of the questionnaire to the second administration. As such, the

interpretation of differences in scores between players should be considered with caution if these differences are small.

5.2 Behavioural variables

Mean scores of the Buss Perry Aggression Questionnaire in this study were lower [59.62 (95% CI; 57.97 - 61.27)] than what was found when the same questionnaire was administered in male youth hockey players. Emery et al (2009) reported a mean of 70.57 (95% CI; 67.35 – 73.80) in the non body checking group (which was selected to compare to female youth hockey players as they too have no body checking).[25] It is difficult to say whether this difference in mean aggression ratings between male youth hockey players and female youth hockey players could have an influence on injury rates. However, one could hypothesize that lower levels of aggression may be a factor in the lower injury rates seen in this study compared to boys. Further, perhaps differences in measured aggression contribute to different styles of play in male and female hockey.

Mean empathy scores were also much lower in this study than in the study of male youth hockey players by Emery et al (2009).[25] In the non-body checking cohort, mean empathy scores were 3.50 (95% CI; 0.24 – 6.77)[25] versus in the current study where the overall mean was -6.12 (95% CI: -8.38 to -3.85). When examining the confidence intervals of these two scores and considering the large range of possible scores (-88 to 88) it is arguable that the two findings are quite similar.

Since the Body Contact Questionnaire has not been used prior to this it is difficult to compare the findings of this study. However, a body checking questionnaire was employed in the boys study (but with a total possible score of 55 compared to 50 with the body contact questionnaire).[25] This study yielded a mean score of 24.22 (95% CI; 23.56 - 24.88) out of a possible total score of 50. In the boys study with the body checking questionnaire a mean score of 22.43 out of 55 (95% CI; 21.38 – 23.49) was reported in the non body checking cohort, indicating attitudes towards body checking that were on the more negative end of the scale.[25]

5.3 Injury Rates

Overall injury rates in this study [(IR = 1.91) 95% CI; 1.45- 2.70] were lower than those reported in the literature in women's ice hockey which ranged from 2.5 -12.6 injuries per 1000 athlete exposures.[1] Dryden et al (2000) examined Midget players and found an injury rate of 6.7 injuries per 1000 player hours, a rate higher than what was found in the current study for Midget players [(IR=2.80) 95% CI; 1.82 – 4.30].[15] While the injury definitions were similar making this comparison easier, injuries in the Dryden et al (2000) study were self reported compared with the therapist reporting utilized in this study.[15] Injury rates in this study were also much lower than what has been found in male youth hockey where injury rates have ranged from 11.7 injuries per 1000 player hours [44] to 34.4 injuries per 1000 players hours. [58] There are many possible reasons why the rates in female youth hockey appear lower than in boys or women's hockey. In boys hockey,

body checking is permitted at some levels of play and is associated with an increased risk of injury.[24, 29, 45, 49, 63] Further, differences in the speed or nature of the two games or biomechanical differences between males and females may have an effect on injury rates. It is perhaps more difficult to speculate why injury rates differ between female youth hockey players and women. Perhaps differences in the speed of the game or the physical force of adults compared with younger players. Further, given that previous injury is an established risk factor for injury, women have likely had more previous injuries than girls which could contribute to the higher injury rate seen in women's hockey.[16 60] Given that this study utilized validated injury surveillance methods and an inclusive injury definition, it is unlikely that differences in injury definition are contributing to the lower injury rates seen in this study.

5.4 Concussion Rates

Concussion rates in varsity women's hockey were reported by Agel et al (2007) and were between 1.8 per 1000 player hours in practices (in the 2000-2001 season) and 3.6 per 1000 player hours in games (in the 2003-2004 season).[1] These rates are considerably higher than the concussion rate found in this study [(IRR = 0.29) 95% CI; 0.12 – 0.68]. However, the study by Agel et al (2007) was examining women's varsity athletes in the NCAA and would be better compared against other elite athletes. In a study by Emery et al (2006) examining the same age groups, study methodology and injury definition as the current study, but in boys youth hockey, concussion rates were

consistent with this study ranging from 0.24 concussions per 1000 player hours (95% CI; 0.05 – 0.7) in Atom to 0.97 concussions per 1000 player hours (95% CI; 0.51 – 1.25) in Midget.[21]

5.5 Mechanisms of Injury

Mechanisms of injury reported in this study appear consistent with what has been reported in the literature, in both women's hockey and boys youth hockey. Body checking is not permitted in female youth hockey, however, it was reported as the mechanism of injury in 20.75% injuries. This is consistent with findings by Dryden et al (2000) who found body checking to be the most common mechanism of injury in women's hockey accounting for 21.6% of injuries.[15] Dryden et al (2000) and the current study both highlight the fact that, despite being illegal, body checking appears to be occurring in girls hockey and must be considered. Possible interventions might be considered to target such mechanisms of injury such as the fair play program evaluated by Brunelle et al (2005).[8]

5.6 Injury Severity

The majority of the injuries reported in this study overall (74%) resulted in less than one week of time loss and this is consistent with the women's hockey literature.[1, 15, 51] This is also consistent with studies in male youth populations that examined time loss as a measure of injury severity.[9, 21] In Bantam however, there were a higher number of

injuries resulting in greater than one week of time loss (71.42%) compared with those resulting in less than one week of time loss (28.57%). This finding is consistent with the study by Emery et al (2006) where slightly more injuries were reported that resulted in greater than one week of time loss (52.05%) than less than one week time loss (47.95%) in Bantam only.[21] While the difference in time loss does not appear to be extremely large in either study, perhaps this finding speaks to unique circumstances in Bantam only. For example, perhaps the gap between the most skilled players and the less skilled players becomes more noticeable at this age group, resulting in more severe injuries for those players in the lower skill group. Or perhaps more severe injuries are a result of larger differences in size, strength or speed between players in this age group.

5.7 Injury Type

Injury types reported in this study are consistent with the types of injury reported in the literature in women's hockey players.[51] However, the incidence of each injury type differed between studies. For example Schick and Meeuwisse (2003) found concussion to be the most common injury type in their study (25.00%) whereas in the current study muscles strains (28.3%) and ligament sprains (16.98%) were the most common.[51] Dryden et al (2000) also found concussion to be the most common in the Midget age group, but muscle strains and strains were most common in the adult recreational league.[15] In the boys youth literature overall, Benson and Meeuwisse (2005) report that contusions, sprains/strains, fractures, concussions and lacerations were the most common injury

types.[3] Findings of this study are most consistent with what was reported in male youth hockey players using the same injury surveillance methodology and injury definition in the same city, where concussion was also the most commonly reported injury type.[21] Differences in injury type between adult populations and youth populations could be due to many factors (force, speed of game, history of previous injury etc) and highlight the importance of considering youth injury separately.

5.8 Risk Factors for Injury

History of previous injury in all age groups, session type and positive menstrual history (in Pee Wee) were found to be significant risk factors for injury in this study. There was also a suggestion that age group and division of play were risk factors for injury. The finding that previous injury is a risk factor is consistent with studies examining ice hockey injury risk factors in both boy's and women's ice hockey. [16, 60] Many potential explanations are suggested in the general sport literature as to why previously injured players are found to be at an increased risk including, lack of rehabilitation, decreased levels of physical fitness, persistent instability, premature return to play and underestimation of the previous injuries severity.[19, 40] It must be acknowledged however that the theories behind why previous injury is a risk factor require much more attention in the literature.

