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Injury Rates and Profiles in Female Ice Hockey

by

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ABSTRACT

Objective: To prospectively examine the incidence of injury in a female hockey population and compare injury rates, types and conditions to a male hockey population. **Methods:** Six male and six female teams from the Canada West Universities Athletic Association (CWUAA) were followed during the entire 1998/99 varsity season. Pre-season medical history forms were completed by each athlete. Injury report forms and attendance records for each team session were submitted by team therapists. **Results:** Male athletes reported 161 injuries, while females had 66 injuries. When the exposure was taken into account, the overall injury rates for male (9.19 injuries per 1000 athlete exposures) and female (7.77 injuries per 1000 athlete exposures) athletes did not differ significantly. Ninety-six percent of female and seventy-nine percent of male injury was related to contact mechanisms. Females were more likely to be injured by contacting the boards or their opponent. The most common injuries in female athletes were concussion injuries. Concussion injury also contributed the most time lost to hockey participation. Females incurred more ankle sprains, thigh adductor strains and sacroiliac dysfunctions than male athletes. Females were most likely to be injured during the second period of play. Males reported higher rates of new injuries, game injuries, and facial and dental injuries. **Conclusions:** Although the injury rate for female hockey is expected to be lower than male hockey due to the lack of intentional body checking, the injury rate was similar between male and female groups. It appears that females may not possess appropriate body contact skills and are likely to be injured when contacted. Males are prone to traumatic injuries during competitions most likely due to the high rate of illegal stick work occurring during male hockey competition.

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Finally I would like to thank the Olympic Oval Research Fund for supporting this project.

Female hockey is a relatively new sport. It has faced, and continues to face, much adversity as it grows and expands. In my experiences, this group of female hockey athletes possesses more integrity and determination than any other group. It was exciting being involved in female hockey at this development stage, and incredibly rewarding being involved with these wonderful athletes.

This work is dedicated to my parents, Vern and Judy Schick. You may not have understood all my decisions, but you have supported every choice I have ever made. I can never thank you enough for your commitment to me over the years.

Also to Jason, my source of strength and comfort. Thank you for keeping me smiling throughout this process.

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"There comes a time in one's life
when one must risk something
or forever sit on one's dreams."

unknown

1. Introduction

1.1 Introduction to the Research Problem

Ice hockey is a popular Canadian past time. Thousands of participants and spectators gather in arenas across Canada every winter. Female hockey has recently increased in popularity and participation numbers have increased dramatically (Avery and Stevens 1997). Researchers have studied male hockey injury data extensively (Reilly 1982; Tegner and Lorentzon 1991; Tator et al. 1994; Pelletier at al. 1993; Pettersson and Lorentzon 1993; McKnight et al. 1992; Lorentzon et al. 1988; Finke et al. 1988; Dick 1994). However, the female game has yet to be studied to the same extent. Female hockey and male hockey differ greatly regarding the style of play (Falconer 1998). Research has yet to determine how these differences affect injury rates and patterns in female hockey.

In this study, ice hockey injuries will be studied from an epidemiological perspective. This technique is a relatively new research method (Walter and Hart 1990). Athletic injuries constitute a large percentage of injuries to the population and are a burden to the health care industry (Finch 1997). It is only by using an epidemiological approach that one may understand the underlying factors for athletic injury and work to institute injury prevention measures. The rationale for using this epidemiological approach will be further described.

1.2 History of Female Ice Hockey

1.2.1 Origins of Female Ice Hockey

There is some debate as to the exact time that hockey first began to be played in Canada, but most agree it was in the 1880's (Avery and Stevens 1997). However, there is no disputing the fact that women have participated in ice hockey since its inception. The first female ice hockey game was played in Ottawa, Ontario in 1891 (Avery and Stevens 1997; Etue and Williams 1996).

At the turn of the century, women enjoyed more freedom in education and athletics and more opportunities than in the past (Avery and Stevens 1997). During this changing social context female hockey rode the wave of popularity. Female hockey became known as "skirty" (from the male counterpart "shinny") because women wore long woolen skirts on the ice. Some of these skirts had buckshot pellets sewn into the hems to keep the skirts at ice level (Etue and Williams 1996).

Women did not shy away from aggressive play and were eager to improve their hockey skills (Etue and Williams 1996). When games were opened to the public they were well attended and spectators were eager to pay admission fees. When travel improved in the 1920's, female hockey continued to grow. The 1930's saw the rise of a dynasty team, the Preston Rivulettes from North Toronto. The Rivulettes won several Ontario championships and Dominion (Canadian championship) titles finishing with a record of 348-2 between 1930 and 1939.

1.2.2 Female Hockey through the Years

During the war the game of female hockey suffered dwindling numbers. Hockey fans shifted their focus towards the National Hockey League (NHL). Also during this time, input from the conservative sectors in education, the recreation movement and the church led to the demise of competition for girls (Avery and Stevens 1997). Distinctions were made between activities that were appropriate for males and females. Athletic organizations emphasized female sports that were not overtly competitive. This had a devastating effect on female hockey causing intercollegiate leagues to cease completely in 1933.

After World War ll, female hockey prevailed, but struggled (Avery and Stevens 1997). Leagues fluctuated in size depending on finances and availability of players. Teams had to travel long distances to find competition. However, with the liberal movement of the 1960's and 70's, female hockey again began to increase in popularity. Teams were formed in Eastern Canada and intercollegiate competition was renewed. Also during the 70's the dynasty team from the West, the Edmonton Chimos, were formed (Etue and Williams 1996). Led by star center, Shirley Cameron, this team traveled throughout Alberta in an old bus competing with men's teams. On weekends they would travel to packed arenas to claim half the gate admissions. To the delight of the fans, the Chimos often defeated the men's teams.

1.2.3 Female Ice Hockey in Recent Years

The first Senior National Championship for female hockey was held in 1982 (Etue and Williams 1996). However sponsorship and attendance for this event was poor in the first years of its inception. Despite this, female hockey continued to increase its numbers across Canada. The decision to include female hockey in the 1991 Canada Winter Games promoted the development of female hockey in the under-18 age group. The first World Championship was hosted by the Ontario Women's Hockey Association in 1990 (Etue and Williams 1996). Canada defeated United States in this competition, and has claimed the championship every year since. To attract attention during this event the Canadian team wore fuchsia pink jerseys and silky white pants. Another event that may have been focused only on media attention was the November 1991 Tampa Bay Lightening game with female goaltender Manon Rheaume in net (Etue and Williams 1996; Theberge 1995b). Rheume was the first female to compete in the NHL, bringing unparalleled attention and respect to the female game.

After much pressure from the Female Hockey Council, the announcement to include female hockey in the Olympics was made in 1992 (Etue and Williams 1996). Female hockey was an official Olympic sport in the 1998 Nagano Olympics. Since the announcement was made, female hockey participation numbers have increased dramatically and the level of competition has increased accordingly (Avery and Stevens 1997; Clark 1995; Falconer 1994).

Alongside club competition, female hockey at the university level has enjoyed a resurgence (Avery and Stevens 1997). There are now six varsity teams competing in the

Ontario Intervarsity League (CIAU 1999). There are several other varsity and club teams in Quebec and Maritime Universities (TSN On-line 1999). The Canada West female hockey league was organized for its first season in 1997/98. This league consists of seven teams from British Columbia to Manitoba.

The benefits of regular physical activity have been well documented (Taimela et al. 1990; Haycock and Gillette 1976). As female hockey participation numbers increase, more women are given a chance to enjoy the benefits of sport participation. Female hockey athletes report feeling an increased confidence and self-esteem and have more control over their lives (Theberge 1995; Stewart 1993). However there is also a down-side to hockey participation. Athletes put themselves at risk of sustaining a hockey injury every time they step onto the ice. Although we can be certain that injuries do occur in female hockey, we have no indication of injury patterns or rates of injury in this sport. It is essential that these factors be determined for the information of the sporting community and female hockey athletes in particular.

1.3 Objective of the Research

The purpose of this study was to identify and explore injury rates and profiles in female hockey. Based upon the results of this study, preventive strategies may then be developed and implemented.

1.4 Specific Aims of the Research

The specific aims that were completed at the conclusion of this project were:

1. To compare injury rates and profiles in female versus male ice hockey athletes.
2. To determine if the risk of injury differs between females wearing equipment designed for male athletes versus females wearing equipment designed specifically for female athletes.
3. To develop a profile of potential risk factors for injury in female ice hockey participation.

1.5 Significance

The number of female hockey participants has increased markedly in recent years. There were 27,305 Canadian female hockey participants in the 1996/97 season, an increase from 8,146 in 1991/92 (Avery and Stevens 1997).

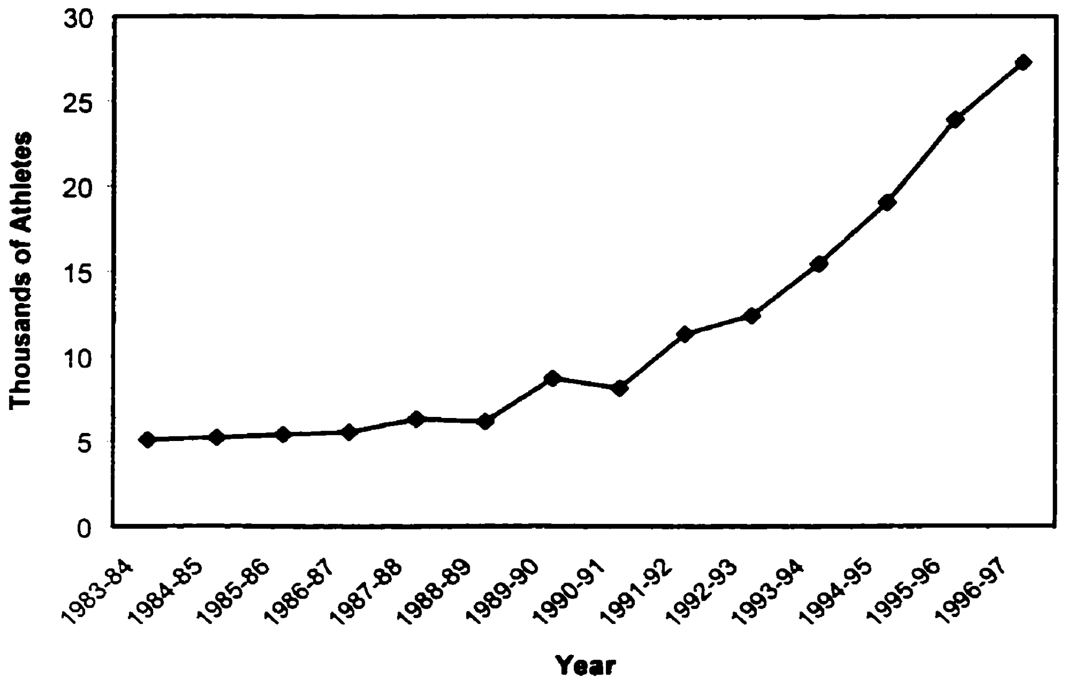

Figure 1 Female hockey registration in Canada.

Adapted from Avery and Stevens (1997 p. 129) and Stewart (1993 p. 35).

Female participation numbers have increased at approximately 25% per year, compared to an 8% increase in ice hockey participation overall (Canadian Hockey Association 1998). This growth is reflected in all levels of female ice hockey from novice to senior divisions (Avery and Stevens 1997). The growth trend of this sport is expected to continue due in part to the recent respect and attention from the media (Etue and Williams 1996).

The injury rates reported for male hockey athletes range greatly depending on the level of play (Daly at al. 1990). However, most articles suggest an injury rate of at least 10 injuries per 1000 athlete exposures (Dick 1994; Pelletier at al. 1993; Lorentzon et al. 1988).

The average number of exposures for each female athlete during one hockey season is approximately 85. Therefore female hockey participants may incur approximately 23, 000 injuries every season in Canada. It is important to note that these numbers are speculative and are based on data collected in male ice hockey only. However, each of these potential injuries may result in time lost from participation, and the most serious ones are a burden to the health care system.

Individuals with knowledge of ice hockey report that female ice hockey involves a very different game style compared to male ice hockey (Falconer 1994). How these differences relate to injury patterns has yet to be determined. Injury surveillance in female hockey will serve to differentiate any existing differences between injury patterns in male versus female ice hockey. Preventive strategies based on the modification of predicted risk factors could then be implemented to lower the burden of injury in female ice hockey participants.

2. Current Knowledge

2.1 Athletic Injury Epidemiology

Epidemiological research is based on the assumption that societal diseases do not occur at random but are predictable and preventable (Patten 1997). Therefore, causative factors for disease may be discovered and modified in order to reduce the burden of disease on society. The same is true for sporting and recreational injuries (Finch 1997). Injuries are no longer thought of as random or chance occurrences. Therefore, these sporting injuries may be studied in relation to certain predisposing or risk factors.

2.1.1 Injury Rates

A prime concern of athletic injury epidemiology is to determine incidence rates of injury. Incidence refers to the rate of the number of new cases reported over a specific period of time relative to the number of individuals at risk (Hulley et al. 1988). In order to obtain estimates of injury rates and risks associated with particular sports and sports activities, appropriate population denominators are needed. These population denominators affect the calculations of relative risk of injury (Finch 1997). Walter and Hart recommend that researchers report injury rates in terms of person units, such as player-games or athlete-exposures (1990). Another concern of epidemiologists is determining the burden of injury to the sport. This is determined by the number of exposures missed due to the particular injury.

Using this data, epidemiologists may decide which injury or injuries have the greatest impact on the sport.

2.1.2 Risk Factors

Taimela et al. state that the outcome of a muscoskeletal injury is a resulting outcome of multiple risk factors (1994). Injury risk factors are divided into extrinsic and intrinsic factors. Intrinsic factors are individual biological and psychosocial characteristics predisposing a person to the outcome of a musculoskeletal injury. The athlete is then exposed to the sporting environment where extrinsic risk factors are present. Extrinsic risk factors are independent of the injured person and are principally related to the type of activity engaged in when the incident of injury occurs (Taimela et al. 1990).

2.1.3 Interaction and Confounding

Epidemiologic studies often struggle to differentiate between interaction and confounding. Interaction refers to a real effect of one variable on a particular outcome. One variable modifies the outcome of interest, in this case, injury. For this reason we may also refer to interaction as effect modification. When effect modification is present the association between the exposure and the condition of interest varies by level of the third variable. Study of these variables should focus on describing how the association is modified by this factor.

A confounder is a variable that is independent of the causative factor, but is a risk factor for the outcome in question. A confounder may negatively or positively enhance the effect of the causitive factor. Confounding only occurs when the amount of the confounder varies between study populations. Confounding differs from effect modification in that it does not manifest itself in the analysis stage of research, but is a form of bias that must be controlled. Confounding must be controlled for in the design or in analysis stage of the research, with strategies such as multivariate analysis or stratification.

2.1.4 Surveillance

In recent years several sport injury surveillance programs have been installed to monitor various sports (Daly at al. 1990). Mueller and Blyth discuss the American Football Coaches Association annual surveys of fatalities:

> Data collection plays an important role in the prevention of injuries.... There is no question that the beneficial changes [reduction in injury rates] are a result of reliable data collection and the publication of the results in the athletic and medical literature....Continuous data are needed in order to observe the development of specific trends, to implement in-depth investigation into areas of concern and to carry out preventative measures. The lessons learnt from the experience of tackle football in the US are valuable ones that should be translated to other sports."
> (Mueller and Blyth 1987 p. 191)

Mueller's recommendation emphasizes the importance of monitoring athletic injury and collecting meaningful data. Sports injury data are important for a number of reasons; they assist in the identification of priority areas for prevention activities, they evaluate the effectiveness of interventions, and they are the basis for the planning of resources required to treat and manage injuries (Finch 1997).

Due to the need for a systematic athletic injury reporting system in Canada, the Canadian Intercollegiate Sport Injury Registry (CISIR) was developed and validated by Meeuwisse and Love in 1993 (Meeuwisse and Love 1997). This system is based on this multifactorial paradigm of athletic injury epidemiology. The CISIR is administered by the Sport Epidemiology Research Group (SERG) at the University of Calgary Sport Medicine Center. The CISIR injury reporting system will be used in the current project.

2.2 Gender and Injury Across Sports

In the late 1890's Pierre de Coubertin described his fledgling modern Olympic Games as; "The solemn periodic manifestation of male sport based on internationalism, on loyalty as a means, on arts as a background, and the applause of women as a recompense" (Canadian Association for the Advancement of Women in Sport, 1999). At this time women were not allowed to compete in the Games and participated only as spectators. Since the turn of the century great change has occurred, and women now share the spotlight in athletic arenas. In the 1996 Olympic Games in Atlanta, the Canadian team was a near equal 50/50 split of male and female athletes.

The increase in the numbers of women participating in highly competitive athletics has brought a concomitant increase in athletic injury (Loudon et al. 1996). Current research is attempting to determine whether these increases in injury are a result of increased participation alone, or if females are more prone to particular injuries. At present there is little agreement in this area of research.

Early research in female sport reported that injuries were most likely due to inexperience and lack of conditioning (Collins 1987; Garrick and Requa 1978; Zelisko et al. 1982). Female athletes were thought to suffer from injuries simply due to their lack of skill or coordination. The reason for finger injuries in a touch football study was described by Collins as "ignorance of proper catching technique" (1987). Females seemed to be just learning their respective sports and incurred injuries in this process. Overall injury rates for female athletes were lower than male injury rates because female sports were not played with the same intensity, aggression or speed.

In recent years epidemiological research has reported a different trend in female versus male athletics. Clarke and Buckley report that injury rates appear to be more related to the sport than to the gender (1980). Injury rates in female athletes are reported to be similar to, or even higher than male injury rates. Studies have found similar injury rates between males and females in comparable sports (Garrick and Requa 1978; Haycock and Gillette 1976; Shively et al. 1981). In high school athletics, injury rates for injuries requiring loss of at least one day of participation the injury rate was 0.21 injuries per athlete for both male and female groups (Beachy et al. 1997). However when considering all injuries, females reported 0.64 injuries per athlete and males reported 0.58 injuries per athlete. In an epidemiological study across 11 sports, de Loes reports a total injury rate of 4.3 for male and 4.5 for female participation (1995). Table 1 summarizes injury rates for various male and female sports in Switzerland.

Table 1 Injury incidence rates for various youth sports in Switzerland. (de Loes 1995 p. 136)

Sport	**Male Incidence Rate** (per 1000 participants)	**Female Incidence Rate** (per 1000 participants)
Handball	7.2	7.6
Soccer	6.6	6.7
Hiking	3.6	2.5
Basketball	3.5	4.9
Alpine skiing	3.0	3.9
Volleyball	3.0	3.8
Alpinism	2.9	3.0
Judo	2.3	2.3
Athletics	1.6	1.6
Fitness training	1.7	1.6
Apparatus gymnastics	1.5	2.9
Total	4.9	3.2
After standardization	4.3	4.5

Another study agrees with this higher injury rate for females. During a 5-day soccer competition of children aged 10-19, players sustained injuries at a rate of 35.9 for boys and 43.5 for girls (Andreasen et al. 1992).

