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University of Alberta

Epidemiology of Women's Recreational Ice Hockey Injuries

by

Donna Marion Dryden

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment

of the requirements for the degree of Master of Science

in

Medical Sciences - Public Health Sciences

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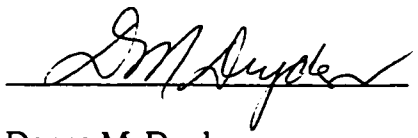

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Epidemiology of Women's Recreational Ice Hockey Injuries submitted by Donna Marion Dryden in partial fulfillment of the requirements for the degree of Master of Science in Medical Sciences - Public Health Sciences.

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Abstract

This thesis presents the results of a prospective cohort study that examined the incidence and nature of women's recreational ice hockey injuries. A descriptive analysis was conducted for injuries sustained by 314 participants playing women's ice hockey in the greater Edmonton area in Alberta, Canada. One hundred and two players reported a total of 125 injuries. The injury rate was 7.5 injuries/1000 player-exposures. The most common diagnosis was sprain/strain (52%), and the most common injury site was the lower extremity (31%). The dominant injury mechanism was player contact, either as a result of collision with another player or body check (40%). An analysis of personal risk factors associated with injury was conducted for the study participants. Risk factors found to be significantly associated with injury were: injury in the past year (O.R. = 1.55), more than five years of hockey experience (O.R. = 1.44), and an exposure level of more than 50 games/practices during the season (O.R. = 1.37).

Preface

This thesis is presented in the paper format. It comprises an introductory chapter, two related research papers, and a concluding chapter. Each chapter is presented with its own introduction, body of text, conclusion and set of references. Chapters Two and Three of this thesis have been written with the intention that they will be submitted for publication.

Acknowledgment

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I would like to thank the hockey league officials and players who endorsed and participated in this study. Without their support, this research would not have been possible.

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Chapter 1

Introduction

1.1 Introduction

Participation in exercise and sport has benefits for both the individual and society (20,29). However not all effects are positive: injury is frequently an unwanted side effect of participation in physical activities (27). Before efforts can be taken to reduce sports injuries, it is first necessary to determine the nature and extent of injuries, and to identify mechanisms and risk factors that play a part in their occurrence (35).

Ice hockey is a fast-paced, physical game involving both finesse and controlled aggression (11). High velocity impact with sticks and pucks, unyielding boards and skating surfaces, and acceleration and deceleration forces all contribute to the potential for injury in the hockey arena (11). Epidemiological data regarding mechanisms and types of injuries have helped to establish a foundation on which to base measures for the reduction of hockey injuries. However, almost all that we know about the incidence, mechanism and nature of ice hockey injuries comes from studies of male players. It is not clear whether data from male hockey players can be generalized to female players. Gender differences in the pattern of injury have been observed in other sports (17,34,44).

Women in Canada have been playing organized ice hockey for over 100 years, however in the past decade there has been a rapid growth in the number of females participating in this sport. Between 1987 and 1997, the number of female players increased by 250 percent, bringing the total to approximately 27,000 females who were registered with the Canadian Hockey Association (CHA) in 1997 (3). With the inclusion of women's ice hockey in the 1998 Winter Olympic Games, it is anticipated that this growth will continue.

To date, no published studies have been devoted to the examination of injuries among female ice hockey players. This prospective study of female

recreational ice hockey players will quantify the burden of injury experienced by participants and will identify risk factors that contribute to injury.

This chapter presents a summary of the literature in three categories:

(1) injury rates, mechanisms and anatomical distribution of ice hockey injuries;

(2) patterns of injury for males and females participating in team sports;

(3) risk factors associated with ice hockey injuries.

1.2 Ice Hockey Injuries: Rates, Anatomy, Diagnoses and Mechanisms

Anatomically, the injury pattern for ice hockey has shifted since 1978 when full facial protection became mandatory in minor hockey leagues. Since then, various other leagues have mandated either full or partial face shields for its players, and some individual players voluntarily choose to wear facial protection (37). The result has been a decline in the number of eye/facial injuries (4). Full facial protection is mandatory in women's ice hockey. The literature presented in this review will therefore focus on leagues in which full facial protection is required, and to recreational leagues in which facial protection is optional.

A systematic review of the English language literature on ice hockey injury was conducted. The following databases were searched: Medline, 1966 through July 1998 (descriptors/key words: [athletic injuries, injury/ies, injured] in combination with ice hockey); EMBASE, 1983 through March 1998 (descriptors/key words: [injury/ies, injured] in combination with ice hockey); SPORTS Discus, 1975 through March 1998 (descriptors/key words: [injury/ies, injured] in combination with ice hockey); and ERIC, 1984 through April 1998 (descriptors/key words: [injury/ies, injured] in combination with ice hockey). As well, reference lists of cited works were examined to identify additional references. Additional sources of information included sports medicine textbooks and conference proceedings.