No studies exist which examine menstrual history and injury in female ice hockey however, menstrual phase and hormonal changes have been examined with respect to

specific injuries (for example ACL injuries).[5, 7, 12, 31, 53]. In the current study, players who had begun to menstruate (at the Pee Wee level by ages 11 and 12) were at an increased risk of injury over those who had not yet begun to menstruate. The possibility of collinearity ("very high correlation between independent variables") [38] or confounding must be considered here, however, relative age (i.e. first or second year eligibility, division of play and body weight) were not found to be significant risk factors in this analysis (three factors that could be affecting this finding). Assuming no confounding or collinearity, it is possible that the hormone changes which have been shown to increase risk of ACL injury influence other types of injury as well. Youth sport is unique in the fact that adolescence it is a time of rapid skeletal growth and menarche is a marker for this growth. As such, this could be what this finding is highlighting. Unfortunately there is a gap in the literature in this area with respect to sport injury (aside from ACL injuries) and therefore this finding is difficult to compare and interpret. It is fair to conclude that the relationship between menstrual history and injury in ice hockey (and in sport in general) should be examined further.

When stratified by age group, session type was found to be a significant risk factor in Midget only. However, once assessed for effect modification and confounding, no differences between the four age groups were seen nor was the crude different from the adjusted Incidence Rate Ratios and therefore the overall finding of an increased risk of injury in games was reported. This finding is consistent with the literature where session type has been found to be a significant risk factor for injury [8, 21, 26, 54].

There is some suggestion when examining age group and division of play that these are also risk factors for injury. For example, the comparison between Atom and Midget yielded a confidence interval where the lower limit was very close to one (95% CI; 0.85 – 9.5) and a p-value of 0.06. While a significant increase in risk was expected between these two groups (as has been shown in other studies) this study controlled for cluster and therefore the finding reported here is the most conservative. Other studies were analysis was done at the individual level (as apposed to cluster analysis) would have found age group to be a significant risk factor and therefore the type of analysis must be considered when comparing findings. Similarly, when examining the difference in risk between divisions at the Bantam level, one can see that lower limit the confidence interval is very close to one (95% CI; 0.96 - 33.48) and the p-value was p=0.06. Again, this suggests a difference in risk between those in the lower division (B) and those playing in the higher division of play (A) and would have been revealed in an individual level analysis. Further, in Midget, significant differences were shown between divisions, although in this case, a decrease was found between the lowest division of play (IRR = 1.0) and the higher divisions of play [IRR = 0.28 (95% CI; 0.14 – 0.56), p=<0.00005] in A and [IRR = 0.51 (95% CI; 0.29 – 0.92), p=0.02] in AAA. Other potential risk factors such as height, weight, player position, relative age, ice hockey experience, levels of aggression, levels of empathy and attitudes towards body contact were examined. However, none were found to be significant in this study. While some studies have found some of the above factors to put players at an increased risk of injury, findings remain

mixed across the women's ice hockey literature and the male youth literature. In their systematic review of ice hockey injuries, Benson and Meeuwisse (2005) note that ice hockey risk factors are understudied in pediatric populations and are poorly delinated.[3] Regardless, factors such as age, [4, 19, 21, 44, 48, 58, 64] relative age, [61] level of play, [21, 61, 62, 64] player position, [48, 58, 62] body weight and height, [8, 9, 26, 62] have been found to be significant risk factors in some studies. Whether these factors put female ice hockey players at an increased risk of injury requires further investigation.

5.9 Exploratory Analysis

Differences in means between baseline and follow up indicated that height and aggression are not static. Albeit exploratory, this is an interesting finding that speaks to the potential need to include multiple data collections within a season. While the changes in both these variables were not found to be significant risk factors for injury in this study change in risk factor variables does warrant future investigation. In the exploratory case control study, injury was not found to influence ratings of aggression significantly; however this may still have clinically important implications. It must be noted that it was not possible from this analysis to determine when the changes in aggression occurred (i.e. pre or post injury) and therefore causality can certainly not be discussed. Further, it would not be possible to conclude with this analysis that changes in selected variables (i.e. aggression) was a risk factor for injury as it was also not known when these changes may have occurred.

5.10 Limitations

5.10.1 Sources of Bias

Recruitment for this study was done at the team level and every team in Atom, PeeWee, Bantam and Midget were given the opportunity to participate. As a result the way in which teams were selected was not a major source of bias in this study. However, one team was lost to follow up after they had consented to participate and four teams decided not to participate and it is possible that the teams who opted to not participate were systematically different than those who did, indicating a possible participation bias. However, there is no reason to believe that teams who consented to participate and those who did not differed with respect to injury risk given the reasons provided for their choice (i.e. lack of volunteers to take on study roles) as well as how teams are created within Girls Hockey Calgary. Teams were formed following skills assessments to ensure an even distribution of skill across teams in each age group. As a result, factors that could have an effect on injury risk (i.e. socioeconomic status, parents' level of education etc) were distributed across all teams and not likely to have contributed to selection bias.

All data collected at baseline, with the exception of the SCAT, and with both follow-ups were self reported. As such, self report bias is a possible source of bias influencing the results in this study.

5.10.2 Injury Definition

While the definition of injury used for this study considered time loss and medical attention injuries it is still possible that the definition underestimated injury frequency. For example, a player sustains an injury but was removed from the session and did not seek medical attention. The next day the player may not be able to play hockey, however if there is no session that day and the player is able to play in a subsequent session, the injury would not be counted. This would be a misclassification bias (non-differential as the misclassification would be the same in all study groups)[38] and would shift the estimate of effect towards the null. As mentioned in the completeness of reporting section, sixty five injury report forms were received but only fifty three were found to meet the study definition. Arguably, a more encompassing injury definition could have altered the findings of this study, however, these injuries likely be of very little magnitude and therefore not of great concern here.

5.10.3 Injury Reporting

Injury reporting was the responsibility of the team designate as well as the study therapist. Given that the therapist was not present at every session, the team designate was asked to contact the therapist when an injury occurred. It is possible that some injuries were not reported to the team therapists and therefore were missed if team designates forgot about the injury, or were less diligent than other team designates. Further since eleven different therapists were working with the study teams, differences

in how the therapists reported injuries could have influenced the number of injuries that were reported (non-differential misclassification bias as the misclassification would be the same in all study groups)[38]. As a result, it is likely that injuries were under reported in this study and therefore the injury rates reported are likely underestimated.

5.10.4 Weekly Exposure Data

Weekly data was missing in some cases and therefore imputation was used to estimate these missing values. This technique was necessary as to not underestimate the estimates of exposure to injury for each player, however, the limitations of the approach must be acknowledged. The major limitation of this approach is that it is possible to overestimate exposure for players who were not playing due to an injury (i.e. as each player with missing data is given the same value based on the team's mean of reported data). However, if a player should have actually been given a value of zero since they were not participating due to an injury, than the exposure would be overestimated for those with injuries. This would then underestimate the injury rate. This is a possible misclassification bias and it is differential as it would affect only those who had incurred an injury and would bias the results towards the null.

5.11 Strengths

As previously mentioned this is the first study of its kind to examine female youth ice hockey injury. This study utilized prospective injury surveillance methods and

recorded hours of player participation (rather than estimated). All study materials had been previously validated in male youth ice hockey and the Body Contact Questionnaire (which was developed specifically for this study) was validated specifically for this population.

Cluster analysis was used to adjust results to reflect that within team similarities maybe greater than between team similarities. Given that recruitment was done at the team level this was the most appropriate analysis for this data and therefore the most conservative estimates are presented. This study had an adequate number of clusters to detect differences in age (as per the a-priori sample size calculation). However, the rho value ($\rho = 0.05$) indicating that the within cluster variability was lower than the between cluster variability therefore the confidence intervals seen in the results are slightly wider than with independent analysis.