Research has also reported the most common areas and types of injuries that females incur. Table 2 reports the total injury rates (per 1000 athletes) for the 11 sports surveyed in the de Loes study.

Table 2 Injury types in male versus female athletes in youth sports participation in Switzerland. (de Loes 1995 p. 137)

	Distorsions (sprains)	**Contusions**	**Fractures**	**Luxations**	**Wounds**	**Intracranial fractures**	**Other**
Male	1.4	0.6	0.4	0.1	0.5	0.3	0.1
Female	1.8	0.6	0.3	0.1	0.2	0.1	0.1

In a study of female Australian basketball and netball players the most common areas of injury were the ankle, hand and knee (McKay et al. 1996). Arendt reports that due to an increased Q-angle, increased knee valgus and recurvatum, females are more susceptible to patellofemoral pain syndrome (1996). Also, since women have relatively weaker shoulder musculature, they must work harder to do the same amount of work or cover a certain distance (Arendt 1996). Several female swimmers and rowers develop shoulder pain due to impingement or increased capsular laxity and subsequent subluxation. Bunions and other toe deformities are more common in females than in males most likely because female shoes are smaller and tighter than male shoes (Arendt 1996).

In recent years the medical world has become concerned with anterior cruciate ligament (ACL) injuries in the female population (Arendt and Dick 1995). Several studies have reported increased ACL injury rates in female sports compared to their male counterparts (Arendt and Dick 1995; Levy et al. 1997; Lloyd Ireland et al. 1997; Moeller and Lamb 1997). The National Collegiate Athletic Association (NCAA) report shows that female basketball and soccer players have a significantly higher incidence of knee injuries in general and ACL injuries in particular than their male counterparts (Arendt and Dick 1995; Cox and Lenz 1984; Ferretti et al. 1992). A study of female rugby injuries reported a knee injury rate of 1.3 injuries per 1000 athlete exposures, with an ACL injury rate of 0.36 (Levy et al. 1997). In a retrospective study of ACL injuries in soccer a significant difference between male and female injury rates was discovered, with rates of 0.057 and 0.1 respectively (Bjordal et al. 1997). Also in the 15-18 age group the risk of females sustaining an ACL injury was 5.4 times the risk of their male counterparts. Reynolds et al. report ACL injury rates for various sports in Table 3.

Table 3 Anterior cruciate ligament rate per 1000 athlete exposures (1990-1993).
(Reynolds et al.1983)

Sport	Injury rate per 1000 exposures		Female/male ratio of injuries
	Females	Males	
Gymnastics	0.52	0.17	3.17
Soccer	0.31	0.13	2.30
Basketball	0.23	0.06	3.72
Lacrosse	0.15	0.19	0.76

In the female population non-contact ACL injuries are more common than in the male population (Moeller and Lamb 1997). This is an interesting finding considering the fact that females are not necessarily different in regards to ligament laxity from male participants (Weesner et al. 1986). Weesner et al. reported that there were no significant differences in ACL laxity between male and female basketball athletes at the varsity level (1986). Other studies report that it is muscular imbalance, not ligament laxity that results in injury (Baumhauer et al. 1995). Females do not have the hamstring strength or speed of reflex to properly decelerate during sharp cutting motions (Arendt and Dick 1995). Others report that females are simply less coordinated and efficient at their respective sports. Recent research has focused on the effects of female hormones on ligament laxity. Liu et al. report that estrogen fluctuations cause change in ACL composition and may render it more susceptible to injury (1997).

2.3 Gender and Injury in Ice Hockey

Ice hockey involves athletes moving at very high speeds. High-velocity impact with boards, sticks, a puck, the net, and even skate blades make the potential for injury in ice hockey significant (Daly at al. 1990). Ice hockey injuries have created a significant burden on the health care industry (United States Consumer Product Safety 1982). For this reason male ice hockey has been studied extensively in epidemiological research (Reilly 1982; Tegner and Lorentzon 1991; Tator et al. 1994; Pelletier at al. 1993; Pettersson and Lorentzon 1993; McKnight et al. 1992; Lorentzon et al. 1988; Finke et al. 1988; Dick 1994). Female hockey is not a new sport, however the sport has only gained recognition in recent years due to the substantial increase in participation (Etue and Williams 1996). Since it has only recently gained popularity, female hockey injury trends have yet to be studied. As of 1998 there was no published research regarding patterns of injury in female hockey. However we may speculate on injury in female hockey by extrapolating from male injury data and female injury data from other sports.

2.3.1 Injury Rates

Researchers are often concerned with the injury rates of various sports. This information is used to determine the risk involved in sporting participation. The results of a critical analysis including only the most recent articles are included in the following writing. A literature search using the keywords, "hockey," "epidemiology" and "injury" on the Medline and SportDiscus databases was undertaken. Case study or anecdotal articles were discarded.

The most recent articles using a study population of at least one team of an adolescent or older age group were chosen for critical review. Table 4 summarizes the articles reviewed and the study designs incorporated.

Table 4 Summary of epidemiological studies in male ice hockey.

Year	Authors	Research Design	Population Size	Population Description	Injury Rate
1995	Stuart and Smith	Prospective	1 team over 3 seasons	American Junior A Team	games- 96.1/1000 AE* practices- 3.9/1000 AE
1993	Bancroft	Prospective	28	American college players	games- 6.8/1000 AE practices- 1.32/1000 AE
1993	Dick	Prospective	120 teams	American colleges in NCAA	games- 16.2/1000 AE practices- 2.4/1000 AE
1993	Pelletier et al.	Prospective	340	Canadian Athletic Injury Reporting System, 17 teams	19.95/1000 AE
1988	Lorentzon et al.	Prospective	24-25	Swedish National Team	79.2/1000 AE

*AE= Athlete Exposures

(Stuart and Smith 1995; Lorentzon et al. 1988; Bancroft 1993; Pelletier et al. 1993; Dick 1994)

The above studies vary in regards to their reported injury rates. These variations are likely due to the injury definition used in the study, or due to the study design. For example the Lorentzon study was completed on a Swedish National Team during international competition. A reported injury was any event requiring treatment by a therapist. Therefore any treatment was recorded as an injury. Other studies used the injury definition of any event requiring the athlete to miss participation. Studies using this definition do not include such injuries as lacerations that occur frequently in hockey but do not require the athlete to miss participation time. Also the Lorentzon study was done during high-level international competition and does not include practice time. This inclusion or exclusion of practice exposure in the analysis would have a definite effect on the injury rate, as injuries are lower in practice situations (McKnight et al. 1992).

To date there is no research that reports injury rates for female hockey. Since female hockey does not allow intentional body checking and because females are not capable of generating the same forces as their male counterparts, it would expected that overall injury rates in female hockey would be lower.

2.3.2 Most Common Injuries

Another factor of interest is the types of injury sustained during hockey participation. Research has demonstrated the most prevalent injuries in male hockey. The most common injuries reported are contusions and lacerations, although the distribution of type of injury varies greatly from study to study. Table 5 summarizes the types of injuries registered in four research studies by the percentage of total injuries.

Table 5 Summary of injury types (male ice hockey).

Type of Injury	Molsa et al. 1997	Bernard et al. 1993	Roy et al. 1989	Lorentzon et al. 1988	Rielly 1982
Concussion		8%	3%	4%	6%
Contusion	38.8%	33%	71%	24%	19%
Sprain	39.7%	20%		11%	8%
Strain			4%	12%	7%
Fracture	8%	14%		9.5%	14%
Dislocation		7%		9.5%	10%
Laceration	11.2%		10%	30%	29%
Unknown	2.3%	18%			

Researchers have reported injuries to each body region as a percentage of total injuries sustained during their studies (Pelletier et al. 1993; Rielly 1982) These studies are summarized in Table 6. The head, shoulder and lower extremity appear to be injured most often in male ice hockey.

Table 6 Summary of injury by body part (male ice hockey).

Authors	Head	Shoulder	Upper Extremity	Neck/ Back	Leg/Hips	Knee	Ankle/ Foot
Pelletier et al. 1993	18.2%	15%	11%	5%	20%	18.6%	4%
Rielly 1982	34.5%	14.4%	15%	2.9%	10.6%	13.6%	9.6%

There is no research regarding injury types in female hockey. Therefore this type of information is unknown and injury profiles have yet to be determined. It will be interesting to determine whether ice hockey will follow injury patterns of other sports and report an increased rate of knee injuries and in particular, ACL injuries.

2.3.3 Injury by Position

Injury in hockey may be related to the position of the player. Pelletier reports the injury rates according to the position played. Forwards, defensive players and goalies suffered injury rates of 19.95, 18.14, and 20.16 injuries per 1000 athlete exposures respectively (Pelletier at al. 1993). Goalies are expected to be less prone to injury because of their ample padding and relatively low amount of body contact. However, goalies are susceptible to injury from the puck moving at very high speeds. Defensive players are usually more robust, and do less overall skating than forwards, therefore the injury rate is slightly lower than in forwards.

No research of this type has been reported in female hockey. However, female player positions have the same attributes as in male hockey. Therefore, similar differences in injury rates due to position are expected in female hockey.

2.3.4 Rules and Style of Play

Several injuries in hockey may be attributed to body contact. Table 7 is a summary of research studies that have attributed injuries to body checking. A large percentage of injury (38-65%) in male ice hockey is attributable to body contact.

Table 7 Injuries related to body checking (male ice hockey).

Authors	# of Injuries	% of Injuries Related to Body Checking
Molsa et al. (1997)	75 of 253 total injuries	29.7%
Dick (1994)	16.2 per 1000 Athlete Exposures	38%
Bernard et al. (1993)		46.5% of minor injuries 66.5% of major injuries
Lorentzon et al. (1988)	78 per 1000 Athlete Exposures	43%

In a study of shoulder injures in male ice hockey, illegal activities were associated with 43% of the injuries. Of these, 31% were associated with illegal body checks, such as checking from behind, charging, and boarding. The remaining injuries were related to illegal stick activity (Finke et al. 1988). The most common source of shoulder injury was contact with the boards. McKnight et al. also report that direct impact or contact mechanisms are the leading causes of injuries in ice hockey (1992). In his study, the direct impact mechanism was responsible for 96% of all upper body injuries. All of the head, face and neck injuries were caused by the direct impact injury mechanism. The consensus of these studies is that body contact is a direct cause of a large percentage of injury in male ice hockey.

This alarming injury rate is one of the reasons that youth and female hockey have eliminated body checking. Female hockey may be compared to a league using fair-play rules. In this league team points for advancement are not only given for wins, but also for the lack of penalties. Certain penalties detract points from the team standings. Observers note that when these fair-play rules are used there is a significant reduction in body contact and aggressive penalties. An interesting study examined the injury rate in a tournament that was governed half by the fair-play rules and half by regular rules. The difference in injury incidence and penalties assessed under rules that promote good behavior was striking in the fair play tournament (Roberts et al. 1996).

The body checking issue still raises much controversy in female hockey. Most female leagues allowed body checking until the late 1980's and only banned it because of the disparity of player sizes and abilities. "Some coaches and players believe that a main reason for eliminating body checking is to reduce the risk of injury. Others dispute this association and believe that eliminating body checking has actually increased the risk of injury" (Theberge 1997). One coach states: "Checking is part of the repertoire of a hockey player's skills. When it is not available, players resort to other tactics to accomplish their task." (Theberge 1997) This is a reference to illegal stick work such as hooking or slashing. Many believe that checking is a safe activity when executed properly. Some female athletes believe that if checking had been taught at an early age to female, as it is to male, hockey players it would be safer (Theberge 1997).

It is likely that a different injury pattern will emerge from the reduced contact in female hockey. Rule changes often result in different injury patterns. For example with more severe penalization for checking from behind, the result was a decrease in injuries without changing the nature of the game (Watson et al. 1996). In male ice hockey, contusions, lacerations and sprains were the most common types of injuries reported (McKnight et al. 1992; Pettersson and Lorentzon 1993). These injuries are usually a result of contact therefore these rates would be expected to be lowered when contact is reduced. Accordingly, it would be expected that female ice hockey athletes would sustain less contact-type injuries such as contusions.

2.3.5 Age and Injury

Several researchers have related age to injury (Taimela et al. 1990; Jackson et al. 1996; Walter and Hart 1990). Degenerative changes play an obvious role in the injury etiology in older players (Taimela et al. 1990). A study by Jackson, et al. (1996) revealed that aerobic power in active females decreases with age. This decrease in conditioning may contribute to injury in female ice hockey athletes as they age. Older, more experienced athletes have often been injured previously and are more susceptible to recurring injury. However, some studies report that most injuries occur in adolescents or young athletes, and the risk of injury decreases with age (Taimela et al. 1990). This result can be attributed to the fact that healthier athletes are able progress to the older age groups, or that as athletes become more proficient at their sport, they are less prone to injury.

2.3.6 Experience and Injury

The experience level of the athlete may have an effect on injury outcome. Those players who are new to the game and do not yet understand the concepts may find themselves in dangerous or injurious situations. However, as athletes gain more experience their playing level increases substantially. This increased intensity may also contribute to injury. Athletes moving at higher speeds would be more susceptible to injury (Tegner and Lorentzon 1991). Female hockey athletes develop strength and stick-handling skills and are able to shoot the puck at speeds up to 130 km/hour (Kathy Berg, personal communication, January 18, 1999). When the puck is moving at these speeds, it becomes a potential injurious factor. Sutherland reported a concomitant increase in the incidence of injury with an increase in the level of skill and intensity of activity (1976). In a review of brain injuries in ice hockey Honey reports concussion incidences (per 1000 player-hours) as 0.0 to 2.8 for ages 5-14, 0.0 to 2.7 for high school players, 0.2 to 4.2 for university players and 0.0 to 6.6 for elite level players (1998). In summary, athletes may be more susceptible to injury if they are inexperienced, or as they gain experience and generate greater forces.

2.3.7 Previous Injury

Individuals with previous injuries are at a higher risk of recurrence (Taimela et al. 1990). Previous injuries may not necessarily recur if the original injury is treated adequately, but certain individuals may be at a higher risk of injury due to injury-prone biological characteristics (Taimela et al. 1990). Injuries may cause a weakening of affected and surrounding structures, making these structures more susceptible to injury.

2.3.8 Height and Weight

The size of the female athlete may play a role in injury outcome. In a study of male players, those who weighed 73kg or more had a risk of shoulder injury two times that of younger, lighter players. This may be attributed to the magnitude of forces generated (Finke et al. 1988). Larger players were able to exert an impact force 70% greater than exerted by smaller players (Brust et al. 1992). It follows that larger athletes who can generate very large impact forces are more susceptible to injury. Goldberg et al. agree with this study, stating that in football, the probability of injury increases with the bodyweight of the participants (1984). The average mass of high-level female ice hockey athletes in two separate studies were 69 and 67kg (Doyle-Baker and Fagan 1996; Bracko 1998). Female players, as related to the average male player, may be considered small, and therefore would not have these greater forces.

2.3.9 Physiological Factors

Physiological factors may play a role in injury etiology. Overall lack of fitness and conditioning may be a predisposing factor for injury (Taimela et al. 1990). When an athlete has not achieved a proper level on conditioning, the overall risk of injury increases. For most women, this baseline level of conditioning is significantly less than their male counterparts (Collins 1987; Cox and Lenz 1984; Garrick and Requa 1978). Some researchers believe that women are more susceptible to injury because of the higher fat percentage and lower percentage of lean mass (Arendt 1996). Batterham and Birch report that females are unable to generate as much power as males, independent of muscle size (1996). Women are therefore not able to generate the same strength as men, causing them to be more affected by external injurious forces. Another assumption is that women have increased ligamentous laxity. This proposed laxity would contribute to joint injury (Arendt 1996). Bone mineral density may determine whether or not athletes will suffer from fractures during participation. Females, on average, have less bone mineral density than males, although participating in sports increases bone mineral content (Dook et al. 1997).

Female physiology certainly affects the style of female ice hockey:

> "If there's weakness in the women's game, its' in shooting, and that's based on upper-body strength. Elite women's slap-shots are as accurate as men's, but weaker.... Their passes also suffer in quickness because of their relatively weaker wrist strength."
> (Falconer 1994)

Physiology is reported to be a determining factor in the inherent characteristics of female hockey. How these intrinsic characteristics affect injury rates has yet to be determined.

2.3.10 Equipment

Facial and head injuries are numerous in male ice hockey (Pettersson and Lorentzon 1993; Tegner and Lorentzon 1991; Bancroft 1993). Wearing appropriate helmets is reported to reduce the risk of concussion (Honey 1998). The use of visors or full-face masks has reduced the number of injuries in some leagues (LaPrade et al. 1995). One study reports that the mandatory use of the helmet and face mask in their study population seems to be the primary factor in reducing injuries to the head, face, or neck when compared to other research investigations (McKnight et al. 1992). Female hockey institutes the mandatory full-face mask rule. Therefore, the injury rate to the head area would be expected to be lower than in corresponding male leagues that do not use the full-face masks.

Until recently there has been very little hockey equipment available that has been designed specifically for women (Louisville Hockey 1999). The female body is different from male's, yet females have been expected to "fit the mold" of male hockey equipment. To date there is no published research assessing the impact of this equipment on the female hockey athlete. However, anecdotal reports from female athletes have referred to problems with this equipment designed for males (Theberge 1995). One area of particular concern is with skates (Women's Hockey International 1999). New skates designed for females feature adaptations such as higher insteps, narrower boots especially in the heel area, and a longer proportioned Achilles. Interesting comparisons may be made between injury outcome in athletes who wear these new skates designed for females, versus those that wear men's skates.

2.3.11 Psychological Factors

One of the differences between male and female hockey and resulting injuries may lie in the psychology of participating athletes. Female sports seem to have a different atmosphere compared to corresponding male sports. Girls are socialized to avoid overt competition (Williams 1995). Female sports tend to be less aggressive than corresponding male sports. However, this attitude may be evolving as females become more involved in "male dominated" sports (Etue and Williams 1996). An in-depth profile by Theberge of a competitive senior female team portrays this image (1995). Team members were described as conveying a sense of taking initiative, of being powerful and fearless (Theberge 1997). Quotes from athletes included, "I will never let another person physically overpower me," and, "I think the most satisfying is the physical." (Theberge 1997). Female hockey athletes are certainly aggressive. Before body checking was banned from world competition, several players in the world tournament were sent to hospital due to various injuries received from body checks (Etue and Williams 1996).

Personal experience supports the belief that female athletes treat their injuries differently than their male counterparts. In regards to injury female hockey athletes are often nonchalant. In the Theberge study athletes normalized the presence of pain in their lives, through strategies of denial and "disrespect" or indignation toward painful injuries:

> Frequent bruises, sore joints, muscle pulls and cuts are referred to as "minor stuff" and "you just warm up and play." They are regarded as something that "just happens" in hockey and should not affect your game. (Theberge 1997 p. 77)

One player, when discussing a wrist injury that was causing discomfort during a practice, stated, "If it hurts its OK, as long as it works" (Susan Lippitt, personal communication, January 11, 1999).