Direct comparison of hockey injury data is difficult due to differences in injury definition, sources of injury data, and denominator selection. Injury rates have been calculated in number of ways. For case rates, or number of injuries/1000

participants, the numerator is the total number of injuries that occurred during the study period, and the denominator refers to everyone in the population who is exposed to the possibility of injury. The result is generally multiplied by a constant (e.g., 1000) (9). More recently, researchers have developed methods to take into account varying exposure levels of participants to the risk of injury. Rates that incorporate level of exposure include: number of injuries/1000 athlete exposures (an athlete exposure is defined as one athlete participating in one practice or game in which there is the possibility of sustaining an injury); number of injuries/1000 time-exposures (a time-exposure is defined as an athlete participating in one minute, hour, or day of activity); or number of injuries/1000 element-exposures (an element-exposure is defined as one athlete participating in one period, game or practice of activity) (9).

1.2.1 Literature Review

The summaries of the articles included in the literature review are presented in chronological order. Table 1.1 presents an overview of the literature.

Hornof et al. examined insurance records for approximately 66,000 players registered in the ice hockey union in Czechoslovakia for the years 1967 and 1968 (13). The injury rate was found to be 30 injuries/1000 participants. The head/face was the site most often injured (37%), while the mechanism of injury was either a blow by a stick or puck (54%). The study population included all levels of hockey, however the authors offered no differentiation by competitive level or age.

A rate of 5 injuries/1000 athlete exposures was observed in a retrospective study of 251 high school hockey players in Minnesota during the 1982-83 season (12). The lower extremity accounted for 30 percent of all injuries. The most common diagnosis was contusion (29%), and the most common mechanism for injury was collision with another player (35%). Fifty-four percent of injuries were classified as mild and required less than eight days away from hockey. The researchers identified age, weight, height, and playing experience as possible risk factors for injury.

In an examination of differences in the injury experience of Peewee (12 to 13 years) hockey players playing in body checking and non-body checking leagues, researchers in Quebec reported four times more injuries among players in the body checking league (2842 injuries/1000 games versus 667/1000 games) (26,28). Contusion was the most common diagnosis in both leagues. In the body checking league there were 62 fractures/1000 games, while in the non-checking league there were 4 fractures/1000 games. In the league allowing body checking, 56 percent of injury was caused by an opponent compared with 19 percent for the other league. The researchers suggested that large differences in body size between the smallest and largest players magnified the negative effects of body checking.

Ice hockey injuries among minor league players in Minnesota were reported by Brust et al. (7). During the 1990-91 season, the authors followed 150 players who were registered at three levels: Squirts (9 to 11 years), Peewee (11 to 13 years), and Bantam (13 to 15 years). Overall, the injury rate was 350/1000 participants, with Squirt players sustaining 10 percent of the injuries, Peewees 27 percent, and Bantams 54 percent. Contusion was the largest diagnostic category (50%), and the upper extremity was the body region most commonly injured (33%). Player contact accounted for 50 percent of injury. Sixty-six percent of injury was associated with rule violations.

Varsity hockey players from seven colleges and universities in the eastern United States participated in a three year prospective study from 1987 through 1990 (21). The injury rate was 10.2/1000 athlete exposures. Overall, the lower extremity was the most common site of injury (52%), and sprain/strain was the most common diagnosis (44%). Direct impact with another player or the ice was the most common mechanism of injury (41%). Sixty percent of injury was classified as minor and required less than eight days away from hockey.

Hockey players at the University of North Dakota were followed for two complete seasons (4). The injury rate was found to be 3/1000 athlete exposures. The lower extremity (58%) was the most common site of injury. Sprain/strain was the

most prevalent diagnosis (58%). Thirty-six percent of injuries required 10 or more days away from hockey.

Injuries to Bantam level (14 to 15 years) players in Quebec were analyzed over two seasons from 1987 to 1989 (5). Anthropometric and biomechanical (force of impact and maximal skating speed) profiles were established for each player. Body checking was identified as the cause of 75 percent of all major injuries and 46 percent of minor injuries. The authors concluded that large physical differences between the smallest and largest players (in excess of 40 kg) magnified the negative effects of body checking.

A large sample of 1437 ice hockey players aged 9 to 18 years was followed over the 1990-91 season in Helsinki (6). The injury rate was 89/1000 participants. Fifty-five percent of injury was to the upper extremity, while contusions, sprains, and lacerations were the most common type of injury (47%). The most frequent mechanism was player contact (45%). Thirty-two percent of injury was caused by rule violations.