Chapter Six: CONCLUSIONS

6.1 Summary of Study Findings

Injury rates ranged from 1.01 injuries / 1000 exposure hours (95% CI; 0.33 - 3.09) in Atom to 2.80 per 1000/ exposure hours (95% CI; 1.82 – 4.30) in Midget. The overall incidence rate was 1.9 injuries / 1000 player hours (95% CI; 1.45- 2.70) or 16.35 injuries / 100 players (95% CI; 10.75 – 24.90). The overall rate of concussion was 0.29 concussions per 1000 player hours (95% CI; 0.12 – 0.68). The most commonly reported mechanism of injury was intentional contact with another player followed by no contact with other players and incidental contact with other players. The most commonly reported types of injuries were ligament and muscle strains followed by contusions and concussions. The majority of injuries resulted in less than one week of time loss, with more severe injuries being reported in the higher age groups. Significant risk factors included history of previous injury, games versus practices and menstrual history (in PeeWee only) and some suggestion that age group and division of play were risk factors. Risk factors that were not found to be significant in this study included, height, weight, hockey experience, relative age, aggression, empathy and attitudes towards body contact. The exploratory analysis examining injury as a risk factor for changes in aggression was not significant.

6.2 Public Health Implications

Injury is a significant and costly issue and understanding injury is critical before any attempt at prevention can be made. Prior to this project, the extent of the problem of

injury in female youth ice hockey players was unknown. This study has laid a foundation upon which future research in this population can build. While injury rates in this study were not shown to be as high as in male or women's hockey, they remain a public health concern due to high participation rates in female youth hockey. Reducing the injury rate in girl's ice hockey will allow female youth to remain active in hockey and in sport in general to reap the many benefits of participation.

6.3 Recommendations for Future Research

This study was the first to examine female youth ice hockey injury and therefore further research is recommended in the area. Future research should aim to expand on this study's findings. Future research should also consider the intracluster correlation coefficient (ρ) reported in this study when calculating the power required for further investigations in the area. Further research should be conducted examining the risk factors for injury in female youth hockey to gain a better understanding of how they could be targeted with interventions. More research is needed with respect to behavioural risk factors and how factors such as aggression and empathy affect injury. As such future research aiming to create interventions should consider both physical and behavioural risk factors for injury.

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APPENDIX A: CONSENT FORM

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Founding Director
Dr. RC Jackson

CONSENT FORM

TITLE: *Risk Factors and Mechanisms of Injury among Female Youth Ice Hockey Players*

SPONSOR: *Unknown*

INVESTIGATORS
Principal Investigator: Dr. Carolyn Emery University of Calgary
Co-Investigators (University of Calgary): Dr. Willem Meeuwisse, Dr. Brent Hagel, Melissa Decloe

This consent form is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. For further details about this study, or to have your questions addressed please contact us. Take the time to read this carefully and to understand any accompanying information. If you choose to participate, please keep your copy of this form and return the study copy (signed and witnessed) to your team designate.

BACKGROUND
In Canada, sports and recreation participation is the leading cause of injury in children and adolescents. An adolescent sport injury will likely reduce future involvement in physical activity, which may also affect the future health of our population. There is a critical need for research that will lead to injury prevention in adolescent sports and recreation. It is essential to have an understanding of sport specific participation and injury rates, risk factors, and current sport safety practices in adolescents. This will allow researchers to target the appropriate groups of adolescents with specific sport injury prevention strategies.

Your child's team has been randomly selected to participate in this survey. We would like to invite your child to participate.

WHAT IS THE PURPOSE OF THE STUDY?
The purpose of this project is to examine the public health significance of injury and risk factors for injury in female youth ice hockey

WHAT WOULD MY CHILD HAVE TO DO?
Each team will be assigned a therapist (a Physiotherapist, Certified Athletic Therapist, senior physiotherapy student or Athletic Therapy Certification Candidate). This therapist will review with each player on their assigned team a preseason questionnaire that you will be asked to complete with your child. **Any injury which occurs during hockey participation (competitive or training activity) which requires medical attention and/or results in the inability to complete the session of activity in which the injury occurred and/or requires the participant to miss one or more days of sporting activity is reportable.** In the event of an injury, the therapist will be asked to assess your child's injury and make the appropriate recommendations for treatment. The therapist will be present at one session every week. Referral by the therapist to a sport medicine physician at the

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Dr. RC Jackson

University of Calgary will occur for all suspected concussions, injuries that result in time loss of greater than seven days and at the discretion of the study therapist. If you have your child seek medical attention elsewhere, it is requested that the attending medical professional (i.e. physician, physiotherapist etc.) complete the section at the end of the injury report form.

In addition, your child's hockey team will have an assigned parent or "team designate" who will record information regarding your child's presence or absence at all practices and games. This team designate will also help to identify any hockey injury, which should be referred to the assigned therapist on a weekly basis for assessment and follow-up recommendations.

ARE THERE ANY BENEFITS FOR MY CHILD?

If you agree to participate in this study there may or may not be a direct medical benefit to your child. His/her injury risk may be decreased during the study but there is no guarantee that this research will help him/her. If your child experiences a sports injury during the study duration, a therapist designated to your child's team will be available on a weekly basis for assessment of injuries and be able to make recommendations for follow-up treatment. The information we get from this study may help us to provided better sport injury prevention in future adolescent sport activities.

DOES MY CHILD HAVE TO PARTICIPATE?

If you agree to allow your child to participate, we require you to sign and return this form to your designated team study personnel. Two copies of the form are provided. Please keep one for your records. Please have another adult witness your signature on the copy that you return to us. Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in this research project and agree to allow your child to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your child's participation. You will be informed if there is new information available through this study period.

WILL WE BE PAID FOR PARTICIPATING, OR DO WE HAVE TO PAY FOR ANYTHING?

There will be no financial compensation to the child or costs to the child as a participant in this study.

WILL MY CHILD'S RECORDS BE KEPT PRIVATE?

All of the information collected from the survey will be anonymous and will remain strictly confidential. Only the investigators responsible for this study, the research assistants who will be doing the baseline assessments, the statistician who will analyze the data and the University of. Calgary, Conjoint Health Research Ethics Board will have access to this information Confidentiality will be protected by using only a study identification number in the database. Any results of the study, which are reported, will in no way identify study participants.

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Founding Director
Dr. RC Jackson

IF MY CHILD SUFFERS A RESEARCH RELATED INJURY, WILL WE BE COMPENSATED?

In the event that your child suffers an injury because of participating in this research, the University of Calgary, the Calgary Health Region or the researchers, will provide no compensation. You still have all your legal rights. Nothing said here will in any way alter your right to seek damages.

SIGNATURES

Your signature on this form indicates that you have understood to your satisfaction the information regarding your child's participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, or involved institutions from their legal and professional responsibilities. Your child is free to withdraw from the study at any time without jeopardizing your health care. If you have further questions concerning matters related to this research, please contact:

Melissa Decloe (Research Coordinator) (403) 210-8961

If you have any questions concerning your rights as a possible participant in this research, please contact The Ethics Resource Officer, Internal Awards and Research Services, University of Calgary, at 220-3782.

Parent / Guardian's Name	Signature and Date
Child's Name	Signature and Date
Investigator / Delegate's Name	Signature and Date
Witness Name	Signature and Date

The University of Calgary Conjoint Health Research Ethics Board has approved this research study.

PLEASE SIGN THIS PAGE AND RETURN THE FULL DOCUMENT TO YOUR TEAM DESIGNATE.
KEEP THE OTHER COPY FOR YOUR RECORDS

APPENDIX B: SAMPLE SIZE CALCULATION

$\alpha = 0.05$ acceptable type I error (using 2-tailed test)
$\beta = 0.20$ acceptable type II error

p_1=0.20 proportion of players estimated to sustain an injury in the young group (Atom and Peewee ages 9-12) based on Emery & Meeuwisse, (2006) injury rate = 13.93 (95% CI 10.96 to 17.35).[21]

p_2 =0.40 proportion of players estimated to sustain an injury in the older group (Bantam and Midget 13-16) based on Emery & Meeuwisse, (2006) injury rate = 45.93 (95% CI 40.93 to 49.8). [21]

$p_m = 0.30$ the mean of p_1 and p_2
ρ= 0.06 estimated intra-class correlation coefficient based on Emery (2007). [17]
c= 27 number of clusters (teams)

The number of hockey players required per group is calculated by:

$$N = \frac{2(Z_{1-\alpha/2} + Z_{1-\beta})^2 p_m(1-p_m)}{(p_2 - p_1)^2} \qquad N = \frac{2(7.84)(0.21)}{0.04}$$

$$N = \frac{2(1.96+0.84)^2 0.30(1-0.30)}{(0.40-0.20)^2} \qquad N = \frac{3.2928}{0.04}$$

$$N = \frac{2(2.8)^2 0.30(0.70)}{(0.04)} \qquad N = 82.32 \text{ or } 83 \text{ players per group}$$

(166 total)

m = average cluster size: the number of players per team required based on 27 participating teams and the above sample size calculation prior to adjusting for inflation.