Most female hockey athletes have had to face great diversity in their ice hockey experiences (Etue and Williams 1996; Theberge 1995). Many females grew up playing on male teams where they were often less than welcome. These girls had to prove their worth and right to play with the boys each time they stepped on the ice. Female athletes such as Angela James and Hayley Wickenheiser who have played for Team Canada were once kicked off boy's teams. Parents often yelled insults from the stands at female players on boys' teams. Once, when Hayley Wickenheiser was changing in a separate room, a parent from the opposing team banged on the door yelling obscenities and berating her for playing a "boys' sport" (Etue and Williams 1996).

Female athletes who continued to play hockey in a male dominated atmosphere had to do so by playing aggressively. They certainly could not slow down for an injury or they would be regarded as a weak and fragile girl. This attitude is most likely the reason that female athletes continue to ignore their injuries. "Playing through pain is an indication of a player's ability and an affirmation of her commitment to her team and her sport." (Theberge 1997). Players show little awareness of the physical dangers of their sport participation. The increasing evidence that female athletes readily accept violence inflicted on their bodies in competitive sport suggests an incorporation, rather than resistance of the dominant model of men's sport (Theberge 1997). These attitudes towards injury may contribute to the injury patterns in female ice hockey.

2.3.12 Playing Conditions

Extrinsic factors surrounding the athlete may have on effect on the injury outcome. Several studies have shown that the injury rate varies with the type of session (competition versus practice) (Bancroft 1993; Pelletier at al. 1993; Pettersson and Lorentzon; Tegner and Lorentzon 1991; McKnight et al. 1992). The increased intensity of a game situation leads to an increased injury risk. Other factors may come into play during participation. A smaller ice surface makes play more compacted and collisions are more likely. Softer ice may have dangerous ruts or soft spots that are potential injury risks. The lighting in an arena may affect play, especially in regards to the vision of the goalie. Another difference in female hockey versus male hockey is the length of games. Many female hockey leagues, included most of the CIAU games, only have 3-10 minute periods while male hockey is double that time. This lower exposure may reduce the injury incidence. The number of sessions in a day may also contribute because if an athlete is fatigued, injury may result. Perceived fatigue in male high school hockey athletes is a strong predictor of injury (Smith et al. 1997). In the CWUAA men have two games scheduled on Friday and Saturday of weekends throughout several weeks. The female league schedules two tournaments where females must play four to six games in one weekend. The fatigue by the fifth game of such a tournament may contribute to injury.

2.3.13 Summary of Risk Factors for Injury in Female Hockey

Observers of ice hockey notice widespread differences in the playing style of male and female ice hockey players. It is therefore inappropriate to suggest that injury information can be extrapolated from the published data solely describing the male game. However, there is evidence to support the concept that player position, ice conditions, and competition situations have an effect on injury rates (Reilly 1982; Lorentzon et al. 1988). Age, experience, and previous injury have been shown to affect injury occurrence in general athletic injury studies, however none of this research has been applied directly to ice hockey (Taimela et al. 1990; Jackson et al. 1996). Anecdotal accounts have reported problems with female athletes wearing equipment designed for male athletes. Research on a large population is required in order to determine if this equipment is truly detrimental to female participants. There are gaps in ice hockey research, especially regarding female participants, and this research will function to explore these issues.

2.4 Summary of Current Knowledge

Currently there is little agreement in regards to proposed gender differences in athletic injury. Studies have reported similar injury rates, or increased injury rates in female versus male sports. However, there is agreement that female athletes are more prone to ACL injury.

Although there has been no reported research in female hockey we can speculate from male data (and data from other sports) the rates and types of injuries that may occur. Female ice hockey athletes may be more susceptible to knee injuries than their male counterparts. Also, equipment worn by female ice hockey athletes may play a role in injury etiology. Descriptive studies in the area of female hockey are needed before researchers may work to prevent injuries in female hockey. Research using an epidemiological approach with prospective, systematic data collection is a valid method of studying athletic injury patterns.

3. Methods

3.1 Introduction

A prospective cohort study was undertaken during the 1998/99 varsity ice hockey season. The study utilized the CISIR injury reporting system that had been previously validated. Ethics approval for the CISIR system was granted by the Ethics Committee of the University of Calgary. From 1993 to 1996 a consent form was required for each participating athlete. For the 1997/98 varsity season and subsequent years this consent was not required.

Twelve Canada West University Athletic Association (CWUAA) teams agreed to participate in the study. Six corresponding male and female teams were subsequently enrolled. These were the University of British Columbia Thunderbirds, University of Alberta Pandas (female) and Golden Bears (male), University of Calgary Dinosaurs, University of Lethbridge Pronghorns, University of Saskatchewan Huskies, and University of Manitoba Bisons.

The study included two comparison groups; male and female hockey participants. An analytical design could have been used in this research to compare female to male hockey athletes. However, it is felt that this approach was inappropriate for this study for several reasons.

In order to compare two groups one must assume that the groups are similar except for the factor of interest. If the groups are not similar, the differing factors should be measured or controlled for in the design or analysis stage of the research. For example, in order to compare female hockey athletes to male hockey athletes the groups must be similar in every way, except for gender. This is not the case. Female athletes are smaller in size, do not skate as quickly, and are not as strong as their male counterparts. Females may differ from males in their physiological and anatomical make-up. Female hockey athletes compete in fewer competitions through the season that are shorter in length. Female hockey has different rules than male hockey and a different playing style is evident. There may be other differences inherent to female and male hockey that are not presently evident to the researcher.

Due to the lack of research in the area of female hockey injury, how these factors affect injury rates and patterns in female hockey has yet to be determined. The purpose of the present research is to describe injury patterns in female hockey and to generate hypotheses for further research. Although, data is collected for male hockey participants it is for descriptive comparisons only. It is not appropriate to analytically compare male and female participants because of the multitude of differences between the groups. However, descriptive analysis may allow for the detection of factors that require further, more controlled research.

3.2 Data Collection

The study involved the following steps; enrollment of participants, recording of participation, and reporting of injuries that occurred. The Canadian Intercollegiate Sport Injury Registry (CISIR) reporting system was used for data collection. The CISIR is a validated injury reporting system used in CWUAA sport since 1993 (Meeuwisse and Love 1997). The CISIR system is administered by the Sport Epidemiology Research Group (SERG) at the University of Calgary. For the purposes of this study, the CISIR forms were used in male ice hockey with no alterations. However, because of the nature of female ice hockey organization, additional forms were added to the standard CISIR system for application in female varsity hockey. The data collection procedures are described in the following text.

3.2.1 Enrollment of Participants

Male Hockey

Initial contact was made with the team athletic therapist of each participating institution at the beginning of the 1998 school year. Instructions for completion of the CISIR forms were given at this time. Each athletic therapist was provided with a CISIR handbook of guidelines for participating in the CISIR data collection system. The head therapist of each institution received the pre-participation Injury History Questionnaires (IHQ's) and CWUAA Reassessment forms (see Appendices A and B). The IHQ was for athletes who were new to varsity ice hockey (rookie athletes). The Reassessment forms were used to update information on returning athletes who were already in the CISIR database from a previous year or years of participation (veterans). The athlete and therapist together completed these forms reporting such variables as age, position, year of varsity sport, and previous injury. The forms were completed and returned at the beginning of the varsity season. The data from IHQ and Reassessment forms provided demographic data for each athlete.

Female Hockey

The enrollment of participants in female hockey was similar to male hockey except for the exclusion of the Reassessment forms. Female hockey was new to the CISIR system and therefore there were no participants in the database. All female hockey participants completed an IHQ. These IHQ's were returned to the SERG at the beginning of the female varsity season.

3.2.2 Exposure Information

Male Hockey

During the varsity hockey athletic season attendance at each team session was recorded. The team therapist in attendance recorded whether each athlete was participating fully, partially or not at all. If they were not participating fully they were then classified as injured, sick, or absent. The resulting data was used to calculate a population denominator of total exposure and time loss due to injury. The size of the ice surface and and type of session (game or practice) was also recorded on this Weekly Exposure Sheet (WES) (see Appendix C). The WES information was collected from the day of team selection to the last day of competition for the season.

Female Hockey

Differences in the structure of female varsity hockey (from male hockey) were taken into account for collection of exposure data. Male hockey competitions are scheduled two games per week for 17-20 weeks. Female ice hockey athletes in the CWUAA participate in two varsity tournaments, comprising their entire season. Because of this, or because females are given limited ice time, females also tend to have less practice sessions. This would result in a much lower exposure rate for female hockey participants.

Female hockey is still developing at the varsity level and opportunities for competition are limited (Kathy Berg, personal communication, January 18, 1999). Unlike males, many female hockey athletes are members of other teams outside their university participation. Therefore female players may be injured while playing for another team. These teams are usually club teams and may be either male or female. This outside participation presented a challenge to the collection of injury data in female hockey and limited the application of the standard CISIR WES system.

To capture this outside exposure another method of collecting exposure information was introduced. The Participation Calendar (see Appendix D) was developed to document all participation in female hockey. The Participation Calendar was new to the CISIR system. Face validity of this calendar was assessed by several individuals who could give appropriate input into the content of the forms. The forms were shown to three female hockey coaches and four female athletes. The forms were also assessed by five athletic therapists who had participated in the CISIR system previously. In accordance to comments made by these individuals, the forms were altered to make them slightly more readable and easy to understand. The forms were then taken to the same individuals for re-assessment. All those mentioned were satisfied with the content of the forms. When the forms were submitted they were further scrutinized to determine their compatibility with information on the WES.

After this process, the Participation Calendars were distributed to all female varsity athletes. The Participation Calendar was filled out by the athletes on a weekly basis. The athletes indicated whether they were participating in a game, practice, weight training, or dry-land training session. Next they indicated what team they were playing with and whom they were competing against, if applicable. The Participation Calendars were collected bi-weekly by the team therapist of each institution.

The standard hockey CISIR WES was used for all varsity participation in which the team therapist was present. The WES information was collected from the day of team selection to the last day of competition for the season in a manner similar to the male hockey data. The WES sheet and Participation Calendars, in some cases provided duplicate data, in which data was cross-checked. In the cases that data did not match, the therapist was queried as to the correct information. The number of cases where this occurred was monitored to provide an estimate of the accuracy of each recording tool.

3.2.3 Injury Reporting

Male Hockey

When an injury occurred in male hockey, an Individual Injury Report Form (IIRF) (see Appendix E) was completed by the therapist. The mechanism, situation, type and severity of injury were all reported on this form. For the purposes of this study an injury reporting definition was stated as, "any event requiring subsequent treatment or involvement of a therapist or other medical personnel." After collecting information on all injuries requiring a therapist's attention, the injuries were further classified according to severity or region of injury. The injuries of interest in this study included "any event causing a subsequent time lost from participation in the sport, or any transient neurological symptoms." This injury definition was then validated against the time-loss information from the WES. Each IIRF is numbered so that it could be matched to the corresponding time loss on the WES.

Female Hockey

In female hockey the IIRF described above was used with no changes from male hockey. However female athletes also suffered injuries during their outside participation. Often the team therapist responsible for the CISIR forms was not present when such an injury occurred. The therapist was made aware of this injury either because the athlete was still unable to participate at the next varsity session, or because the athlete reported being injured on the Participation Calendar. The Participation Calendars thus opened a new means of communication between athletes and their therapist. When the varsity team reconvened, the team therapist noted any injuries reported on the Participation Calendar. An IIRF was filled out at this time, retrospectively, by interviewing the injured athlete.

3.2.4 Equipment Information for Female Hockey Athletes

The Equipment Information Form was used to collect information on the type of equipment used by female athletes only (see Appendix F). This form was distributed and completed by each institution during the first CWUAA tournament in January, 1999. The athletes completed the form by indicating the types of each kind of equipment they were wearing at the time. The forms were returned immediately to the SERG.

3.2.5 Submission of CISIR Forms

The WES's, IIRF's, and Participation Calendars were mailed to the SERG bi-weekly by the head therapist at each university. The forms were reviewed for any problems before being entered into the computer system. For example, IIRF's were matched to the corresponding time loss on the WES and the dates of each were checked for equivalence. Requests for clarification were made to the head therapist of the institution upon the finding of any missing or unclear data.

3.3 Data Entry

All data collected by the CISIR system was entered into the existing Microsoft FoxPro database developed for this purpose. Queries in Microsoft Fox Pro were used to extract relevant data and to tabulate proportions. The data were then imported into Microsoft® Excel and EpiInfo® analysis software for further statistical examination.

3.4 Analysis

The data entered from the WESs was used to tabulate the total exposure or total number of sessions in male hockey. The same method was used in female hockey. In addition, any sessions occurring outside varsity participation that were recorded on the Participation Calendars were added to the total exposure for female hockey. Each session coded as "full" was recorded as one exposure and each session coded as "partial" was recorded as half an exposure.

The rate of injury was calculated as the total number of injuries divided by the total number of exposures (see Appendix G). Separate injury rates were calculated for injuries in each region (shoulder arm, hand, knee, ankle, etc.). Relative risks and confidence intervals for these injuries in male versus female athletes were calculated using EpiInfo®.

Data collected on the IHQs, Reassessment forms and IIRFs included such characteristics as age, experience, position and previous injury information for all participating athletes. Using this information, a complete profile of injury characteristics was compiled. Statistical tests were done to distinguish relative risk of injury between male and female athletes. This analysis was done with the calculator function in EpiInfo®. Statistical tests were used to determine risk differences in total injury rates, injury severity, injury status, type of session, period of play and zone of the ice when injured.

Therapists indicated on the IIRFs whether each injury was a result of contact. Using this information, injuries were classified according to contact mechanisms. Each category of contact was expressed as a percentage of total injuries for both male and female athletes.

The WES and IIRF databases were used to ascertain which injuries had the most impact on the sport of hockey. Burden of injury was determined by calculating the total time lost for each injury. Injuries were then classified according to region of the body and specific injury assessment.

4. Results

4.1 Athlete Demographics

4.1.1 Team Size

A total of 261, including 114 female and 147 male, athletes were enrolled in the study. The team size varied from institution to institution and between genders. The distribution of the team size is displayed in Figure 2. Female varsity team rosters are not as large as their male counterparts. The average female team had 19 athletes while the average male team had 24.5. Female teams may not enlist as many players because of the limited competition during the season available for the female teams (Kathy Berg, personal communication, January, 1999). Also, universities do not have as many scholarships available for female hockey athletes as they do for male hockey athletes (Avery and Stevens 1997).

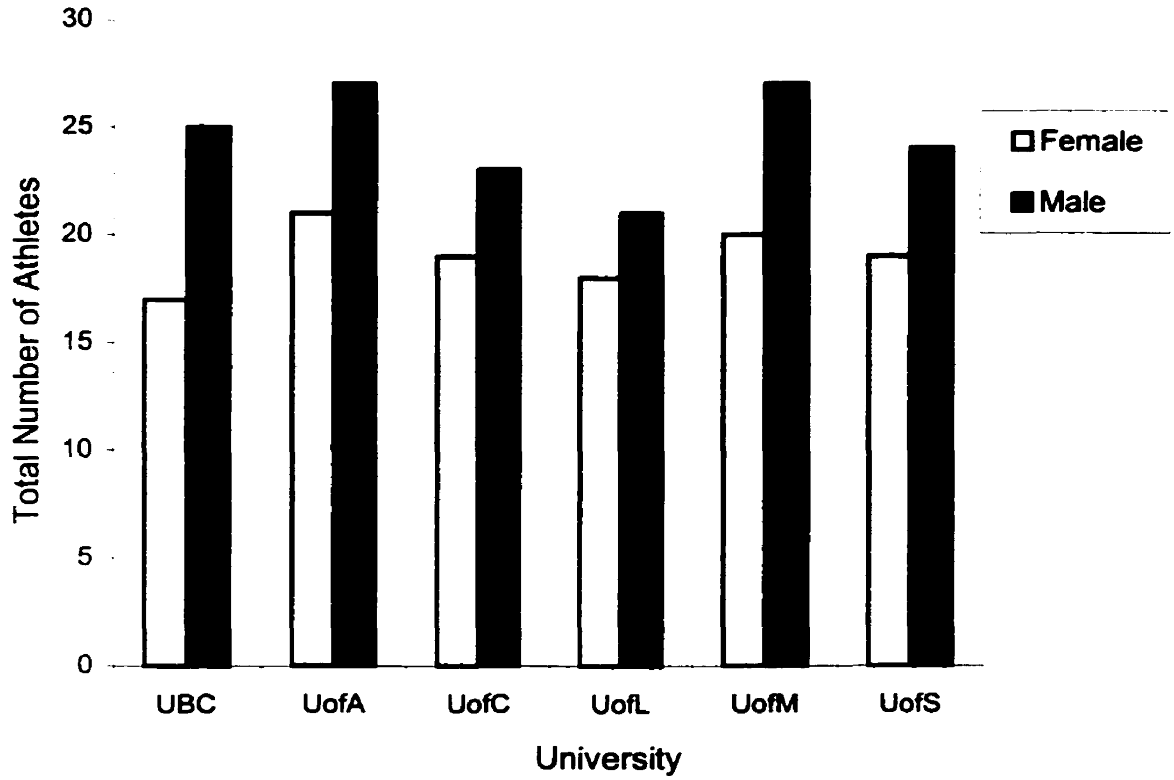

Figure 2 Team size according to institution and gender.

4.1.2 Athlete Age

The age of participating athletes also varied by gender. The average age of female participants was 20.9 years while the average age of male participants was 23.5 years. The differing age distribution is clear in the Figure 3.