Data from the National Collegiate Athletic Association Injury Surveillance System (NCAA ISS) were examined for the years 1986 through 1990 (11). A total of 36 teams were represented in the data. The injury rate ranged from a low of 15 injuries/1000 athlete exposures in 1986 to a high of 18/1000 athlete exposures in 1990. The knee was the most common site of injury (16%). Player contact was the most common mechanism (43%).

Using data from the Canadian Athletic Injuries/Illness Reporting System (CAIRS), Pelletier et al. analyzed injuries sustained by male varsity hockey players over six seasons from 1979 to 1985 (24). The injury rate was 20/1000 player-games. Thirty-nine percent of injury was to the lower extremity. The most common mechanism was body checking (legal and illegal) (50%). The most common diagnosis was sprain/strain (42%).

Injury data for ice hockey were collected over a one year period for the city of Kingston, Ontario (36). The injury rate for males was 5.9 injuries/1000 player hours while the rate for females was 11.9/1000 player hours. The lower extremity was the

site that suffered most injury (25% for males, 38% for females), however females were noted to have suffered more knee and finger injury than male hockey players. Contusion was the most common diagnosis (40% for males, 51% for females). For males, body check/collision was the most common mechanism of injury (39%). This information was not presented for the female hockey players.

Analysis of national sports insurance data for 1990 and 1991 provided researchers from Finland with information on acute sports injuries sustained by licensed players in five sports, including ice hockey (15). The injury rate for male hockey players was 105/1000 participants and for females was 67/1000 participants. Injury rates for both males and females were highest among the 20 to 24 year old players. No breakdown by gender was provided for injury location or diagnosis. Overall however, the body region most injured was the lower extremity (38%), and sprain/strain was the most common diagnosis (37%).

Researchers in Minnesota followed 66 players aged 9 to 14 years for one season to determine the incidence and nature of injuries (33). The injury rates were 1.0/1000 hours of ice exposure time for Squirts (9 to 10 years), 1.8/1000 hours for Peewees (11 to 12 years), and 4.3/1000 hours for Bantams (13 to 14 years). The most common type of injury was contusion (36%) and the upper extremity was the site most often injured (44%). The most frequent mechanism of injury was collision with players, boards, or ice (50%).

Four hundred and thirty-one male adult recreational and old-timer hockey players were followed for the 1992-93 season in Edmonton, Alberta (39). The injury rate was 12.2/1000 player-exposures. Most injuries occurred to the lower extremity (34%). Sprain/strain was the most common diagnosis (39%). The most common mechanism of injury was player contact, either body checks or collisions with other players (40%). Penalties were assessed in 31 percent of injury instances.

Eighty-six male high school players in Minnesota were followed through the 1994-95 season (31). The injury rates were 34.4/1000 player-game hours and 0.2/1000 player-practice hours. Seventy-four percent of injury resulted from collision with other players, the boards or the ice. Thirty-seven percent of injuries were to the

lower extremity. Contusions and sprains/strains comprised 37 percent each of the injury diagnoses.

During the 1993-94 hockey season, researchers in Minnesota collected injury data at 13 girls' tournament games (8 to 14 years) and 26 boys' tournament games (11 to 14 years) (8). The injury rate for girls was half that for the boys: 50.5 injuries/1000 player hours versus 106.4/player hours. However, only four injuries were reported by the girls compared with 20 for the boys. All injuries to the girls were contusions to the upper body or lower extremities. For the boys, contusions comprised 65 percent of the injuries, and the head/neck was the most common site of injury (40%). Girls' injuries resulted from falling or being hit by a puck or stick (100%), while boys' injuries resulted primarily from collisions with other players (42%). Girls were assessed an average of 0.9 penalties per game compared with 8.6 per game for the boys. The authors suggested that the lower injury rate among the girls related to the absence of legal body checking, and less aggressive attitude toward the game of hockey compared with the boys.

1.2.2 Summary of the Literature

It is clear from the summarized studies that injury rates in ice hockey vary considerably by age, level of competition, injury definition, and data collection methods. However, some common threads on the nature of ice hockey injury can be found. The body region most commonly injured is the lower extremity. Contusion and sprain/strain are the most common diagnoses. Most injuries are a result of player contact, either through body checks or collision with other players. Differences in size may contribute toward the chance of injury.

Only three of the studies provided information about female ice hockey players (8,15,36). Of these, one study reviewed injuries sustained by girls (8 to 14 years) during tournament games (8). The other two studies reviewed data from insurance company records (15) and emergency department records (36) to identify injuries sustained by both male and female hockey players at all levels of hockey.

These studies begin to paint a picture of the pattern of injury for female ice hockey players, but are limited in scope and methodology.