The required inflation factor based on 12 participating players per team is calculated by:

$$1 + (m-1)\,\rho = 1 + (12-1)0.06 = 1.66$$

An estimated (83)*(1.66) or 138 players will be required for each group. If there are 12 (N_t) participating players per team then an estimated 27 clusters will be required.

In addition, we must consider a potential non participation / drop out rate. We will estimate this to be $R_o = 0.05$.[20]

Our original sample size per group (N_t) will have to be adjusted by the following formula:

$$N = N_t / (1-R_o)^2$$
$$= 12/0.95^2$$
$$= 13.29 \text{ or } 14 \text{ players per team}$$

If a total of 27 teams are recruited to participate, a total of 14 players will be required to participate from each team (a total of 378 individuals) to ensure the desired study power. This number is believed to be feasible based on the previous hockey study with similar methodology where on average 14 players per team consented to participate. [21]

APPENDIX C: PRESEASON QUESTIONNAIRE

UNIVERSITY OF CALGARY

Study Subject ID# [ ]
(To be completed by study coordinator)

GIRLS HOCKEY STUDY 2008- 09

Preseason Baseline Questionnaire

Sport Medicine Centre

Name:	Today's Date: _____ Day Month Year
Gender: ☐ Female	
Age:	Phone #: ( ) -
Height: _____ feet ____ inches or _____ cms	Date of Birth: _____ Day Month Year
Weight: (lbs)	

Dominant Hand (for writing): ☐ Right ☐ Left

Age Group: ☐ Atom ☐ PeeWee ☐ Bantam ☐ Midget — Division:

Position: ☐ Forward ☐ Defense ☐ Goalie — Team:

Please check off how many years of organized girls hockey you have played prior to this season (check only one):

☐ 0 years ☐ 4 years ☐ 8 years
☐ 1 year ☐ 5 years ☐ 9 years
☐ 2 years ☐ 6 years ☐ 10 years
☐ 3 years ☐ 7 years ☐ other

Please check off how many years (if any) of organized hockey you have played prior to this season in a boys league (check only one):

☐ 0 years ☐ 4 years ☐ 8 years
☐ 1 year ☐ 5 years ☐ 9 years
☐ 2 years ☐ 6 years ☐ 10 years
☐ 3 years ☐ 7 years ☐ other

If you have played organized boys hockey, what was the last age group! that you played with?
☐ Atom ☐ PeeWee ☐ Bantam ☐ Midget

EQUIPMENT (check all that apply):

a) Mouthguard:
at games: ☐ always ☐ less than 75% ☐ never
at practices: ☐ always ☐ less than 75% ☐ never

type of mouthguard worn: ☐ Dentist custom-fit ☐ off the shelf

b) Brace: ☐ Knee ☐ Ankle ☐ Other*
*specify: _____

c) Tape: ☐ Knee ☐ Ankle
*specify: _____

d) Helmet:
make: ☐ Bauer ☐ CCM ☐ Itech ☐ Jofa ☐ Mission ☐ Nike ☐ RBK ☐ Other _____
model (eg. Jr 652C, Jr Ignite 4, etc.): _____
type: ☐ full clear visor ☐ full wire cage ☐ combination visor/cage
age: ☐ new this season ☐ new last season ☐ 2-3 years old ☐ >3 years old

MEDICAL/INJURY HISTORY:

1. Have you ever had a concussion or been "knocked out" or had your "bell rung"?
☐ Yes ☐ No If **yes**, please list:

Date	Activity at the time	Time unconscious		Memory loss (yes or no)	Time loss before FULL return to sport

b) If you answered **yes** to Question 1, please indicate whether you have any persistent problems with:
a) memory ☐ Yes ☐ No
b) dizziness ☐ Yes ☐ No
c) headaches ☐ Yes ☐ No

questionnaire continues (over) →

Preseason Baseline Questionnaire Page 2
GIRLS HOCKEY STUDY 2008- 09

2. In the past **6 weeks** have you had an injury requiring medical attention and at least one day of time lost from physical activity? ☐ Yes ☐ No

*If **yes**, please describe this injury or these injuries to the best of your ability:*

Injury Date	Injury Type	Body Part	Sport of Occurrence	Treatment description	Estimated time loss from sport (days/wks)

3. In the past **one year**, have you had any other injury requiring medical attention & at least one day of time lost from physical activity? ☐ Yes ☐ No

*If **yes**, please describe this injury or these injuries to the best of your ability:*

Injury Date	Injury Type	Body Part	Sport of Occurrence	Treatment description	Estimated time loss from sport (days/wks)

4. Do you have any incompletely healed injury? ☐ Yes ☐ No

*If **yes**, describe this injury to the best of your ability:* _____

5. Have you been diagnosed by a physician with a bone fracture, arthritis, systemic disease (ie. cancer, heart disease), neurological disorder (ie. head injury, cerebral palsy) or have you required surgery in the past year? ☐ Yes ☐ No

*If **yes**, describe this condition(s) to the best of your ability:* _____

6. Have you started to menstruate (ie. started your periods)? ☐ Yes ☐ No

Are your periods regular (ie. approximately 1X/month)? ☐ Yes ☐ No

At what age did you begin to menstuate? _____ Years _____ Months

7. In the past **6 weeks**, how many weeks and how many hours per week (on average) did you participate in a school PE class?

_____ *number of weeks* _____ *hours per week*

8. Based on the past **6 weeks** of activity, did you participate in any sports on a weekly basis **(NOT including PE class)**? ☐ Yes ☐ No

*If **yes**, please estimate the average number of hours per week you participated in each sport:*

SPORT	hrs/week	SPORT	hrs/week	SPORT	hrs/week
Aerobics		Floor hockey		Skateboarding	
Alpine skiing		Football		Snowboarding	
Badminton		Golf		Soccer	
Baseball		Gymnastics		Squash	
Basketball		Hiking/ Scrambling		Speed skating	
Boxing (incl. kick)		Hockey		Swimming	
Cross-country skiing		Horse riding		Tennis	
Cycling (road or mtn)		Lacrosse		Track and field	
Dance		Martial arts		Volleyball	
Dirt biking		Rock climbing		Waterpolo	
Diving		Rollerblading		Weight training	
Field hockey		Rugby		Wrestling	
Figure skating		Running		*Other:	
				*Please describe:	

APPENDIX D: FOLLOWUP QUESTIONNAIRE

UNIVERSITY OF CALGARY

Study Subject ID# ☐

(to be completed by study coordinator):

GIRLS HOCKEY STUDY 2008- 09

Sport Medicine Centre

Followup Questionnaire

Name:

Height: feet inches **or** cms **Weight:** (lbs)

EQUIPMENT (check all that apply):

a) Mouthguard: ***at games:*** ☐always ☐less than 75% ☐never ***at practices:*** ☐always ☐less than 75% ☐never

type of mouthguard worn: ☐Dentist custom-fit ☐off the shelf

b) Brace: ☐Knee ☐Ankle ☐Other* **c) Tape:** ☐Knee ☐Ankle

*specify: _____ *specify: _____

d) Helmet:

make: ☐Bauer ☐CCM ☐Itech ☐Jofa ☐Mission ☐Nike ☐RBK ☐Other _____

model *(eg. Jr 652C, Jr Ignite 4, etc.)*: _____

type: ☐full clear visor ☐full wire cage ☐combination visor/cage

age: ☐new this season ☐new last season ☐2-3 years old ☐>3 years old

Have you been diagnosed by a physician with a bone fracture, arthritis, systemic disease (ie. cancer, heart disease), neurological disorder (ie. head injury, cerebral palsy) or have you required surgery in the past year? ☐Yes ☐No

*If **yes**, describe this condition(s) to the best of your ability:* _____

Have you started to mentruate (ie. started your periods)? ☐ Yes ☐ No

Are your periods regular (ie. approximately 1X/month)? ☐ Yes ☐ No

At what age did you begin to menstuate? _____ Years _____ Months

In the past **6 weeks**, how many weeks and how many hours per week (on average) did you participate in a school PE class?