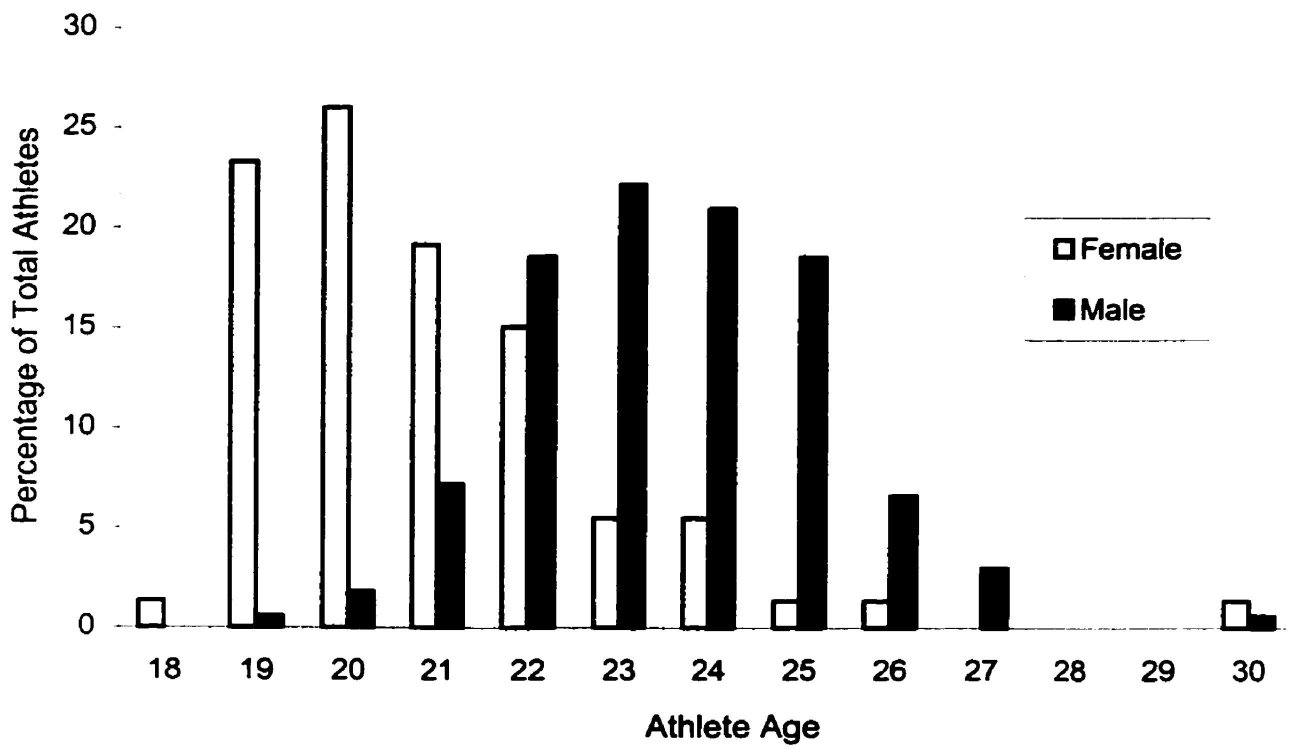

Figure 3 Athlete age distribution according to gender.

4.2 Athlete Exposure

The Participation Calendar was developed to record athlete exposures outside of varsity participation in female hockey. In cases where the Participation Calendar and WES reported duplicate information, the records were cross-checked. In these cases, the Participation Calendar matched the WES 98% of the time. Female athletes reported a total of 733 sessions (8.63% of total participation) of hockey participation outside their varsity participation.

In total, female athletes had 8969.5 athlete exposures and male participants had 17512.5. This difference in exposure can be attributed to the fact that female teams are smaller in size, and that female athletes do not have as many games and practices throughout the season as their male counterparts. The distribution of exposures by institution and session type is displayed in Figures 4 and 5.

Female varsity hockey participants only had about half the exposures of their male counterparts. As mentioned previously, female participants only partake in two CWUAA tournaments comprising their entire season. Male athletes participate in a structured league schedule of two games every week. Male athletes also have correspondingly higher numbers of practices to prepare for these regular competitions.

There is a wide variation of exposure levels between institutions for female varsity hockey. This reflects the status of varsity teams in the newly formed CWUAA league. Some teams are highly organized and compete in senior women's leagues in their respective areas. In some smaller centers such as Lethbridge these women's senior teams are not yet established, therefore competition is difficult to find. Therefore, these teams only meet for a limited number of practices before competing in the CWUAA tournaments.

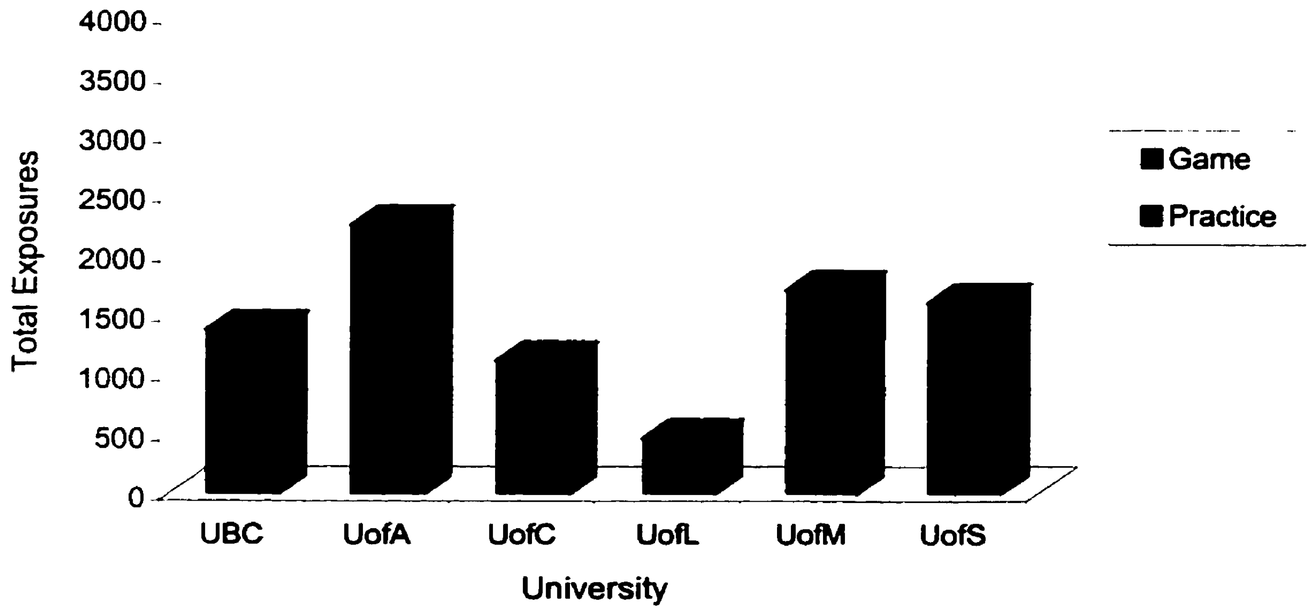

Figure 4 Total exposures in female CWUAA ice hockey.

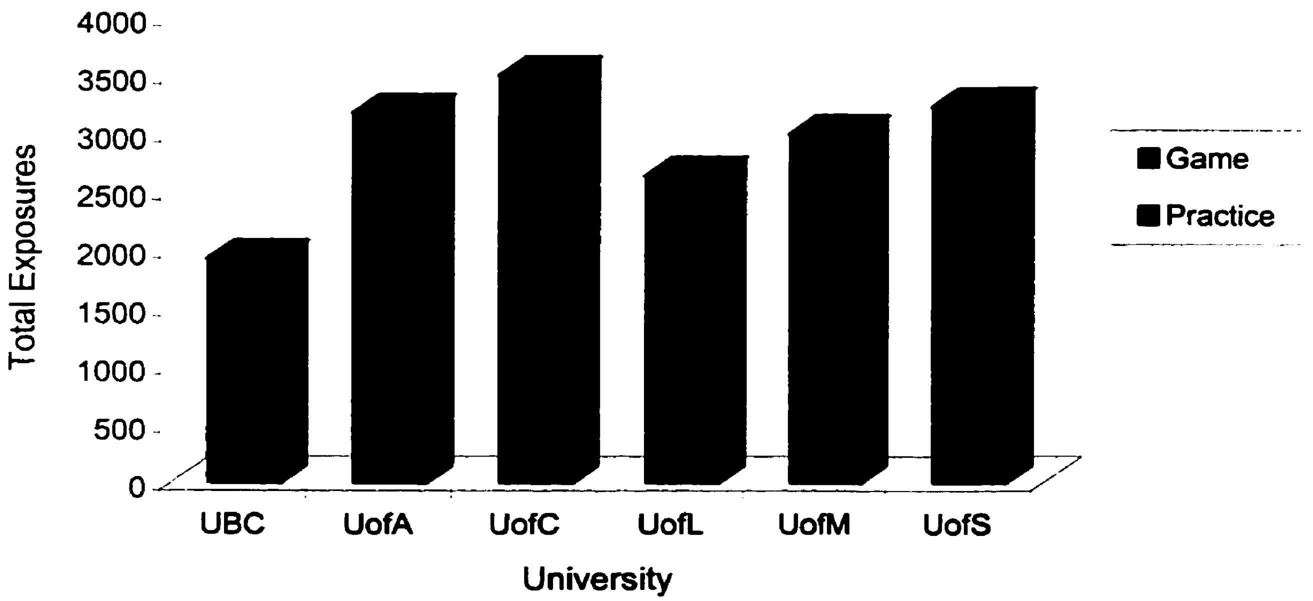

Figure 5 Total exposure in male CWUAA ice hockey.

4.3 Injury Rates

Therapists at each university were instructed to report every incident or injury requiring assessment or treatment by themselves or a physician. However, there is some discrepancy between therapists in regards to what they report as an injury. For this reason, only time loss injuries were used for analysis. This allows checking injury reports with corresponding time loss on the WES. Therefore the following analysis uses the injury definition; "Any injury sustained during the 1998/99 CWUAA varsity hockey season which required assessment or treatment by a team physician or therapist and resulted in at least one session of missed participation."

4.3.1 Numbers of Injuries

In total, 41 (36%) female athletes and 84 (57%) male athletes sustained injuries during the 1998/99 varsity season. Several athletes incurred more than one injury over the course of the season. The distribution of the number of injuries is displayed in Figure 6. A greater percentage of male athletes sustained at least one injury when compared to female athletes.

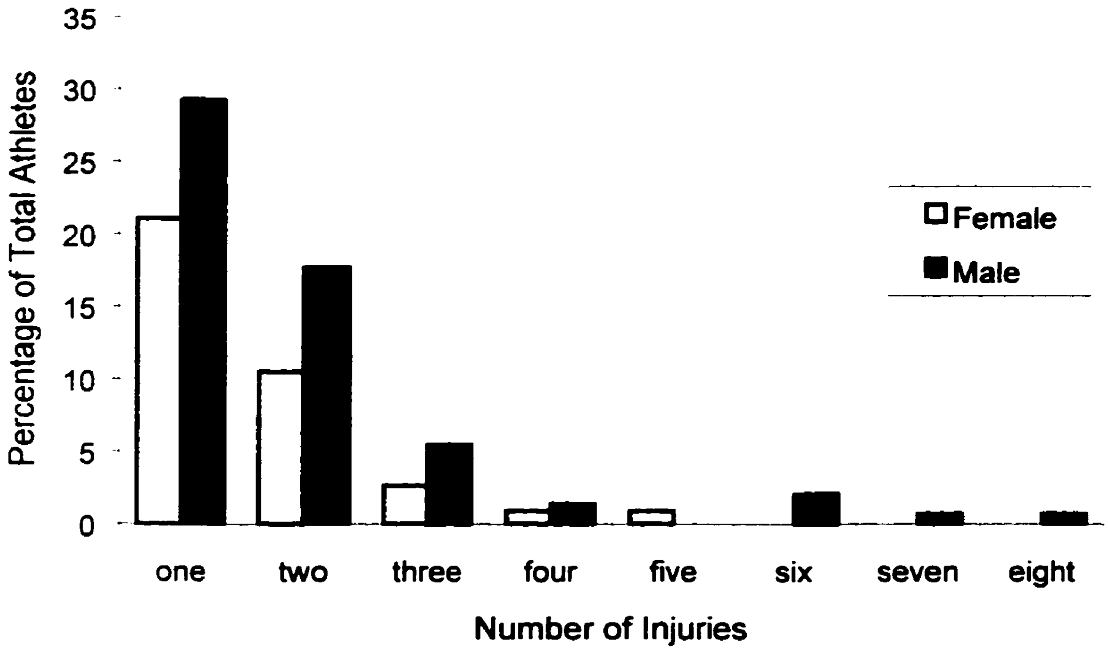

Figure 6 Numbers of injuries incurred according to gender.

4.3.2 Total Injury Rates

The total rates of injury for female and male athletes were 7.77 and 9.19 injuries per 1000 athlete exposures respectively. This difference was not statistically significant. Therefore one may state that in this study female and male hockey athletes do not differ in regards to the rate of total injuries sustained.

Table 8 Relative risk estimates of injury rate for male and female athletes.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
Male	17512.5	161	9.19	1.18	(0.89, 1.57)	no
Female	8489.5	66	7.77			p=0.258

(see Appendix G for calculations)

4.3.3 Injury Severity

Injuries were classified according to the amount of subsequent missed participation. Figure 7 demonstrates the distribution of injuries according to their severity. Males incurred significantly more injuries in the most severe category. The risk of sustaining an injury requiring 14 or more missed sessions in male hockey was 5.33 times the risk in female hockey. All other severity categories were not significantly different.

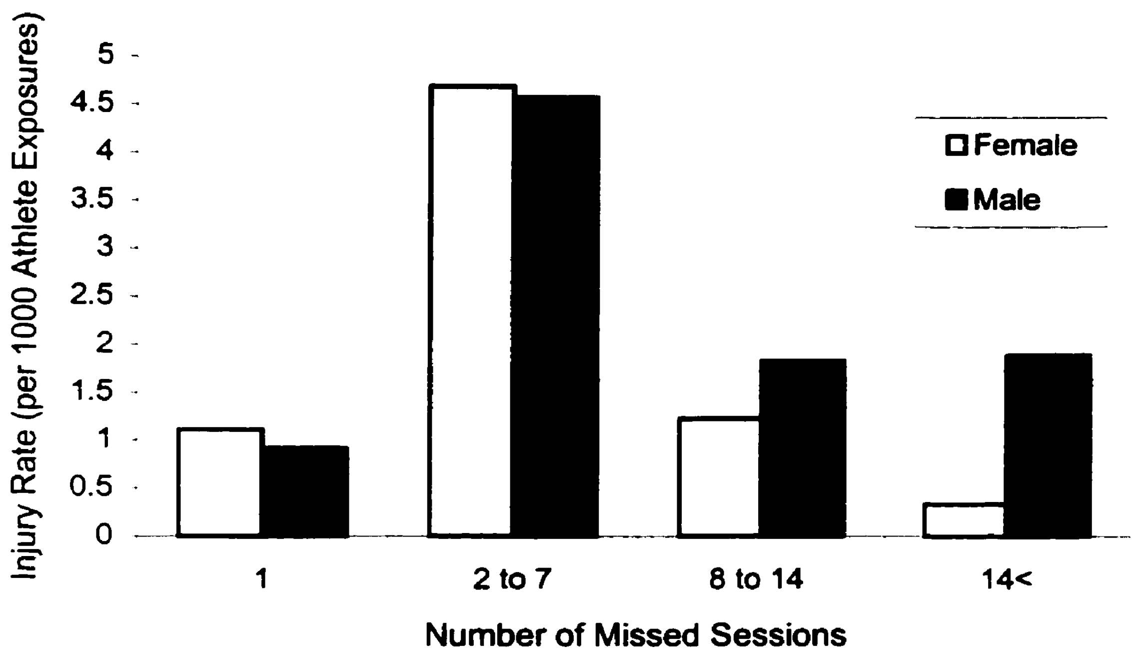

Figure 7 Injury severity according to gender.

Table 9 Relative risk estimates for male and female athletes in categories of injury severity.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
1 session						
Male	17512.5	16	0.91	0.78	(0.35, 1.71)	no
Female	8489.5	10	1.18			p=0.534
2 to 7 sessions						
Male	17512.5	80	4.57	0.92	(0.64, 1.34)	no
Female	8489.5	42	4.95			p=0.697
8 to 14 sessions						
Male	17512.5	32	1.83	1.41	(0.71, 2.80)	no
Female	8489.5	11	1.30			p=0.416
>14 sessions						
Male	17512.5	33	1.88	5.33	(1.64, 17.39)	yes
Female	8489.5	3	0.35			p=0.001

4.3.4 Injury Status

For each injury the therapist indicated whether the injury was a new injury, an ongoing injury or a recurrence of a past injury. The distribution of these classifications is displayed in Figure 8. Male athletes sustained higher rates of "new injuries." This suggests that male athletes have a higher rate of traumatic injuries. A traumatic injury is defined as "a physical injury or wound caused by external force or violence" (Thomas 1993). It should be noted that the recurrent injuries were as reported by the athlete, and did not involve analysis from the CISIR database. When completing the IIRF, the therapist queried the athlete as to whether they had sustained this type of injury previously.

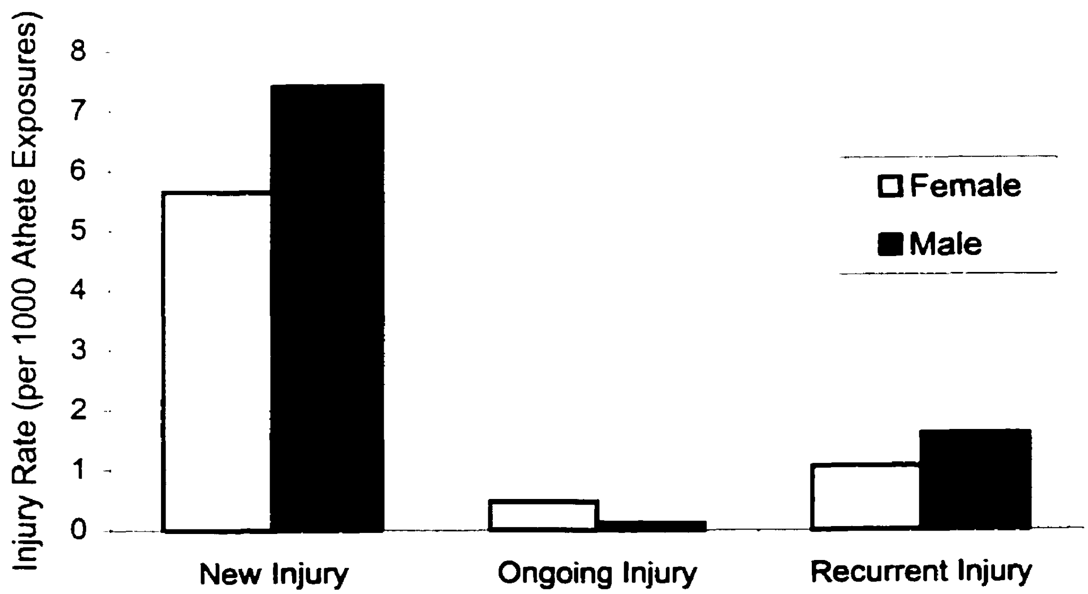

Figure 8 Injury status according to gender.

Table 10 Relative risk estimates of injury status for male and female athletes.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
New Injury						
Male	17512.5	130	7.42	1.31	(0.94, 1.83)	no
Female	8489.5	48	5.65			p=0.110
Ongoing Injury						
Male	17512.5	2	0.11	0.24	(0.04, 1.32)	no
Female	8489.5	4	0.47			p=0.094
Recurrent Injury						
Male	17512.5	28	1.60	1.51	(0.71, 3.20)	no
Female	8489.5	9	1.06			p=0.380

4.4 Injury Mechanisms

4.4.1 Injuries due to Contact

Injuries were classified according to contact mechanisms. Female injuries were caused by contact 96% of the time, while male injuries were attributed to contact 79% of the time. Females were more prone to injury from contact with the boards and their opponent than their male counterparts. Male athletes sustained 11 injuries due to contact from the stick while no injuries were caused by stick contact in female hockey. The "other" category of contact includes contact with the goal posts, puck and ice.

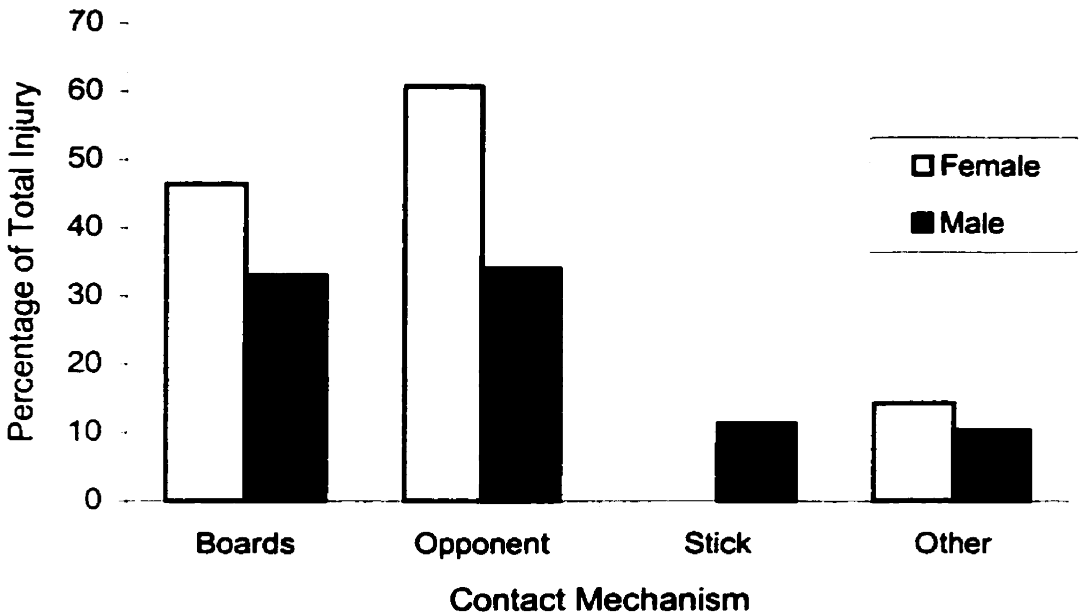

Figure 9 Percentage of injuries due to contact mechanisms.

Table 11 Relative risk estimates of injury due to contact mechanisms for male and female athletes.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
Board Contact						
Male	4732.0	32	6.76	1.50	(0.78, 2.85)	no
Female	2875.5	13	4.52			p=0.282
Opponent Contact						
Male	4732.0	33	6.97	1.18	(0.66, 2.12)	no
Female	2875.5	17	5.91			p=0.663
Stick Contact						
Male	4732.0	11	2.32	-	-	-
Female	2875.5	0	-			
Other Contact						
Male	4732.0	10	2.11	1.52	(0.48, 4.84)	no
Female	2875.5	4	1.39			p=0.588

4.4.2 Injury Region as Related to Contact

Injuries in each body region were analyzed according to the mechanism of the injury. Concussions were most often due to contact with an opponent in the female population while in the male population concussions were caused by all contact mechanisms more evenly. Knee injuries were often caused by contact with an opponent in male hockey. Athlete collisions with opponents were the most common cause of shoulder and ankle injuries in both male and female populations.

Table 12 Percentage of particular injuries attributed to contact mechanisms in male and female athletes.

Region of Injury	Board Contact		Opponent Contact		Stick Contact		Other Contact	
	# of Injuries	Percentage of Total Injuries	# of Injuries	Percentage of Total Injuries	# of Injuries	Percentage of Total Injuries	# of Injuries	Percentage of Total Injuries
Ankle								
Male	0	-	2	25.0%	0	-	1	12.5%
Female	2	25.0%	0	-	0	-	0	-
Knee								
Male	3	12.5%	12	50.0%	0	-	2	8.3%
Female	3	30.0%	3	30.0%	0	-	0	-
Neurologic								
Male	4	23.5%	3	17.6%	1	5.9%	3	17.7%
Female	3	27.3%	7	63.6%	0	-	2	18.2%
Shoulder								
Male	14	58.3%	5	20.8%	0	-	0	-
Female	1	20.0%	0	-	0	-	0	-
Thigh								
Male	0	-	4	14.8%	1	3.7%	1	3.7%
Female	0	-	1	9.1%	0	-	0	-

4.5 Injury Classifications

4.5.1 Injuries According to Body Region

Injuries were categorized into the specific body region of injury. This distribution is displayed in Figure 10, ordered by the total injury rates for male and female athletes combined. Neurological injury was most common in the female population while thigh injury was most common in the male population. There were no significant differences between male and female athletes in regards to injury regions. However male athletes incurred more shoulder, knee and thigh injuries than female athletes.

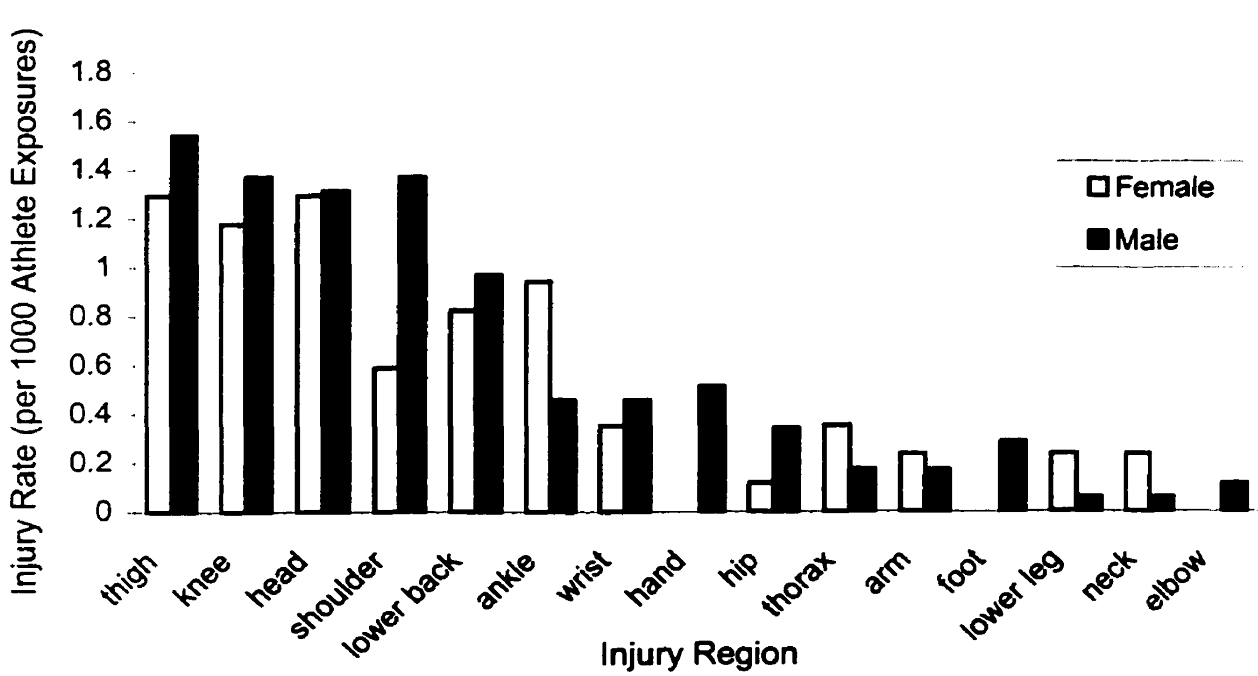

Figure 10 Injury rates according to body region of injury.

Table 13 Relative risk estimates for injury in particular body regions in male and female athletes.

Injury Region	Male		Female			
	# of Injuries	Injury Rate (per 1000 AE)	# of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval
Thigh	27	1.54	11	1.30	1.19	(0.62, 2.53)
Knee	24	1.37	10	1.18	1.16	(0.59, 2.57)
Head	23	1.30	11	1.31	1.01	(0.49, 2.08)
Shoulder	24	1.37	5	0.59	2.33	(0.94, 6.44)
Lower Back	17	0.97	7	0.97	1.18	(0.49, 2.84)
Ankle	8	0.46	8	0.94	0.48	(0.19, 1.36)
Wrist	8	0.46	3	0.35	1.29	(0.36, 5.15)
Hand	9	0.51	0	-	-	-
Hip	6	0.34	1	0.18	2.91	(0.37, 25.53)
Thorax	3	0.17	3	0.35	0.48	(0.10, 2.40)
Arm	3	0.17	2	0.24	0.73	(0.13, 4.60)
Foot	5	0.29	0	-	-	-
Lower leg	1	0.06	2	0.24	0.24	(0.02, 2.82)
Neck	1	0.06	2	0.24	0.24	(0.02, 2.82)
Elbow	2	0.11	0	-	-	-

4.5.2 *Specific Injury Assessments*

The most common injury types are displayed in Figure 11 in order of the most common injury types for male and female athletes combined. Concussions and adductor strains were the most common injuries in both the male and female population. Medial collateral ligament (MCL) sprains and shoulder injuries were similar in both male and female groups. Males incurred several acromioclavicular (AC) sprains and lower back strains, while females did not sustain any of these injuries. Females incurred more concussions, adductor strains, ankle sprains and sacroiliac (SI) dysfunctions than males. However, none of these differences were determined to be statistically significant.

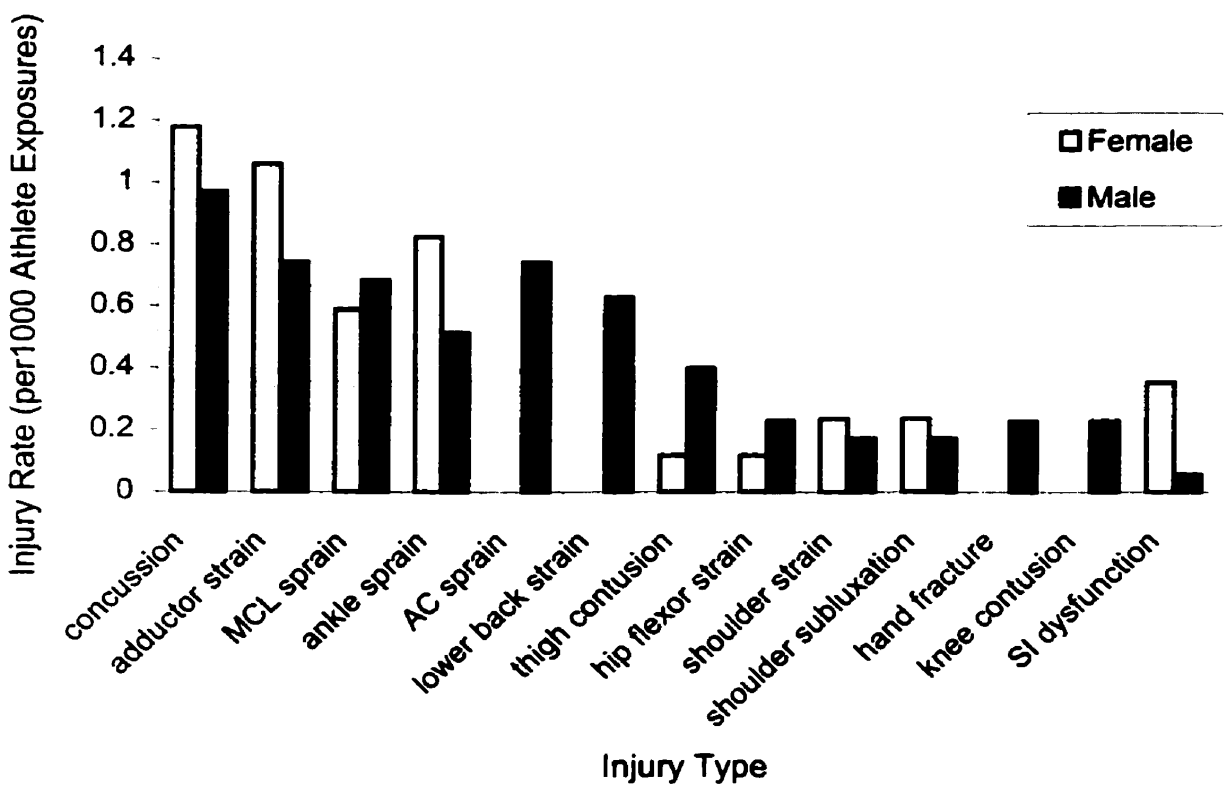

Figure 11 Injury rates according to specific assessment of injury.

Table 14 Relative risk estimates for particular injury assessments in male and female athletes.

Type of Injury	Male		Female			
	# of Injuries	Injury Rate (per 1000 AE)	# of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval
Concussion	17	0.97	10	1.18	0.82	(0.38, 1.80)
Adductor strain	13	0.74	9	1.06	0.70	(0.30, 1.64)
MCL sprain	12	0.69	5	0.59	1.16	(0.41, 3.30)
Ankle sprain	9	0.51	7	0.82	0.62	(0.23, 1.67)
AC sprain	13	0.74	0	-	-	-
Low back strain	11	0.63	0	-	-	-
Thigh contusion	7	0.40	1	0.18	3.39	(0.42, 27.58)

4.6 Burden of Injury

4.6.1 Burden of Injury According to Injury Region

Injury burden was determined by calculating the total sessions of missed participation for each particular injury. In total females missed 352.5 sessions (3.93% of total exposures) due to injury. Male athletes missed 1409.5 sessions (8.05% of total exposures) due to injury. Although injury rates between female and male athletes are similar, the actual time lost due to these injuries is substantially larger in the male population.

The burden of injury classified by body region is displayed in Figure 12. The regions are ordered according to the most common injury regions. Ankle, head, arm and shoulder injuries present the highest burdens to female hockey participation. In the male hockey population knee, shoulder, ankle and thigh injuries result in the most time lost from participation.

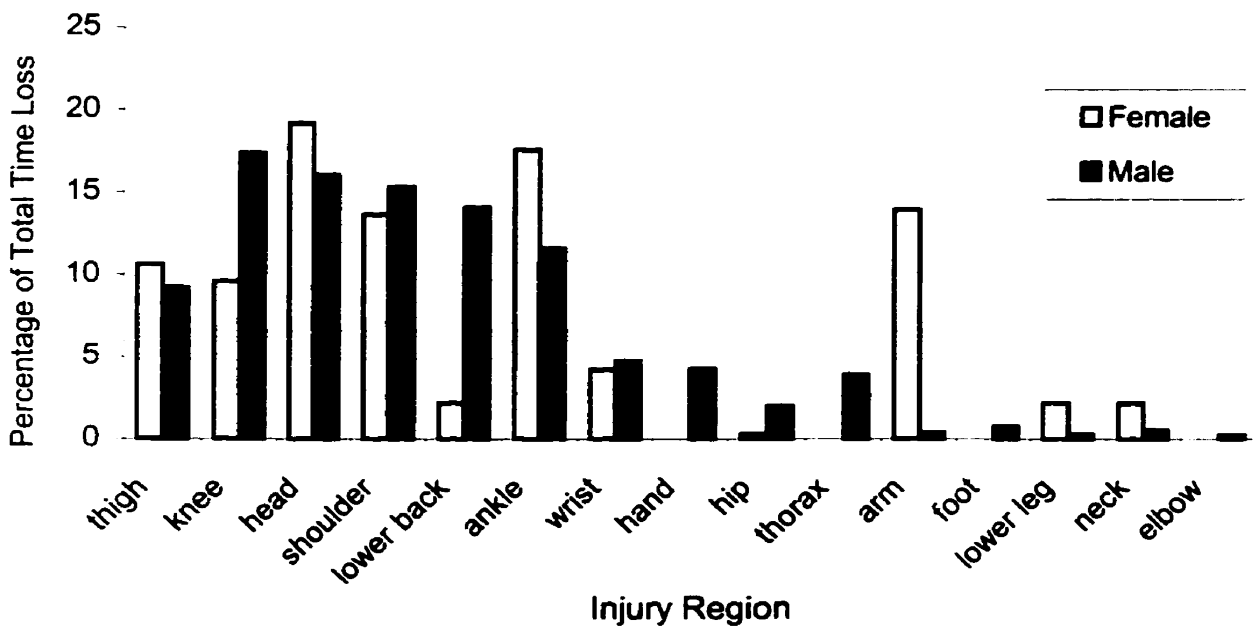

Figure 12 Total sessions lost according to injury region.

4.6.2 Burden of Injury According to Injury Types

Injury burden was classified according to the most common injury types. The resulting distribution is apparent in Figure 13. Injuries are ordered according to the most common injury types. In female athletes, concussions and ankle sprains cause the most time lost from participation. In male athletes concussions, ankle sprains, AC sprains and lower back strains caused the most time loss.

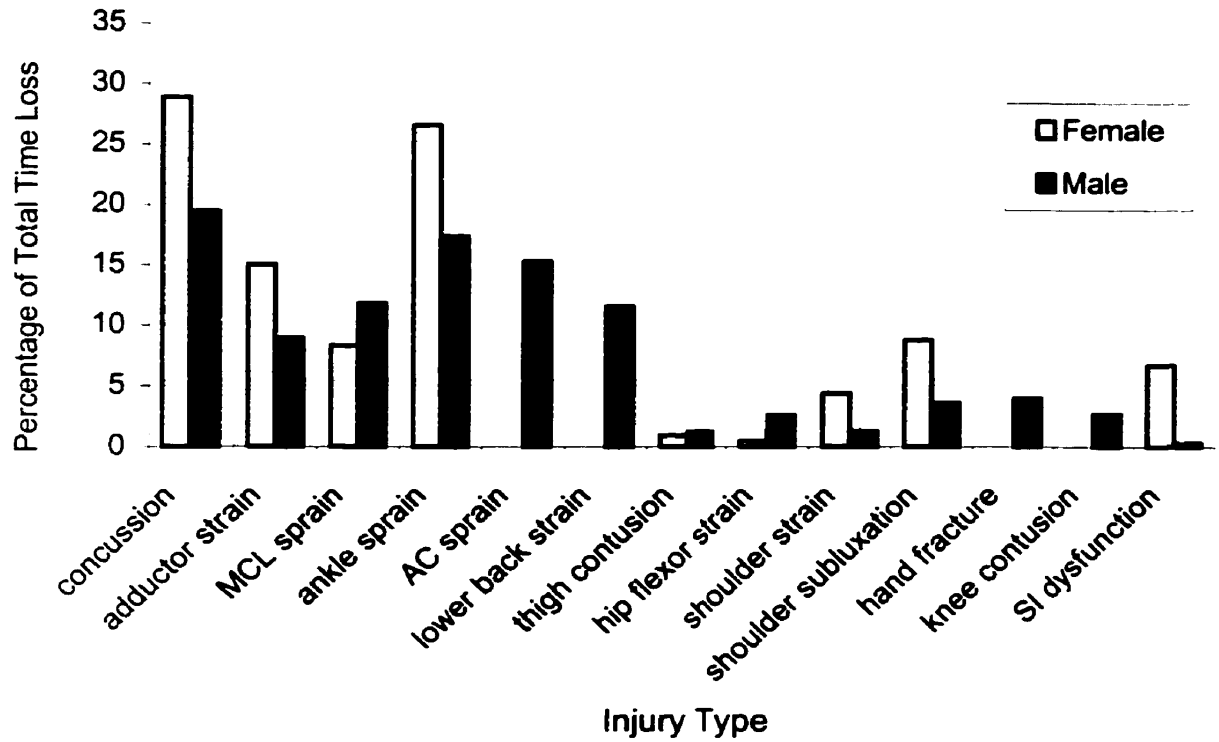

Figure 13 Total sessions of missed participation according to type of injury.