_____ *number of weeks* _____ *hours per week*

Based on the past **6 weeks** of activity, did you participate in any sports on a weekly basis **(NOT including PE class)**? ☐Yes ☐ No

*If **yes**, please estimate the average number of hours per week you participated in each sport:*

SPORT	hrs/week	SPORT	hrs/week	SPORT	hrs/week
Aerobics		Floor hockey		Skateboarding	
Alpine skiing		Football		Snowboarding	
Badminton		Golf		Soccer	
Baseball		Gymnastics		Squash	
Basketball		Hiking/ Scrambling		Speed skating	
Boxing (incl. kick)		Hockey		Swimming	
Cross-country skiing		Horse riding		Tennis	
Cycling (road or mtn)		Lacrosse		Track and field	
Dance		Martial arts		Volleyball	
Dirt biking		Rock climbing		Waterpolo	
Diving		Rollerblading		Weight training	
Field hockey		Rugby		Wrestling	
Figure skating		Running		*Other:	

*Please describe:

questionnaire continues (over) →

APPENDIX E: BUSS PERRY AGGRESSION QUESTIONNAIRE

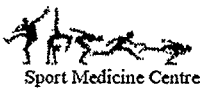
Buss- Perry Scale

Name: _____ **Study ID#:**_____

Date: _____

Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

	1 Least like me	2	3	4	5 Most like me
1) Once in a while I can't control the urge to strike another person.	1	2	3	4	5
2) Given enough provocation, I may hit another person.	1	2	3	4	5
3) If somebody hits me, I hit back.	1	2	3	4	5
4) I get into fights a little more than the average person.	1	2	3	4	5
5) If I have to resort to violence to protect my rights, I will.	1	2	3	4	5
6) There are people who pushed me so far that we came to blows.	1	2	3	4	5
7) I can think of no good reason for ever hitting a person.	1	2	3	4	5
8) I have threatened people I know.	1	2	3	4	5



Buss- Perry Scale

	1 Least like me	2	3	4	5 Most like me
9) I have become so mad that I have broken things.	1	2	3	4	5
10) I tell my friends openly when I disagree. with them.	1	2	3	4	5
11) I often find myself disagreeing with people.	1	2	3	4	5
12) When people annoy me, I may tell them what I think of them.	1	2	3	4	5
13) I can't help getting into arguments when people disagree with me.	1	2	3	4	5
14) My friends say that I am somewhat argumentative.	1	2	3	4	5
15) I flare up quickly but get over it quickly.	1	2	3	4	5
16) When frustrated, I let my irritation show.	1	2	3	4	5
17) I sometimes feel like a powder keg ready to explode.	1	2	3	4	5
18) I am an even tempered person.	1	2	3	4	5

UNIVERSITY OF CALGARY

Sport Medicine Centre

Buss- Perry Scale

	1 Least like me	2	3	4	5 Most like me
19) Some of my friends think I'm a hothead.	1	2	3	4	5
20) Sometimes I fly off the handle for no good reason.	1	2	3	4	5
21) I have trouble controlling my temper.	1	2	3	4	5
22) I am sometimes eaten up with jealousy.	1	2	3	4	5
23) At times I feel I have gotten a raw deal out of life.	1	2	3	4	5
24) Other people always seem to get the breaks.	1	2	3	4	5
25) I wonder why sometimes I feel so bitter about things.	1	2	3	4	5
26) I think that my "friends" talk about me behind my back.	1	2	3	4	5
27) I am suspicious of overly friendly strangers.	1	2	3	4	5
28) I sometimes feel that people are laughing at me behind my back.	1	2	3	4	5
29) When people are especially nice, I wonder what they want.	1	2	3	4	5

APPENDIX F: INDEX OF EMPATHY FOR CHILDREN AND ADOLESCENTS

Index of Empathy for Children and Adolescents

Name: _____ **Study ID#:**_____
Date:_____

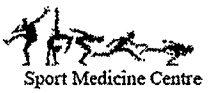
Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

	1 Not at all like me	2	3	4	5	6	7	8	9 very much like me
1) It makes me sad to see a girl who can't find anyone to play with.	1	2	3	4	5	6	7	8	9
2) People who kiss and hug in public are silly.	1	2	3	4	5	6	7	8	9
3) Boys who cry because they are happy are silly.	1	2	3	4	5	6	7	8	9
4) I really like to watch people open presents, even when I don't get a present myself.	1	2	3	4	5	6	7	8	9
5) Seeing a boy who is crying makes me feel like crying.	1	2	3	4	5	6	7	8	9
6) I get upset when I see a girl being hurt.	1	2	3	4	5	6	7	8	9
7) Even when I don't know why someone is laughing, I laugh too.	1	2	3	4	5	6	7	8	9
8) Sometimes I cry when I watch TV	1	2	3	4	5	6	7	8	9

Index of Empathy for Children and Adolescents

Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

	1 Not at all like me	2	3	4	5	6	7	8	9 very much like me
9) Girsl who cry because they are happy are silly.	1	2	3	4	5	6	7	8	9
10) It is hard me to see why someone else gets upset.	1	2	3	4	5	6	7	8	9
11) I get upset when I see an animal being hurt.	1	2	3	4	5	6	7	8	9
12) It makes me sad to see a boy who can't find anyone to play with.	1	2	3	4	5	6	7	8	9
13) Some songs make me so sad, I feel like crying.	1	2	3	4	5	6	7	8	9
14) I get upset when I see a boy being hurt.	1	2	3	4	5	6	7	8	9
15) Grown-ups sometimes cry when they nothing to be sad about.	1	2	3	4	5	6	7	8	9
16) It is silly to treat dogs and cats as though they have feelings.	1	2	3	4	5	6	7	8	9



Index of Empathy for Children and Adolescents

Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

	1 Not at all like me	2	3	4	5	6	7	8	9 very much like me
17) I get mad when I see a classmate pretending to need help from the teacher all the time.	1	2	3	4	5	6	7	8	9
18) Kids who have no friends probably don't want any.	1	2	3	4	5	6	7	8	9
19) Seeing a girl who is crying makes me feel like crying.	1	2	3	4	5	6	7	8	9
20) I think it is funny that some people cry during a sad movie or while reading a sad book.	1	2	3	4	5	6	7	8	9
21) I am able to eat all my cookies even when I see someone looking at me wanting one.	1	2	3	4	5	6	7	8	9
22) I don't feel upset when I see a classmate being punished by a teacher for not obeying school rules.	1	2	3	4	5	6	7	8	9

Used with permission: Bryant, B.K. (1982), An index of empathy for children and adolescents. Child Development, 53, 413-425. Contract 78633