4.7 Injury Conditions

4.7.1 Game versus Practice Injury Rates

Injury rates were analyzed separately for game and practice situations. Male athletes sustained significantly higher injury rates during game sessions. This may be due to the increased intensity of men's games and the high rate of illegal play causing traumatic injury.

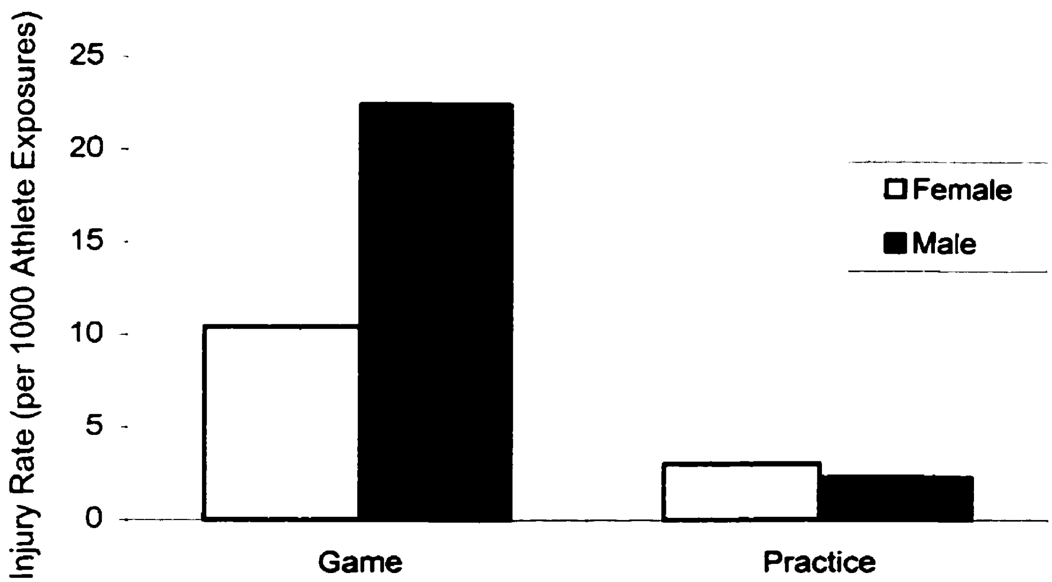

Figure 14 Injury rates by type of session.

Table 15 Relative risk estimates of injury rates during game versus practice sessions in male and female athletes.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
Game						
Male	4732.0	106	22.40	2.15	(1.43, 3.22)	yes
Female	2875.5	30	10.43			$p<0.001$
Practice						
Male	12780.5	29	2.27	1.34	(0.57, 1.89)	no
Female	5614.0	17	3.03			$p=0.3478$

4.7.2 Injury Rates by Period of Play

Figure 15 demonstrates the injury rates according to the period of play. Male injuries were distributed almost evenly between the three periods. Females incurred significantly less injuries during the first period of play in comparison to male athletes. Female games are usually 12 or 15 minutes per period with no flood between the first and second period.

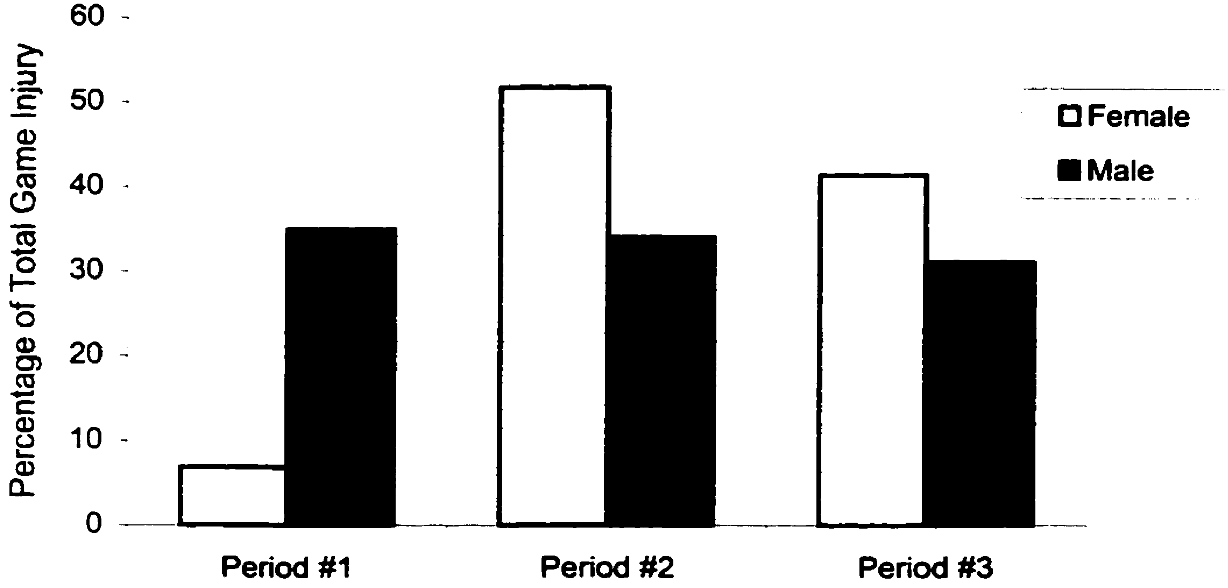

Figure 15 Percentage of game injuries during each period of play.

Table 16 Relative risk estimates for injury rates during period of play for male and female athletes.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
Period #1						
Male	4732.0	36	7.61	10.94	(2.63, 45.42)	yes
Female	2875.5	2	0.70			$p<0.001$
Period #2						
Male	4732.0	35	7.40	1.42	(0.77, 2.60)	no
Female	2875.5	15	5.21			$p=0.308$
Period #3						
Male	4732.0	32	6.76	1.62	(0.83, 3.15)	no
Female	2875.5	12	4.17			$p=0.352$

4.7.3 Injuries by Zone of Play

Injuries during game situations only were categorized into zones of the ice. This information was extracted from the IIRF (see Appendix E). The area behind and to the sides of each net is defined as the "boards" (areas 1, 2, 8 and 9). The area directly in front of and surrounding the net is the "net" area (areas 3 and 7). The "slot" is the area from inside the blue line to the net area (areas 4 and 6). Finally the "neutral" zone is the area between blue lines (area 5). The distribution of injury in each of these zones is displayed in Figure 16. Females did not sustain any injuries at the net, and had a significantly lower rate of injury in the slot region. Male athletes may be more prone to such injurious mechanisms such as hooking and slashing while in the slot area. As previously mentioned, female athletes did not sustain any injuries from stick contact.

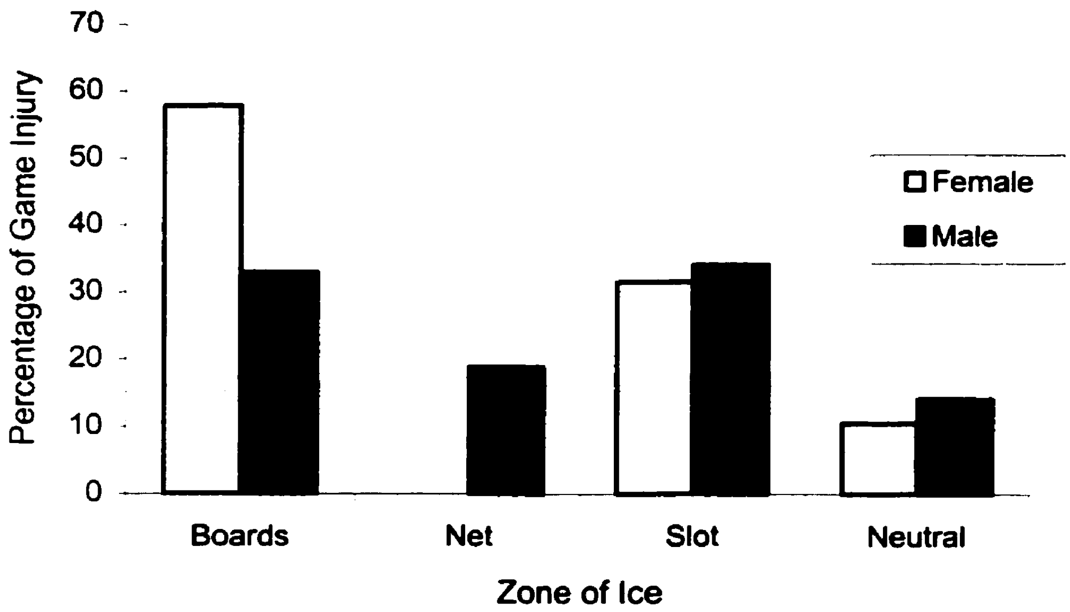

Figure 16 Percentage of game injuries in each zone of the ice.

Table 17 Relative risk estimates of injury rates in particular zones of the ice for male and female athletes.

Zone of Ice	Number of Injuries	Percentage of Total Game Injuries
Boards		
Male	28	32.94%
Female	11	57.89%
Net		
Male	16	18.82%
Female	0	-
Slot		
Male	29	34.12%
Female	6	31.57%
Neutral		
Male	12	14.12%
Female	2	10.52%

4.7.4 Injuries According to Athlete Position

Figure 17 displays the injuries incurred by athletes in each position as a percentage of total game injuries. Injury numbers are similar for forwards and defense in female versus male hockey. However, goaltenders were injured more often in male hockey. This is likely due to the fact that the puck moves at higher speeds in male hockey and becomes more probable cause of injury in male hockey.

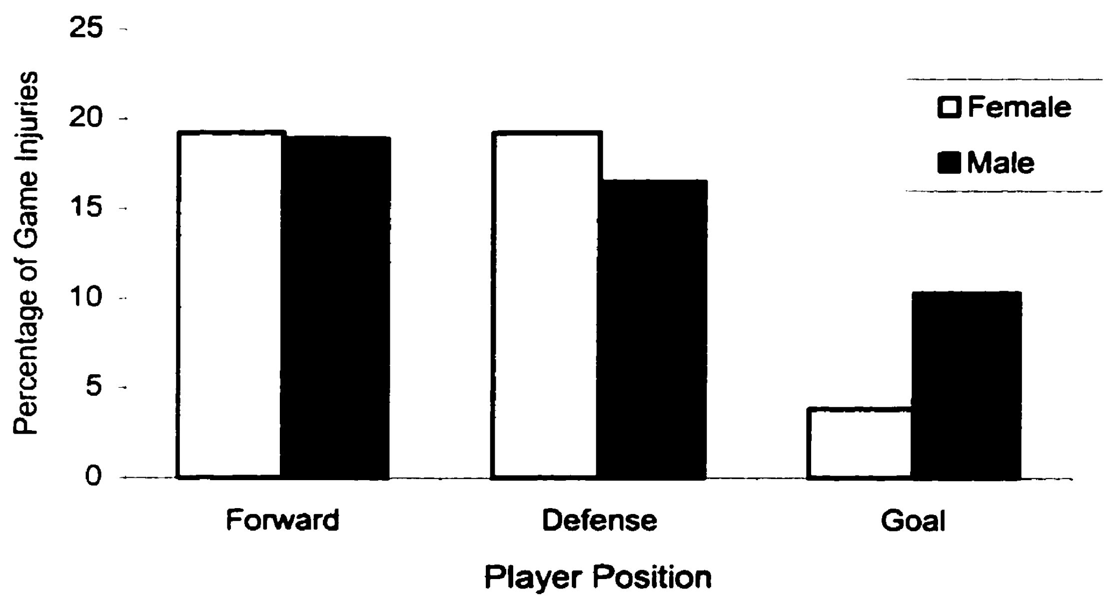

Figure 17 Injuries according to player position as a percentage of total game injuries in female and male hockey.

Table 18 Percentage of game injury according to player position for male and female athletes.

Player Position	Number of Injuries	Percentage of Total Game Injuries
Forward		
Male	55	18.90%
Female	15	19.23%
Defense		
Male	32	16.49%
Female	10	19.23%
Goal		
Male	10	10.39%
Female	1	3.84%

4.8 Concussion and Facial Injury

The injury definition used in the previous analysis excludes all injuries that did not result in at least one session of missed participation. Concussion injury is considered a serious injury, therefore these injuries are compared further in Figure 18. All concussion injuries incurred are divided into missed, partial and full participation categories. The "missed participation" category was included in the previous analysis. A greater percentage of concussion injury did not result in time loss in the female group.

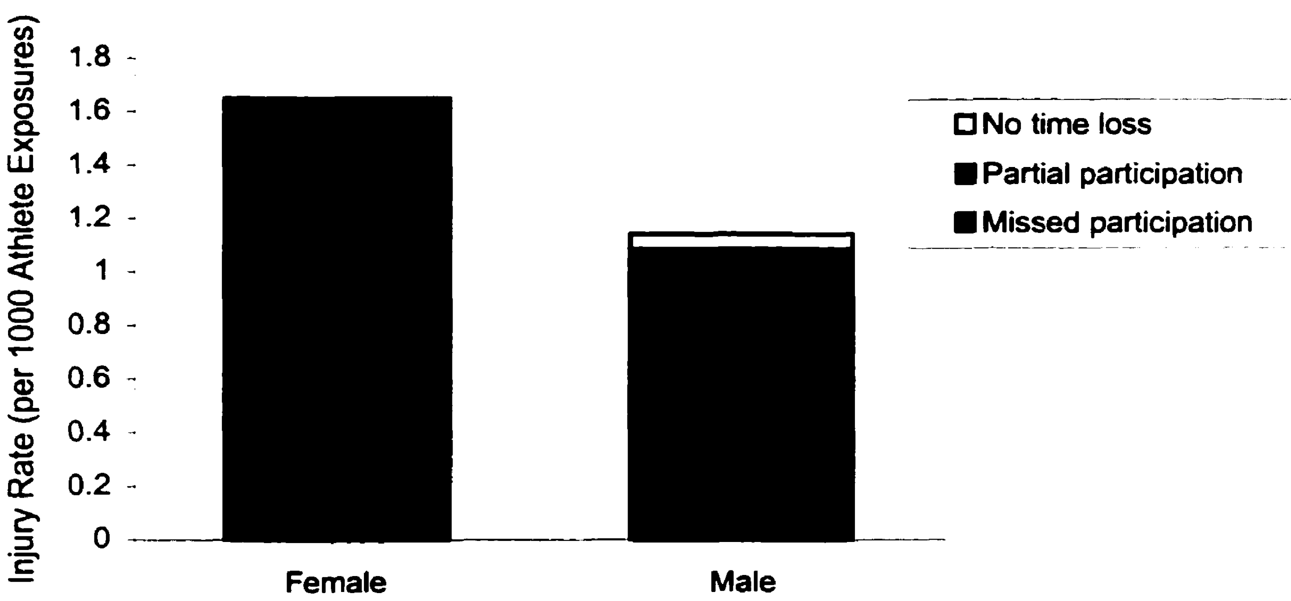

Figure 18 Injury rates for concussion injury in male and female athletes.

Table 19 Relative risk estimates for concussion injury rates in male and female hockey athletes.

	Athlete Exposures	Number of Injuries	Injury Rate (per 1000 AE)	Relative Risk	95% Confidence Interval	Statistically Significant
No time loss						
Male	17512.5	1	0.06	-	-	-
Female	8489.5	0	-			
Partial participation						
Male	17512.5	2	0.11	0.19	(0.04, 1.00)	yes
Female	8489.5	5	0.59			p=0.041
Missed participation						
Male	17512.5	17	0.97	0.92	(0.41, 2.05)	no
Female	8489.5	9	1.06			p=0.836

Most facial lacerations, facial fractures and dental injuries and were also eliminated from the previous results. Although these injuries may not result in time loss, they are consequential to the athlete's health and are significant injuries requiring medical or dental treatment. These injuries have a significant impact on the health care system and are therefore considered separately in this section. Table 20 summarizes the injuries in this study that did not result in time lost to participation.

Table 20 Summary of facial injuries in male and female athletes.

	Male	Female
Facial lacerations	30	0
Facial fractures	3	0
Dental injuries	8	0

Male athletes sustained several facial lacerations, facial fractures and dental injuries. It should be noted that in the CWUAA league, female athletes wear full-facial protection while male athletes wear only half-facial protection. Females did not incur any facial or dental injuries because of the full-facial protection worn during participation. The nature of the male and female games may also have an impact on the rates of these types of injuries.

4.9 Equipment Wearing Patterns of Female Athletes

One of the objectives of this research was to determine if risk of injury differed between females wearing equipment designed for females or equipment designed for males. However there were relatively few female athletes who wore equipment specifically designed for females. There were also very few injuries in each region that could be attributed to equipment. Therefore this analysis was not possible.

The Equipment Information Form was used to extract information regarding equipment wearing patterns of female hockey athletes. Table 19 displays equipment wearing patterns for specific makes of equipment in female hockey. Figures 20-22 display additional equipment information for female athletes.

Table 21 Equipment wearing patterns according to specific equipment make for female hockey athletes.

Equipment Make	Helmet	Shoulder Pads	Pants	Shin Pads	Skates
Bauer	27	22	1	19	19
CCM	10	7	4	1	14
Cooper	5	4	2	5	0
Easton	-	5	17	4	1
Louisville	-	2	5	-	-
Tackla	-	-	12	-	-
Other	-	3	2	12	9

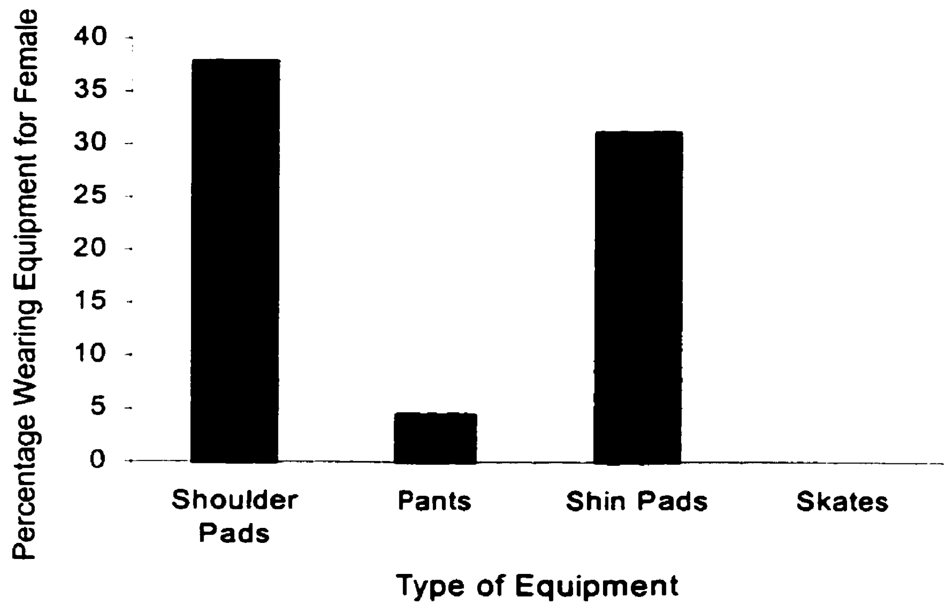

Figure 19 Percentages of female athletes wearing equipment designed specifically for the female body.