APPENDIX G: BODY CONTACT QUESTIONNAIRE

Preseason Baseline Questionnaire Page 3
GIRLS HOCKEY STUDY 2008- 09

Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

	1 Strongly disagree	2	3	4	5 Strongly agree
1. I like body contact*	1	2	3	4	5
2. I like when body contact is used on me	1	2	3	4	5
3. My coach encourages me to use body contact	1	2	3	4	5
4. My parents encourage me to use body contact	1	2	3	4	5
5. My teammates encourage me to use body contact	1	2	3	4	5
6. I could be seriously injured by body contact	1	2	3	4	5
7. I could seriously injure someone else with by using body contact	1	2	3	4	5
8. I think body contact increases my team's chance of winning	1	2	3	4	5
9. I would try to harm an opponent with body contact if it would increase my team's chance of winning	1	2	3	4	5
10. I would body use body contact against another player even if I knew it would injure them	1	2	3	4	5

*Body Contact is defined as an individual defensive tactic designed to legally block or impede the progress of an offensive puck carrier. This tactic is a result of movement of the defensive player to restrict movement of the puck carrier anywhere on the ice through skating, angling and positioning. The defensive player may not hit the offensive player by going in opposite direction to that player or by extending toward the offensive player in an effort to initiate contact. There must be no action where the puck carrier is pushed, hit or shoved into the boards (from Hockey Canada. Hockey Canada Annual Report 2005. 20 Feb. 2005 http://www.hockeycanada.ca/index.cfm/ci_id/18506).

APPENDIX H: INJURY REPORT FORM

1

INJURY REPORT FORM

GIRLS HOCKEY STUDY 2008-09

Injury ID #:
Province:
Phone #:

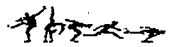
On this form, please report any injury (new or recurrent) occurring during hockey (game, practice or dryland training activity) which requires medical attention and/or results in the inability to complete the session of activity in which the injury occurred and/or requires you to miss at least one day of sporting activity. In completing this form feel free to get the assistance of a parent or coach. Please have any attending medical practitioner (physician, nurse, physiotherapist, athletic therapist) complete the appropriate section on page 5 of this form.

Upon completion*, please return this form to your team designate.

*Please do not submit form until player has fully returned to competitive play and has completed questions 20 through 26.

1. Name:	2. Gender: ☐ Female
3. Study Subject ID #:	4. Team:
5. Age Group: ☐ Atom ☐ PeeWee ☐ Bantam ☐ Midget	
6. Division: ☐ AAA ☐ AA ☐ A ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10	
7. Date of Birth: ___/___/___ (Day / Month / Year)	8. Date of Injury: ___/___/___ (Day / Month / Year)
9. This injury involved: ☐ Sudden onset & contact with another player or equipment ☐ Sudden onset & NO contact with another player or equipment ☐ Gradual onset / overuse ☐ Unknown	
10. Injury Status: ☐ New Injury ☐ Recurrence of Injury from this year ☐ Recurrence of Injury from previous year	
11. Was bracing or taping used on the injured area or limb at the time of injury? ☐ Yes ☐ No if yes, what type?	
12. Injury occurred during: ☐ Practice ☐ Game (a) ☐ *regular season* ☐ *tournament* ☐ *playoff* ☐ *exhibition* (b) ☐ *warmup* ☐ *1st period* ☐ *2nd period* ☐ *3rd period* ☐ Other Team Conditioning (specify):	
13. Position playing at the time of injury: ☐ Forward (Centre) ☐ Forward (Wing) ☐ Defense ☐ Goalie ☐ n/a	
14. Was the player able to return to the same game or practice in which they were hurt? ☐ Yes ☐ No ☐ n/a	

Injury Report Form Continued Page 1



Injury ID #:

15.A) Describe to the best of your ability the events surrounding the injury:

_____

_____

_____

_____

15.B) Please check off all that apply to describe the cause of your injury:

- ☐ Body Check
  - *if yes:* ☐ delivered ☐ received
- ☐ Other Intentional Player Contact
  - *please specify:* ☐ elbowing ☐ slashing ☐ cross-checking ☐ tripping ☐ roughing
- ☐ Incidental Contact with another player or their equipment
- ☐ Contact with the environment, NOT another player
  - *if yes:* ☐ puck ☐ boards ☐ net
- ☐ No contact
- ☐ Unknown

16. Was there a penalty called directly related to the injury event? ☐ Yes ☐ No

16a) If yes, what was the penalty?

☐ Stick related - Describe:_____ ☐ Checking related - Describe:_____ ☐ Fighting

16b) If yes, what was the consequence of the penalty?

☐ 2 minute minor ☐ 5 or 10 minute major ☐ Removal from game ☐ Suspension

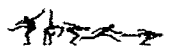
16c) If yes, who received the penalty? (check all that apply)

☐ Injured player ☐ Injured player's teammate ☐ Opposing team player

17. Protective gear worn at the time of injury *(check all that apply)*:

- ☐ Mouthguard
  - *if yes, specify:* ☐ Dentist custom-fit ☐ off the shelf
- ☐ Brace
  - *if yes, specify:* ☐ Knee ☐ Ankle ☐ Other*
  - **please describe:*
- ☐ Tape
  - *if yes, specify:* ☐ Knee ☐ Ankle ☐ Other*
  - **please describe:*
- ☐ Helmet
  - *make:* ☐ Bauer ☐ CCM ☐ Itech ☐ Jofa ☐ Mission ☐ Nike ☐ RBK ☐ Other_____
  - *model (eg. Junior 652C, Jr Ignite 4, etc.):* _____
  - *type:* ☐ full clear visor ☐ full wire cage ☐ combination visor/cage
  - *helmet age:* ☐ new this season ☐ new last season ☐ 2-3 years old ☐ >3 years old
- ☐ Other Equipment *(please describe)*:

Injury Report Form Continued Page 2



Injury ID #:

18. Injury Location *(check all that apply, circle affected side where applicable)*:

☐ Head	☐ Throat	☐ Hand (L / R)	☐ Pelvis	☐ Ankle (L / R)
☐ Face	☐ Shoulder (L / R)	☐ Finger (L / R)	☐ Hip (L / R)	☐ Foot (L / R)
☐ Ears (L / R)	☐ Collarbone (L / R)	☐ Back	☐ Groin (L / R)	☐ Toes (L / R)
☐ Eye (L / R)	☐ Upper arm (L / R)	☐ Side (L / R)	☐ Genitals	☐ Other*
☐ Nose	☐ Elbow (L / R)	☐ Ribs (L / R)	☐ Upper Leg (L / R)	
☐ Teeth	☐ Forearm (L / R)	☐ Chest	☐ Knee (L / R)	
☐ Neck	☐ Wrist (L / R)	☐ Abdomen	☐ Lower leg (L / R)	

Please describe:

19.Type of Injury *(check all that apply to this injury)*:

☐ Bruise	☐ Cut	☐ Dislocation	☐ Knocked out
☐ Bum	☐ Blister	☐ Broken bone	☐ Concussion
☐ Bleeding	☐ Joint swelling	☐ Muscle strain	☐ Other*
☐ Abrasion/Scrape	☐ Joint/ ligament sprain	☐ Tendonitis	

Please describe:

Please do not complete questions 20 through 26 until the player has returned fully to competitive play and has finished all injury-related care.

20. Total number of days you were unable to participate in your normal activities of daily living:
(i.e., work, school, camp, other) ☐

21. Total number of days you were unable to participate in any sport due to this injury: ☐

22. Total number of days you were unable to participate in hockey: ☐

23. Total number of days (or hours) your parent or guardian missed work as a direct result of your injury: ☐ days ☐ hours

24. Did you see any health care professional(s) for assessment or treatment of this injury? ☐ Yes ☐ No

(if yes, please check all that apply once you have completed all care for this injury)

☐ Physician (Family)	(Total # visits ____)	☐ Massage therapist	(Total # visits ____)
☐ Physician (Specialist)	(Total # visits ____)	☐ Dentist	(Total # visits ____)
specialty: _____		☐ Chiropractor	(Total # visits ____)
☐ Physiotherapist	(Total # visits ____)	☐ Other*	(Total # visits ____)
☐ Athletic Therapist	(Total # visits ____)		

Please specify:

25. Did you receive any other treatment for this injury? ☐ Yes ☐ No

(if yes, please check all that apply. Be as specific as possible, including location of service provided)

☐ First Aid	☐ MRI/CT (#)	☐ Cast (#)	☐ Crutches	☐ Surgery
☐ Xrays (#)	☐ bone scan (#)	☐ Brace	☐ Taping	☐ Medications
☐ Other*				

Please describe:

26. Who provided you with clearance to return to activity?

☐ Self ☐ Parent ☐ Coach ☐ Therapist ☐ Physician ☐ Other*

Please describe:

GIRLS HOCKEY STUDY 2008-2009 - ASSESSMENT

Athlete's Name: | ID

Date of Assessment: ____/____/____ (Day / Month / Year)

Patient's specific complaint:

History (including any previous injury to structure(s):

Observation:

Functional Tests:

Special Tests:

Palpation:

Impression/Assessment:

Side | Region | Type of Injury (i.e. Rt AC Joint- 2degree sprain)

SMC Diagnostic Code(s): 1 | 2 | 3

Referral:
- ☐ Study Sport Medicine Physician
- ☐ Physician
- ☐ Dentist
- ☐ Hospital
- ☐ Medi-clinic
- ☐ Physiotherapist
- ☐ Chiropractor
- ☐ Massage Therapist
- ☐ Athletic Therapist
- ☐ Other, please describe:

Injury Severity Score:

At time of injury ☐ ____/____/____ (Day / Month / Year)

At return to play ☐ ____/____/____ (Day / Month / Year)

1 = unable to perform any normal daily activities (i.e. walk, go to school)
2 = unable to participate (i.e. practice) in sport
3 = able to practice but unable to compete in sport
4 = able to compete but performance is impaired
5 = fully able to compete as if there was never an injury

Assessor's signature: _____

Did the team therapist prevent this player from returning to play on medical grounds? ☐ Yes ☐ No

Date: _____

Was the physician's recommended level of function attained before return to play? ☐ Yes ☐ No

If you were seen by a physician, physiotherapist, athletic therapist or other medical practitioner for this injury please have them complete one of the following sections:

Upon completion, please return this form to your team designate

GIRLS HOCKEY STUDY 2008-2009

Athlete's Name:	*IID*
Date: ____ / ____ / ____ (Day / Month / Year)	UCDC
Attending Medical Practitioner's Name:	
Occupation (i.e., Family Physician/Specialist/Therapist/etc):	
Diagnosis:	
Treatment Plan: Expected/Recommended duration of treatment:	

GIRLS HOCKEY STUDY 2008-2009

Athlete's Name:	*IID*
Date: ____ / ____ / ____ (Day / Month / Year)	UCDC
Attending Medical Practitioner's Name:	
Occupation (i.e., Family Physician/Specialist/Therapist/etc):	
Diagnosis:	
Treatment Plan: Expected/Recommended duration of treatment:	

Is this athlete cleared to resume unrestricted competition? ☐ Yes ☐ No

IF NO:

Expected date of clearance: _____

Conditions of clearance: _____

_____

_____

Does this athlete require medical follow up prior to clearance? ☐ Yes ☐ No

APPENDIX I: SPORT CONCUSSION ASSESSMENT TOOL – SIDE ONE

Sport Concussion Assessment Tool (SCAT)

*Please complete this side only (with the aid of a parent if necessary).
This is a baseline evaluation of your everyday status, whether or not you have ever had a concussion.
You will complete the other side of the form with your team therapist at a later date.

This tool represents a s tandardized method of evaluating people after concussion in sport. This Tool has been produced as part of the Summary and Agreement Statement of the Second International Symposium on Concussion in Sport, Prague 2004

Sports concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features that incorporate clinical, pathological and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include:

1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an 'impulsive' force transmitted to the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.
3. Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury.
4. Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course.
5. Concussion is typically associated with grossly normal structural neuroimaging studies.

Post Concussion Symptoms
Ask the athlete to score themselves based on how they feel now. It is recognized that a low score may be normal for some athletes, but clinical judgment should be exercised to determine if a change in symptoms has occurred following the suspected concussion event.

It should be recognized that the reporting of symptoms may not be entirely reliable. This may be due to the effects of a concussion or because the athlete's passionate desire to return to competition outweighs their natural inclination to give an honest response.

If possible, ask someone who knows the athlete well about changes in affect, personality, behavior, etc.

Remember, concussion should be suspected in the presence of ANY ONE or more of the following:

- Symptoms (such as headache), or
- Signs (such as loss of consciousness), or
- Memory problems

Any athlete with a suspected concussion should be monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle.

For more information see the "Summary and Agreement Statement of the Second International Symposium on Concussion in Sport" in the April, 2005 edition of the Clinical Journal of Sport Medicine (vol 15), British Journal of Sports Medicine (vol 39), Neurosurgery (vol 59) and the Physician and Sportsmedicine (vol 33). This tool may be copied for distribution to teams, groups and organizations.
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The SCAT Card
(Sport Concussion Assessment Tool)
Athlete Information

What is a concussion? A concussion is a disturbance in the function of the brain caused by a direct or indirect force to the head. It results in a variety of symptoms (like those listed below) and may, or may not, involve memory problems or loss of consciousness.

YOUR NAME:

YOUR TEAM:

How do you feel? You should score yourself on the following symptoms, based on how you feel now.

Post Concussion Symptom Scale

	None		Moderate				Severe
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Balance problems or dizzy	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Vision problems	0	1	2	3	4	5	6
Hearing problems / ringing	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Feeling "dinged" or "dazed"	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
More emotional than usual	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
Sleeping more than usual	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Other: _____	0	1	2	3	4	5	6

What should I do?
Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

Signs to watch for:
Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:

- Have a headache that gets worse
- Are very drowsy or can't be awakened (woken up)
- Can't recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your feet; have slurred speech

Remember, it is better to be safe. **Consult your doctor after a suspected concussion.**

What can I expect?
Concussion typically results in the rapid onset of short-lived impairment that resolves spontaneously over time. You can expect that you will be told to rest until you are fully recovered (that means resting your body and your mind). Then, your doctor will likely advise that you go through a gradual increase in exercise over several days (or longer) before returning to sport.

APPENDIX J: SPORT CONCUSSION ASSESSMENT TOOL – SIDE TWO

Sport Concussion Assessment Tool (SCAT)

Please complete the OTHER side only.
You will complete this side of the form with your team therapist at a later date.

The SCAT Card
(Sport Concussion Assessment Tool)
Medical Evaluation

*Name: _____ *Date _____

*Sport/Team: _____ *Mouth guard? Y N

1) SIGNS

Was there loss of consciousness or unresponsiveness?	Y	N
Was there seizure or convulsive activity?	Y	N
Was there a balance problem / unsteadiness?	Y	N

2) MEMORY

Modified Maddocks questions (check correct)

At what venue are we? __; Which half is it? __; Who scored last?__

What team did we play last? __; Did we win last game? __?