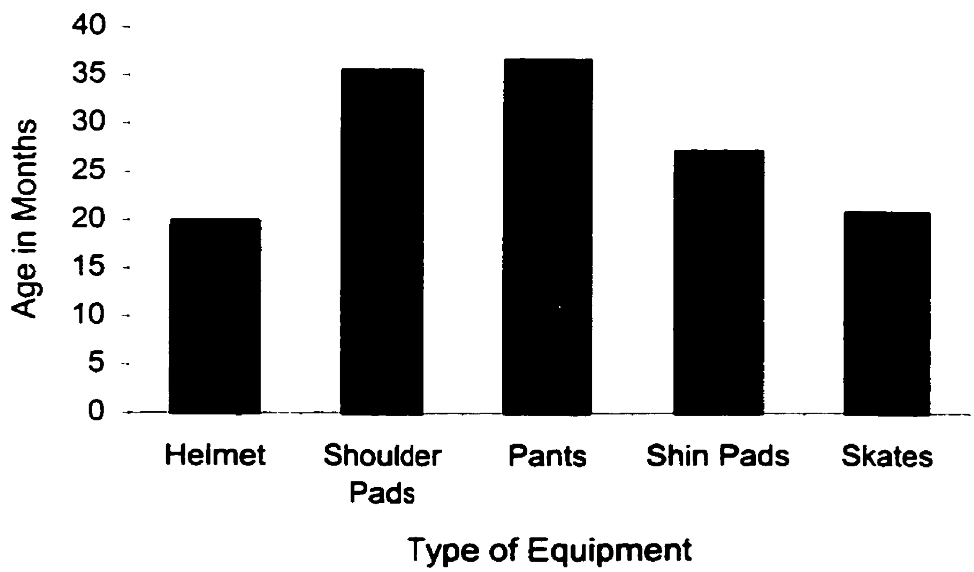

Figure 20 Average age in months of equipment worn by female hockey athletes.

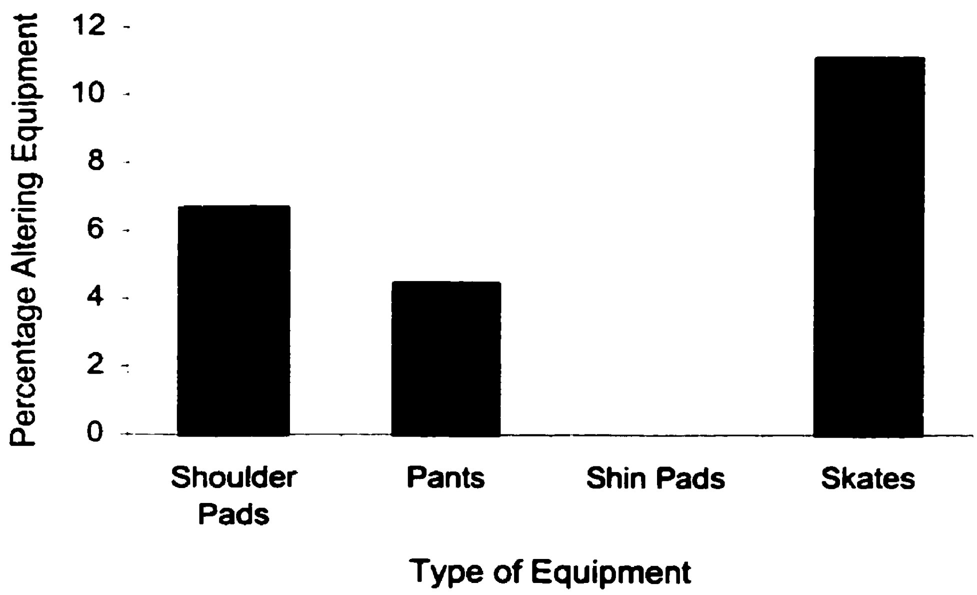

Figure 21 Percentage of female athletes who alter their equipment for a better fit.

5. Discussion

5.1 Introduction

Ice hockey is a fast-paced and often violent sport (Daly 1990). High-speed collisions and contact with obstacles often leads to injury in the sport of hockey (Tegner 1991). In recent years female hockey has gained popularity and participation numbers have increased dramatically (Etue and Williams 1996). There is currently no published literature in the area of female hockey injury epidemiology. However, one may assume that injury rates would be lower in female hockey because of the absence of intentional body checking. This research study is the first to prospectively examine a large sample of female hockey participants through an entire hockey season. This final Chapter addresses the results of this study and discusses the major findings. Finally, potential strategies to reduce injury in hockey will be presented.

5.2 Characteristics of Female Hockey

In this study female hockey had an average of 19 members, while male teams had an average of 24.5. One may speculate on the reason for the smaller female teams. Firstly, there are not as many scholarships for female hockey athletes as there are for male hockey athletes (Avery and Stevens 1997; Kathy Berg, personal communication, January 18, 1999). Secondly, budgets are often very low for female teams and therefore it may not be possible to fund athletes for travel purposes (Kathy Berg, personal communication, January 18, 1999).

Female teams only competed in a limited number of competitions during the 1998/99 varsity season. Females only had approximately half the number of competitions of their male counterparts. Female competitions were also more spread out over time enabling longer periods of recovery between sessions.

For the purposes of this study, each athlete session was referred to as an exposure. The size of female hockey teams and the number of competitions have a direct effect on the total exposures female hockey participants accumulate during a season. In the present study, female hockey athletes only had approximately half the exposures of their male counterparts. As female hockey continues to become established, the number of exposures will likely increase. In the 1999/2000 season, the CWUAA intends to increase the number of competitions to four tournaments. In following years the CWUAA plans to schedule the female league with the same format as the male league (Kathy Berg, personal communication, January 18, 1999). Females will then engage in competitions every week over a six-month season.

In this study, the average age of female hockey participants was three years younger than male hockey participants. Since male hockey athletes often compete in Major Junior leagues before attending university, male athletes are older when they begin their varsity careers. Also, since most female university teams have only been developed in the last two years, female athletes have only been participating for a limited time. In years to come the average age of female participants may increase as the current athletes age.

5.3 Injury Rates

In this study, a greater percentage of male athletes (57%) were injured compared to female athletes (36%). Male hockey participants incurred 161 time loss injuries, while female hockey participants incurred only 66 time loss injuries. When the differing exposure rates were taken into account, female hockey athletes were injured at a rate of 7.77, while male athletes were injured at a rate of 9.19 injuries per 1000 AE. The injury rate calculated for male athletes in this study is somewhat lower than injury rates reported in other studies. Specifically, Pelletier et al. reported an injury rate of 19.95 injuries per 1000 athlete exposures (AE) (1993). However, any treatment was recorded as an injury in this study in comparison to the present study that excluded all injuries that did not result in time lost from participation. There are no published studies regarding injury rates in female hockey for comparison purposes.

The injury rates of 9.19 for males and 7.77 for females did not differ significantly. This result is somewhat unexpected. Observers of hockey state that female hockey is not played with the same speed and aggression as male hockey (Clark 1998). Also female hockey athletes are, on average, smaller than male hockey athletes (Doyle-Baker and Fagan 1996; Bracko 1998). Therefore collisions are not as forceful in female hockey. Further, female hockey does not allow intentional body contact during play. Therefore it would be expected that injury rates would be lower in the female hockey group. However, there are several other factors that may contribute to injury in female hockey including level of experience, anatomic and physiologic differences, and inherent characteristics of the female game.

5.3.1 Injury Severity

Male hockey participants incurred significantly higher rates of the most severe injuries during the 1998/99 varsity season. Male athletes were 5.33 (95% CI 1.64, 17.39) times more likely to miss more than 14 sessions due to an injury. Presumably, this is due to the traumatic nature of male hockey participation. Male hockey athletes are able to travel at faster speeds than female athletes, and are able to generate substantial forces upon collision (Daly et al. 1990). Male hockey athletes intentionally garner large forces and direct them towards their opponents in order to gain advantage. This type of contact is not allowed in female hockey. The sheer number of collisions and the force of these collisions are the most probable cause of more severe injuries in male hockey. Many of the most severe injuries were to the shoulder region and were attributed to contact; further supporting the assumption that the most severe injuries were a result of the nature of the male game.

Due to the nature of female hockey scheduling, injury severity may be under-estimated. Male athletes usually have games and practices on consecutive days, while female ice sessions are less frequent. This allows female athletes more time to recuperate from injury and they may return more quickly to participation. Therefore, females may not have missed as many sessions due to injury, simply because of the nature of the female hockey schedule. For example, if a male sustained an injury with a recovery time of a week he would miss approximately six ice sessions. However, if a female sustained an injury with a recovery time of a week, she would only miss two or three ice sessions. Also, only injuries that resulted in at least one session of missed participation were analyzed in this study. There may be fewer documented injuries in the female group because of the exclusion of all injuries not resulting in time loss.

5.3.2 Injury Status

Both male and female hockey athletes were more likely to sustain a new injury (7.42 and 5.65 injuries per 1000 AE) as opposed to a recurrent (0.11 and 0.47 injuries per 1000 AE) or ongoing (1.60 and 1.06 injuries per 1000 AE) injury. Although the differences were not statistically significant, males were more likely to sustain new injuries than their female counterparts. These data suggest that male hockey athletes are more prone to traumatic injuries during their hockey participation. Injuries such as contusions, lacerations and fractures (that are usually a result of slashing or high-sticking) are more numerous in male hockey. The fact that male participants only wear half-facial protection is likely a factor in the high number of these "new injuries." Many injuries in the new injury category are facial lacerations or dental injuries. It is unknown whether female athletes simply do not partake in these activities such as slashing and checking from behind as readily, or if their full-face shields protect them from injury due to these activities. Certainly, penalties for illegal activities are lower in female hockey than in male hockey (Canadian Hockey Association

1998), so an assumption may be made that these illegal activities do not occur as often in female hockey.

5.4 Injury Mechanisms

A greater percentage of injury was attributed to contact mechanisms in female hockey than in male hockey. Specifically, 96% of injury in female athletes was related to contact as opposed to 79% of injury related to contact in male athletes. These results are similar to those of McKnight who reported that 96% of all upper body injuries were related to contact in his study of male ice hockey (1992). As mentioned, female hockey does not allow intentional body checking. Therefore the numbers of collisions with the boards and with opponents should be lower in female hockey than in male hockey. It is therefore interesting that a larger proportion of injuries were caused by contact in female hockey than in male hockey.

One may speculate on the reason for the higher injury rate due to contact in female hockey. Many female varsity hockey players have played on predominately male hockey teams before participating with female-only teams. On these male teams they were allowed to intentionally body check. Other female varsity hockey players have played on female-only teams through their entire hockey experience and have never been involved in competition with body checking. These athletes have never had the experience of giving a body check, or receiving a body check. When these two groups of athletes come together, the less experienced body checkers may become injured during contact with their opponents.

Several female athletes comment that when they do get hit in female hockey they are not expecting the hit and are taken by surprise (Susan Lippitt, January 11, 1999; Kathy Berg, personal communication, January 18 1999). Females may be injured because they do not know how to anticipate or absorb a hit. Therefore, even though collisions may occur less frequently in female hockey, the collisions that do occur may have more serious consequences.

5.5 Specific Injury Incidence in Female Ice Hockey

The most common injury in male ice hockey reported in the present study was concussion injury. Males sustained concussions at a rate of 0.97 injuries per 1000 AE, or 10% of all injuries. Adductor strains at 0.74 per 1000 AE and MCL sprains at 0.69 per 1000 AE followed in frequency. The concussion injury rate is higher than those reported in other studies. Bernard et al. reported that concussions consisted of 10% of all injuries, while Roy et al., Lorentzon and Rielly reported percentages of 3%, 4% and 6% (Bernard et al. 1993; Roy et al. 1989; Lorentzon 1988; Rielly 1982). The reason for this disparity may be due to the increased awareness and reporting of head injury in recent years. Also, in this study, only those concussions resulting in time loss were analyzed while every concussion was reported in other studies.

The most frequent female hockey injuries in this study were also concussions reported at a rate of 1.18 per 1000 AE. Adductor strains (1.06 per 1000 AE), ankle sprains (0.82 per 1000 AE) and SI dysfunctions (0.35 per 1000 AE) were more common in female ice hockey than in male ice hockey. The rate of concussion injury in female hockey is notable, but is not significantly higher than in male hockey. Concussions also caused the most time lost from the sport. Sixty-three percent of concussions in female hockey were a result of contact with an opponent.

Ankle sprains are also a concern in regards to time lost from female hockey participation. 26% of the total time lost from participation in female hockey was related to ankle sprains. Researchers have speculated that female ligaments are more lax than male ligaments, leading more readily to joint sprains (Arendt 1996). This may be the reason that ankle injuries occurred at a higher rate in female than male hockey athletes. The skate boot provides a relatively rigid support for hockey athletes. Perhaps some characteristic of the skate boot does not conform well to the female foot, making female athletes more prone to ankle injury. Female athletes were most likely to alter their skates for a better fit compared to all other equipment types.

Some injuries of note in the male hockey population were absent in the female hockey population. Acromioclavicular separations, knee and thigh contusions and hand fractures did not occur in the female population. These injuries in males were most often caused by contact, and in particular, contact with the stick. The stick is customarily used as a weapon in male hockey (Canadian Academy of Sport Medicine Position Statement 1991). Administrators of male hockey justify body checking by stating that is an outlet for the natural aggression that occurs in hockey. However research has shown that with the introduction of body contact to hockey, other illegal and aggressive acts increase (Canadian Academy of Sport Medicine Position Statement 1991). Stick-work such as hooking, slashing, high-sticking and spearing are common in male hockey and rarely penalized (Canadian Academy of Sport Medicine Position Statement 1991). Female hockey does not permit body checking and the frequency of illegal acts are also lower (Canadian Hockey Association 1998). In this study no injuries were caused by stick contact in female hockey.

5.6 Injury Conditions

Both female and male hockey athletes are more likely to be injured in game situations as compared to practice situations. Males were injured at a rate of 22.40 injuries per 1000 AE while females were injured at a rate of 2.69 injuries per 1000 AE during games. During practices males and females were injured at rates of 10.43 and 3.03 injuries per 1000 AE respectively. The increased injury rate during competition is consistent with other research (Stuart and Smith 1995; Bancroft 1993; Dick 1994).

Male injury rates are significantly higher during games than female injury rates during games. Specifically males had a risk of being injured during games 2.15 (95% CI 1.43, 3.22) times greater than that of females. Again this is presumably due to the high incidence of illegal activities during male hockey competition. Males were more likely to be injured in the slot area of the ice. It is unknown if more injurious activities occur in this area of the ice, or if the athletes spend more time in this area.

In this study, females were most often injured during the second period of play. Injury rates for the first second and third period were 0.70, 5.21, and 4.17 injuries per 1000 AE respectively. This varies from injury rates of 7.61, 7.40, and 6.76 injuries per 1000 AE respectively in male hockey. The first and second periods differ significantly within female hockey and in comparison to male hockey. Most female games consist of three 15-minute periods with no flood between the first and second period. The quality of the ice obviously decreases as play progresses. Soft ice with ruts becomes a factor in the rate of injury (Daly et al.). Also, female hockey athletes may become fatigued when playing two consecutive periods without a rest. Fatigue may render female athletes more prone to injury during the second period of play (Taimela et al. 1990).

Female and male athletes did not differ in regards to injury rates according to player position. The goal-tender was least likely to be injured in both male (3.84% of all injuries) and female (10.39% of all injuries) groups. The other player positions were injured at the similar rates. Forwards sustained 18.90% of injuries in males and 19.23% of injuries in females while defensive players sustained 16.49% of injuries in males and 19.23% of injuries in females.

5.7 Other Injury

During the course of the 1998/99 varsity season, male hockey athletes incurred a total of 41 facial and dental injuries, while female athletes did not suffer any of these injuries. Again, the illegal play may make male athletes more susceptible to facial injury. However, most of the difference is probably due to equipment variations between male and female hockey. Female athletes wear full-facial protection that shields them from facial injury while male athletes only wear half-facial protection. It is difficult to determine whether females do not engage in injurious activities at the same rate as males, or if they simply do not get injured from these activities because of their facial protection. However, the difference is presumed to primarily be a result of equipment differences.

5.8 Summary of Major Findings

The rate of injury (7.77 injuries per 1000 AE) in female ice hockey does not differ significantly from the rate of injury in male hockey (9.19 injuries per 1000 AE). This result may be surprising considering there is less contact in female hockey. However, 96% of injuries in female hockey are related to contact mechanisms. This finding suggests that female hockey athletes may be less proficient at checking skills making them more prone to injury when contacted. Concussions are the most common injury in female hockey (1.18 per 1000 AE), the majority resulting from contact with the boards or an opponent. Adductor strains (1.06 per 1000 AE) and ankle sprains (0.82 per 1000 AE) ranked as the second and third most common injuries in female hockey. Females suffer less injury during game conditions than their male counterparts. The dangerous play with the stick in male hockey may lead to injury, while this type of play and resulting injury is relatively absent in female hockey. Females are more prone to injury during the second period of play. Although female hockey has been considered a relatively safe sport because of the absence of body checking, there is still a substantial injury risk for female hockey participants. In the present study, females incurred 7.77 injuries every 1000 athlete exposures.

5.9 Alternative Explanations for the Results

As previously mentioned, the vast differences between male and female athletes make direct comparisons between the groups inappropriate. In this study, the total injury rates between male and female athletes differed somewhat. There may be several factors that alter these injury rates. These factors are summarized in Table 22. These factors may be viewed as alternative explanations to gender resulting in the differences between male and female athletes. It is important to note that these factors are only speculated and are not based on findings of this or other research. Further research may be able to distinguish the effects of these factors.

Table 22 Possible alternative explanations for the results.