3) SYMPTOM SCORE

*Total number of positive symptoms (from reverse side of the card) = _____

4) COGNITIVE ASSESSMENT

*5 word recall	(Examples)	Immediate	Delayed (after concentration tasks)
Word 1 _____	cat	___	___
Word 2 _____	pen	___	___
Word 3 _____	shoe	___	___
Word 4 _____	book	___	___
Word 5 _____	car	___	___

Months in reverse order.
Jun-May-Apr-Mar-Feb-Jan-Dec-Nov-Oct-Sep-Aug-Jul (circle incorrect)

or

*Digits backwards (check correct)

5-2-8	3-9-1	_____
6-2-9-4	4-3-7-1	_____
8-3-2-7-9	1-4-9-3-6	_____
7-3-9-1-4-2	5-1-8-4-6-8	_____

Ask delayed 5-word recall now

5) NEUROLOGIC SCREENING

	Pass	Fail
*Speech	___	___
*Eye Motion and Pupils	___	___
*Pronator Drift	___	___
*Gait Assessment	___	___

Any neurologic screening abnormality necessitates formal neurologic or hospital assessment

6) RETURN TO PLAY

Athletes should not be returned to play the same day of injury. When returning athletes to play, they should follow a stepwise symptom-limited program, with stages of progression. For example:

1. rest until asymptomatic (physical and mental rest)
2. (light aerobic exercise e.g. stationary cycle)
3. sport-specific exercise
4. non-contact training drills (start light resistance training)
5. full contact training after medical clearance
6. return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages. **Medical clearance should be given before return to play.**

Instructions:
This side of the card is for the use of medical doctors, physiotherapists or athletic therapists. In order to maximize the information gathered from the card, it is strongly suggested that all athletes participating in contact sports complete a baseline evaluation prior to the beginning of their competitive season. This card is a suggested guide only for sports concussion and is not meant to assess more severe forms of brain injury. **Please give a COPY of this card to the athlete for their information and to guide follow-up assessment.**

Signs:
Assess for each of these items and circle Y (yes) or N (no).

Memory: If needed, questions can be modified to make them specific to the sport (e.g. "period" versus "half")

Cognitive Assessment:
Select any 5 words (an example is given). Avoid choosing related words such as "dark" and "moon" which can be recalled by means of word association. Read each word at a rate of one word per second. The athlete should not be informed of the delayed testing of memory (to be done after the reverse months and/or digits). Choose a different set of words each time you perform a follow-up exam with the same candidate.

Ask the athlete to recite the months of the year in reverse order, starting with a random month. Do not start with December or January. Circle any months not recited in the correct sequence.

For digits backwards, if correct, go to the next string length. If incorrect, read trial 2. Stop after incorrect on both trials.

Neurologic Screening:
Trained medical personnel must administer this examination. These individuals might include medical doctors, physiotherapists or athletic therapists. Speech should be assessed for fluency and lack of slurring. Eye motion should reveal no diplopia in any of the 4 planes of movement (vertical, horizontal and both diagonal planes). The pronator drift is performed by asking the patient to hold both arms in front of them, palms up, with eyes closed. A positive test is pronating the forearm, dropping the arm, or drift away from midline. For gait assessment, ask the patient to walk away from you, turn and walk back.

Return to Play:
A structured, graded exertion protocol should be developed; individualized on the basis of sport, age and the concussion history of the athlete. Exercise or training should be commenced only after the athlete is clearly asymptomatic with physical and cognitive rest. Final decision for clearance to return to competition should ideally be made by a medical doctor.

For more information see the "Summary and Agreement Statement of the Second International Symposium on Concussion in Sport" in the April, 2005 Clinical Journal of Sport Medicine (vol 15), British Journal of Sports Medicine (vol 39), Neurosurgery (vol 59) and the Physician and Sportsmedicine (vol 33).
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APPENDIX K: WEEKLY EXPOSURE SHEET

UNIVERSITY OF CALGARY

Canadian Intercollegiate Sport Injury Registry*

Age Group: _____ Division: _____ Week of:

Weekly Exposure Sheet
GIRLS HOCKEY STUDY 2008 - 2009

Team: _____

Sport Medicine Centre

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Date (Month/Day)	/	/	/	/	/	/	/
Session (Game=G, Practice= P)							
Game Outcome (Win=W, Tie=T, Loss=L)							
Game Penalty Minutes by team (dur-team) / opponent	/	/	/	/	/	/	/
Duration (0.0 hours)							
Session Description (ie. regular season game, playoff game, tournament game, ski training, captain's practice, etc.)							

Athlete	PC	R	IID	PC	R	IID	PC	R	IID	PC	R	IID	PC	R	IID	PC	R	IID	PC	R	IID

PC

Please enter a participation code (PC) for each player indicating:

F Full (75%)

P Partial (<75%)

0 None (0)

R (Reason)

If athlete is NOT fully participating (i.e. coded "P" or "0") please indicate if they are:

I Injured in hockey (Note MUST complete Injury Report Form)

N Non-hockey related injury (Note do not need to complete Injury Report Form)

S Sick

O Other

IID (Injury ID #)

specifies injury report form ID # to attribute time loss

APPENDIX L: CHILD HEALTH RESEARCH ETHICS APPROVAL FORM

Child Health Research Office
Tel: (403) 955-7241
Fax: (403) 955-9111
calgary health region

June 5th, 2008

Dr. Carolyn Emery
Kinesiology
University of Calgary

Dear Dr. Emery:

Re: Project #E-21816 – Risk Factors and Mechanisms of Injury Among Female Youth Ice Hockey Players

Thank you for submitting the subject protocol to the Child Health Scientific Review Committee for review. This proposal has been reviewed and approved for hospital impact only as it is a Masters/PhD Thesis Project. We provide approval to proceed with the subject protocol to the outcome of the CHREB review and have forwarded it on to the CHREB for expedited review.

Sincerely,

F. Uhrmann

for: Brenda Hahn
Child Health Research Office
Alberta Children's Hospital

/js

cc Conjoint Medical Research Ethics Board, Faculty of Medicine, U of C

APPENDIX M: OFFICE OF BIOMEDICAL ETHICS APPROVAL FORM

FACULTY OF MEDICINE | UNIVERSITY OF CALGARY

OFFICE OF MEDICAL BIOETHICS
Room 93, Heritage Medical Research Bldg
3330 Hospital Drive NW
Calgary, AB, Canada T2N 4N1
Telephone: (403) 220-7990
Fax: (403) 283-8524
Email: omb@ucalgary.ca

2008-08-07

Dr. Carolyn Emery
Faculty of Kinesiology
University of Calgary
KN B 121
Calgary, Alberta

Dear Dr. Emery:

RE: Risk Factors and Mechanisms of Injury Among Female Youth Ice Hockey Players

Ethics ID: E-21816

Student: Ms. Melissa Decloe

The above-noted proposal including the Questionnaire (Preseason Baseline Questionnaire; Follow Up Questionnaire; Sport Concussion Assessment Tool (SCAT); Weekly Exposure Sheet; Injury Report Form; Hockey 2008-2009 Assessment), Curriculum vitae , Consent Form (version 2, June 24, 2008), Protocol (May 12, 2008), Committee Sign Off has been submitted for Board review and found to be ethically acceptable.

Please note that this approval is subject to the following conditions:
(1) appropriate procedures for consent for access to identified health information have been approved;
(2) a copy of the informed consent form must have been given to each research subject, if required for this study;
(3) a Progress Report must be submitted by August 07, 2009, containing the following information:
- i) the number of subjects recruited;
- ii) a description of any protocol modification;
- iii) any unusual and/or severe complications, adverse events or unanticipated problems involving risks to subjects or others, withdrawal of subjects from the research, or complaints about the research;
- iv) a summary of any recent literature, finding, or other relevant information, especially information about risks associated with the research;
- v) a copy of the current informed consent form;
- vi) the expected date of termination of this project.

4) a Final Report must be submitted at the termination of the project.

Please note that you have been named as the principal collaborator on this study because students are not permitted to serve as principal investigators. Please accept the Board's best wishes for success in your research.

Yours sincerely,

Glenys Godkewitsch, BA(Hons), LLB, PhD
Chair, Conjoint Health Research Ethics Board

GG/emeg
c.c. Child Health Research Office Ms. Gladys Glowacki (Health Records) Ms. Donna McDonald (RTA) Dr. Brian R. MacIntosh (information) Research Services Ms. Melissa Decloe (Student)
Office of Information & Privacy Commissioner