Factor of Interest	Effect on Injury Rate	Explanation
Athlete age	↑ male injury rate	male athletes are older on average and therefore may be more susceptible to injury
Athlete experience	↑ female injury rate	female athletes are less experienced, rendering them more likely to be injured
Previous injury	↑ male injury rate	since males have probably participated in hockey longer, they are more likely to have been injured previously
Athlete size	↑ male injury rate	males are larger and are able to generate greater impact forces
Skill level	↑ male injury rate	males are more skilled at hockey and are able to move at faster speeds, therefore generating greater impact forces
Style of play	↑ male injury rate	male hockey is played with an increased intensity that may result in increased injury
Level of body contact	↑ male injury rate	male hockey has more collisions that are likely to result in injury
Facial protection	↑ male injury rate	males wear half-shields, making facial injury more likely
Equipment	↑ female injury rate	poor fit of equipment on females may render them more likely to be injured
Number of exposures	↑ male injury rate	males have a greater number of exposures during a season, leading to increased chance of injury as the season continues
Scheduling of ice sessions	↓ female injury rate	since female sessions are sparse, females have more time to recover from injury
Length of games	↓ female injury rate	since female games are shorter, there is less fatigue and less chance of injury
Game structure	↑ female injury rate	the lack of a flood and rest between the first and second periods makes female injury more likely during the second period
Physiology	↑ female injury rate	females are may be less fit than their male counterparts, making them more likely to be injured
Anatomy	unknown	anatomical weaknesses inherent to gender may be an injury factor
Psychology	unknown	psychological differences may exist between male and female athletes that affect injury

5.10 Limitations

Several limitations are recognized in this study:

1. Therapists may not complete the forms until some time after the injury or the session has taken place. Recall bias may result when the therapist attempts to remember events of the past. The researcher had no method of tracking the habits of the participating therapists.
2. The Participation Calendars were completed by the athletes and depended entirely on accurate self-reporting. Again, recall bias may have been a factor. However, the athlete reports matched the therapist reports 98% of the time. An assumption could be made that in cases where there was no comparison between athlete and therapist reports, the athlete was still accurate approximately 98% of the time.
3. Female athletes completed the Participation Calendars and indicated if they were injured during hockey outside their varsity participation. All reports of injury were documented by the team therapist on corresponding IIRFs. Therefore, one may assume that the study was able to capture all injuries in female hockey whether or not they occurred during varsity participation. However, the female athletes may not have reported all injuries on the Participation Calendar. The researcher had no way of determining if the athletes were injured during their outside participation if the injury did not affect subsequent varsity participation. Therefore, injury rates in female hockey may be under-estimated.
4. Due to the structure of female hockey, injury time loss may be under-reported. Since there are often several days between sessions in female hockey, athletes that have

sustained an injury have more time to rest and recuperate. They may be able to return to hockey whereas if they had had a session the day following an injury they would not have been able to return. This would have caused a lower reported injury rate because only time-loss injuries were analyzed. This scheduling difference may have also underestimated the severity and burden of injury by recording fewer sessions missed over a given period of time.

5. The lack of statistical significance in this study could be attributed to inadequate sample size. Differences between male and female groups may be clinically significant. However, a larger sample size is required in order to achieve statistical significance.

5.11 Recommendations for Injury Reduction in Hockey

Female hockey administrators have discussed the plan to re-introduce body checking to female hockey (Etue and Williams 1996). It does not appear that this would be beneficial to female hockey. The results of this study suggest that female athletes appear to be more prone to injury when they come in contact with the boards or their opponent. Perhaps females should be taught to properly anticipate and absorb contact. This intervention should then be examined to determine its effect on the safety and ensuing injury rates of female hockey with an appropriate control group.

The ice should be flooded between every period of female hockey. This will improve the ice quality and reduce the chances of the ice contributing to injury. It would also give female athletes an opportunity to rest before the next period, therefore reducing fatigue.

Again, this intervention and the resulting injury rates should then be examined to determine its effectiveness in reducing injury during the second period.

Every effort should be made to reduce illegal stick work in male ice hockey. Several injuries are a result of slashing and high-sticking activities. Although many of these injuries do not result in time lost from participation they are a burden to the health-care industry. The differences in facial injury in this study are more likely attributed to the differences in facial protection than they can to gender.

5.12 Future Research Directions

The data collected for this research could provide the means for further analysis. The database could be used to analyze other factors involved in female hockey. For example, the time of the season in which injuries were most common could be determined. Also, effects of previous injuries could be determined. These are projects that could be undertaken with the data that has already been collected.

Analysis of injury mechanism is critical in female hockey. A determination should be made between injuries that occur because the athlete is checking an opponent and injuries that occur as a result of being checked. Instruction in checking technique may be given to female hockey athletes. This intervention could be studied in a randomly selected clinical trial. Detailed analysis of ice quality and resulting injury would also be beneficial in studying ice hockey.

Female hockey is still at the development stage. For this reason there exists a wide variety of skill levels in female varsity hockey (Kathy Berg, personal communication, January 18, 1999). Some female athletes are very skilled and are proficient skaters. Others are still developing these skills. Hockey athletes who travel at faster speeds are able to generate larger impact forces upon collision (Daly et al. 1990). Consequently, when faster athletes come in contact with less experienced athletes the slower athlete will suffer the brunt of the force. As mentioned in Chapter 2, the decision to eliminate body checking from female hockey was made due to the wide range of skill level in the participating athletes. The varying skill level in female varsity hockey may play a role in injury due to contact. The analysis of skill level and resulting injury would be beneficial to the understanding of female hockey injury.

Head injury is a major concern in many areas of athletics. In this study, concussion injuries were common in both male and female hockey athletes. It appears that most concussion injuries were a result of contact with the boards or an opponent. The mechanism of these injuries should be analyzed further, perhaps by video, to determine the exact type of contact that results in concussion. The next step would be to introduce preventative strategies for head injury in ice hockey. There may be certain actions that warrant penalization in order to reduce injury. For example, checking from behind regulations were introduced in order to reduce spinal injury (Watson et al. 1996). These issues, as well as protective equipment should be evaluated in future studies.

5.13 Conclusions

This research has been effective in demonstrating injury rates and patterns in female ice hockey. Head injury is the most common injury in female hockey followed by adductor strains and ankle sprains. Although checking is not allowed in female hockey, collisions still occur as a matter of course and injuries are likely to result. This study is the first of its kind to prospectively study injury in female ice hockey. It is the only available information for reporting injury rates and profiles in female ice hockey. It is hoped that the results of this study will aid in the understanding injury in female hockey and provide a starting point for further research.

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APPENDIX A

Injury History Questionnaire

INJURY HISTORY QUESTIONNAIRE

1998/99

Canadian Intercollegiate Sport Injury Registry

To be completed by the athlete.

Last Name ______________________ **First Name** ______________________
Address ______________________ **City** ______________ **Province** ________
Date of Birth ______________ **Home Phone #** (____) ______________ **Postal Code** ____________
Day Month Year
Health Care # ______________________ **Province** ______________
FOR EMERGENCY NOTIFY: Name ______________________ **Relationship** ____________
Address ______________________ **Phone** ______________
Family Doctor's Name ______________________ **Date of Last Physical** ______________
Month Year
Sport: ______________________
Year of Varsity Sport (circle): 1st 2nd 3rd 4th 5th 6th
Year of Eligibilty (circle): None ('Red Shirt') 1st 2nd 3rd 4th 5th

What position will you be playing this year? ____________

HEAD INJURIES / CONCUSSIONS:

		Yes	No
1.	Have you ever had a seizure?	❑	❑
2.	Have you ever had a head injury?	❑	❑
	Have you ever had a concussion or been "knocked out", had your "bell rung", or been "dinged"?	❑	❑

If YES, please list: Number: ______

Date(s) | Activity at the time | Length of unconsciousness (minutes) | Length of time before full return to activity

Did you have any persistent problems with:

Memory YES NO Dizziness YES NO Headaches YES NO

NECK INJURIES / BURNERS / STINGERS:

		Yes	No
3.	Have you ever had a neck injury (i.e. strain, sprain, fracture, etc.)	❑	❑
4.	Have you ever had a stinger, burner or pinched nerve?	❑	❑

(a burning or numb feeling in the shoulder or arm after a hit to the head, neck or shoulder - aka. "brachial plexus stretch injury")

If YES, please list: Number: ______

Date(s) | Activity at the time | Length of time sensation/strength changes persisted?

5. Check any of the areas that you have **INJURED IN THE PAST** and explain the injury below:

Hand ___	Elbow ___	Neck ___	Hip ___	Shin/Calf ___
Wrist ___	Arm ___	Chest ___	Thigh ___	Ankle ___
Forearm ___	Shoulder ___	Back ___	Knee ___	Foot ___

Year of injury	Type of Injury	Side (right, left, both)	Is it still a problem? (Yes/No)

6. Do you have any incompletely healed injury? .... Yes ❑ No ❑

If yes, which injury? ____________________

I hereby certify the above information to be correct.

Athlete Signature ____________________ Date ______________

Injury History Summary

(To be completed by a P.T./Therapist).

Please summarize below the relevant injury information for the CISIR database and for your own records.

Athlete's Name: ____________________ ______________

Problem Description	Side	Treatment	Date Active	Status (eg. Active, Inactive, Recurrent, Ongoing, etc.)	Date Inactive (if appropriate)

Date: ______________ P.T. / Therapist: ______________

APPENDIX B

CWUAA Annual Reassessment Form

C.W.U.A.A. Annual Health Reassessment

PLEASE NOTE: **Athletes using this form MUST have at least one complete pre-season physical examination on file from previous seasons**

Last Name: ____________________ **First Name:** ____________________
SPORT__________ **UNIVERSITY** __________ **DATE** __________
DATE OF LAST PHYSICAL__________ **DATE OF BIRTH** __________
ADDRESS ____________________
PHONE NUMBER ____________________
FAMILY DOCTOR ____________________
Provincial Health Care No.__________ **Province**__________ **Student No.** __________
Year of participation in this **Varsity Sport (circle):** **1st 2nd 3rd 4th 5th 6th**
Year of Eligibility (circle): **None ('Red Shirt') 1st 2nd 3rd 4th 5th**
6th
What position will you be playing this year?____________________

In the past year, have you experienced.....? (please explain "YES" answers below)

any injury requiring you to miss more than one practice or game .... YES NO
any injury requiring physiotherapy or other treatment .... YES NO
any concussion or head injury .... YES NO
any burner/stinger or neck injury .... YES NO
any surgery or operation for any reason .... YES NO
any hospital admission for any reason .... YES NO
any illness or medical condition lasting longer than one week .... YES NO
any heat exhaustion or heat stroke .... YES NO
are you now on, or have you been advised to be on, any medication
on a regular basis .... YES NO
any new allergies to medication, insects, etc. .... YES NO
chest pain or severe shortness of breath on exertion .... YES NO
coughing or wheezing on exertion .... YES NO
fainting or dizzy spells on exertion .... YES NO
irregular heartbeat .... YES NO
bone or joint pains not related to injury .... YES NO
frequent or severe headaches .... YES NO
abdominal pains .... YES NO
skin problems .... YES NO
unexplained weight change .... YES NO
(women only) any abnormality of menstrual cycles .... YES NO

Do you currently have any incompletely healed injury? .... YES NO
Do you have anything you wish to discuss with the team physician? .... YES NO

Have you started using any special equipment? (pads, braces, orthotics, etc.) .... YES NO

Explain "YES" answers: ____________________

Any YES answer may require further evaluation by the team physician.

I hereby certify the above information to be correct
Athlete's Signature: ____________________

APPENDIX C

Weekly Exposure Sheet

Canadian Intercollegiate Sport Injury Registry

Hockey-1998

Weekly Exposure Sheet

University: ____________

Date (MM/DD)							
Session (General...)							
Duration (...)							
Session Description (ie skill, game...)							
Rink Size (Olympic ... x 85, Smaller)							
Ice Conditions (...)							
Recorder's Initials							

Athlete			IID		IID		IID		IID		IID		IID		IID
	Participation:														
	Helmets:														
	Participation:														
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	Helmets:														

Please enter a participation code for each player indicating:

⇓

F	Full (75%)
P	Partial (<75%)
O	or None (0)

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

⇓

I	Injured
S	Sick, or
A	Absent for any other reason

⇓

IID Injury ID#

	2	specifies injury report form id number to attribute time loss

Please enter a participation code for each player indicating:

⇓

F		Full (75%)
P		Partial (<75%)
O		or None (0)

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

⇓

I		Injured
S		Sick, or
A		Absent for any other reason

⇓

IID Injury ID#

	2	specifies injury report form id number to attribute time loss

Athlete			IID		IID		IID		IID		IID		IID		IID
	Participation:														
	Helmets:														
	Participation:														
	Helmets:														
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	Helmets:														

APPENDIX D

Participation Calendar Sample Sheet

October

Name:____________________

Sunday 11	Monday 12	Tuesday 13	Wednesday 14
game/practice **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________	**game/practice** **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________	**game/practice** **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________	**game/practice** **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________
Thursday 15	**Friday 16**	**Saturday 17**	
game/practice **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________	**game/practice** **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________	**game/practice** **(circle one)** • team:______________ • opponent:____________ • Did you participate fully, partially or not at all? F/P/O (circle one) • Were you injured? Yes/No weights/dryland (circle one) • time:________	**★Note:** Partial participation means You missed 25% or more of the session because you were absent, injured, sick, etc.

APPENDIX E

Individual Injury Report Form

Injury ID#

Individual Injury Report Form

Hockey-1998/99

№ 0836

Canadian Intercollegiate Sport Injury Registry

Date of Injury: ____________

Date Reported: ____________

1) **Athlete Name:** ____________

2) **Position played when injured** (Circle):

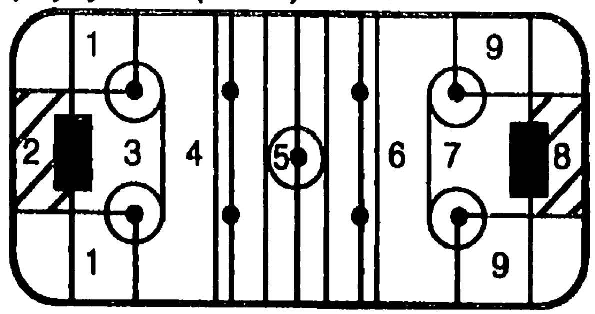
Center / Wing / Defence / Goalie / N/A

❑ Attacking ❑ Defending ❑ Neutral

3) **Normal Position:** ❑ Same as #2

Other: ____________

4) **Injury Zone: (mark X)** ❑ N/A



5) **Contact with boards, stick, or other obstacles:**
❑ N/A ❑ No ❑ Yes (list): ____________

6) **Injury Status:**
❑ New Injury
❑ Recurrence of injury from this season
❑ Recurrence of injury from previous season (this sport)
❑ Recurrence of non/other sport injury
❑ Ongoing Injury

7) **Dental:** Mouthguard?: ❑ Yes ❑ No ❑ N/A

If so what type?: ____________

8) **Injury Conditions:** ❑ Known ❑ Unknown

a) Game: ❑ Home ❑ Away

i) Exhibition
❑ Warm-up
❑ Period #: ___
❑ Overtime#: ___

ii) Regular Season
❑ Warm-up
❑ Period #: ___
❑ Overtime#: ___

iii) Playoffs
❑ Warm-up
❑ Period #: ___
❑ Overtime#: ___

b) Practice:
i) ❑ Skill Training
ii) ❑ Conditioning
iii) ❑ Scrimmage

c) Other:
i) ❑ Weight Training
ii) ❑ Non-sport
iii) ❑ Other Conditioning
iv) ❑ Gradual Onset
v) ❑ Other Sport

9) Did athlete **return to play the same session?:**
❑ Yes ❑ No ❑ N/A

10) **Illegal play?:** ❑ Yes ❑ No ❑ N/A
❑ Check from behind ❑ Cross-check ❑ High stick ❑ Slash
❑ Other: please specify ____________
Penalty called?: ❑ Yes ❑ No

Describe Events Surrounding Injury (including exact mechanism of injury): ❑ Known ❑ Unknown ____________

Remarks: ____________
(subjective report of cause; e.g. unsafe action, hazardous conditions, equipment, etc.)

Other Assessment Notes: ____________
(for a concussed athlete, please provide details surrounding the signs and symptoms; i.e. confusion, headache, tinnitus, amnesia, loss of consciousness, etc.)

Assessment: ____________

Side (Right/Left/Both) | Body Region (and structure) | Type of Injury ("Diagnosis") | (e.g. Right shoulder A/C joint 3° sprain)

Treatment Plan (Check all that apply):

❑ Protect
❑ Rest
❑ Ice
❑ Compression
❑ Elevation

❑ Stretch
❑ Strengthen
❑ Manual therapy
❑ Heat
❑ Modify activity

❑ Transfer to hospital
❑ Tape/Brace/Crutches (circle)
❑ Modalities
(specify): ____________

❑ Observe
❑ Refer to Physician
❑ Refer to Dentist

Other Treatment Notes: ____________

Estimate of time Loss from Injury (days): ______ **Therapist's Name** (print): ____________ **Therapist's Signature:** ____________

Physician's Name: ____________

White-Therapist Copy   Yellow-C.I.S.I.R. Copy   Pink-Physician Copy

APPENDIX F

Equipment Information Form

Canadian Intercollegiate Sport Injury Registry

Hockey-1998/99

Equipment Information Form

University: Calgary

Name: Jane Doe				
Helmet	**Shoulder Pads**	**Pants**	**Shin Pads**	**Skates**
Make:	Make:	Make:	Make:	Make:
Model:	Model:	Model:	Model:	Model:
How long have you used this helmet?	How long have you used these shoulder pads?	How long have you used these pants?	How long have you used these shin pads?	How long have you used these skates?
Have you altered it for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:
Name:				
Helmet	**Shoulder Pads**	**Pants**	**Shin Pads**	**Skates**
Make:	Make:	Make:	Make:	Make:
Model:	Model:	Model:	Model:	Model:
How long have you used this helmet?	How long have you used these shoulder pads?	How long have you used these pants?	How long have you used these shin pads?	How long have you used these skates?
Have you altered it for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:
Name:				
Helmet	**Shoulder Pads**	**Pants**	**Shin Pads**	**Skates**
Make:	Make:	Make:	Make:	Make:
Model:	Model:	Model:	Model:	Model:
How long have you used this helmet?	How long have you used these shoulder pads?	How long have you used these pants?	How long have you used these shin pads?	How long have you used these skates?
Have you altered it for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:
Name:				
Helmet	**Shoulder Pads**	**Pants**	**Shin Pads**	**Skates**
Make:	Make:	Make:	Make:	Make:
Model:	Model:	Model:	Model:	Model:
How long have you used this helmet?	How long have you used these shoulder pads?	How long have you used these pants?	How long have you used these shin pads?	How long have you used these skates?
Have you altered it for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:	Have you altered them for a better fit? Yes No If yes, how:

APPENDIX G

Sample Calculations

Calculation of total injury rate:

=total number of cases/total population at risk
=number of injuries incurred/total athlete exposures
=161/17512.5
=9.19

Calculation of the relative risk of injury in male versus female athletes:

=risk of the outcome in the non-exposed group/risk of outcome in the exposed group
=injury rate in male athletes/injury rate in female athletes
=9.19/7.77
=1.18