Table 1.1. Ice hockey injuries: summary of the literature

Study	Location/ Population/ Data Source	Rate	Most Common Anatomy	Most Common Diagnosis	Most Common Mechanism
Hornof (1973)	Czechoslovakia/ All levels/ Insurance records	30 injuries/1000 participants	Head/face (37%)	Skin lesions (37%)	Puck/stick contact (54%)
Gerberich (1987)	Minneapolis-St. Paul/ High school; male/ Players, coaches, survey	5 injuries/1000 hours	Lower extremity (30%)	Contusion (29%)	Player contact (35%)
Regnier (1989) Roy (1989)	Quebec/ Peewee (12-14 yr.); male/ Survey, observers	With body checking: 2842 injuries/1000 games Without body checking: 667 injuries/1000 games	With body checking: Head/neck (33%) Without body checking: Lower extremity (38%)	With body checking: Contusion (70%) Without body checking: Contusion (69%)	With body checking: Player contact (56%) Without body checking: Player/stick/puck contact (19% each)
Brust (1992)	Minneapolis - St. Paul/ Minor (9 - 15 yr.); male/ Coaches, managers observers	350 injuries/1000 participants	Upper extremity (33%)	Contusion (50%)	Collision with player (50%)
McKnight (1992)	Eastern U.S./ Varsity; male/ Trainers	10 injuries/1000 AE*	Lower extremity (52%)	Sprain/strain (44%)	Collision with player/ice (41%)
Bancroft (1993)	North Dakota/ Varsity; male/ Coaches, physicians	3 injuries/1000 AE*	Lower extremity (58%)	Sprain/strain (58%)	Not provided
Bernard (1993)	Quebec/ Bantam (14-15 yr.); male/ Observers, players	Minor: 2365 injuries/1000 games Major: 120 injuries/1000 games	Not provided	Minor: Contusion (63%) Major: Sprain (38%)	Minor: Body check (46%) Major: Body check (75%)
Bjorkenheim (1993)	Helsinki region/ Minor (9 - 18 yr.); male/ Coaches, players	89 injuries/1000 participants	Upper extremity (55%)	Contusion/sprain/ laceration (47%)	Player contact (45%)

*injuries/1000 athlete exposures

Table 1.1. Ice hockey injuries: summary of the literature (continued)

Study	Location/ Population/ Data Source	Rate	Most Common Anatomy	Most Common Diagnosis	Most Common Mechanism
Dick (1993)	U.S./ Varsity; male/ Trainers	16 injuries/1000 AE*	Knee (16%)	Contusion/sprain (50%)	Player contact (43%)
Pelletier (1993)	Canada/ Varsity; male/ Physicians, trainers	20 injuries/1000 games	Lower extremity (39%)	Sprain/strain (42%)	Body check (79%)
Voaklander (1994)	Kingston/ All levels; male & female/ Emergency dept. records	Male: 6 injuries/1000 player-hours Female: 12 injuries/1000 player-hours	Male: Lower extremity (25%) Female: Lower extremity (38%)	Male: Contusion (40%) Female: Contusion (51%)	Male: Collision with player/Body check (40%) Female: Not provided
Kujala (1995)	Finland/ All levels; male & female/ Insurance records	Male: 105 injuries/1000 participants Female: 67 injuries/1000 participants	Lower extremity (38%)	Sprain/strain (37%)	Not provided
Stuart (1995)	Minnesota/ Minor (9 - 14 yr.); male/ Coaches, physician	Squirt: 1.0 injuries/1000 hours Peewee: 1.8 injuries/1000 hours Bantam: 4.3 injuries/1000 hours	Upper extremity (44%)	Contusion (36%)	Collision with player/ boards/ ice (50%)
Voaklander (1996)	Edmonton/ Recreational; male/ Players	12 injuries/1000 player-exposures	Lower extremity (34%)	Sprain/strain (39%)	Collision with player/Body check (40%)
Smith (1997)	Minnesota/ High school; male/ Players, coaches	34 injuries/1000 player-hours	Lower extremity (37%)	Contusion (37%) Sprain/strain (37%)	Collision with player (33%)
Brust (1998)	Minnesota/ Minor; male & female/ Trainers	Male: 106 injuries/1000 player-hours Female: 51 injuries/1000 player-hours	Male: Head/neck (40%) Female: Upper body/ lower extremity (100%)	Male: Contusion (65%) Female: Contusion (100%)	Male: Collision with player (42%) Female: Puck/stick/ice contact (100%)

*injuries/1000 athlete exposures

1.3 Injury Patterns for Female and Male Participants in Team Sports

Differences in the pattern of injury between male and female athletes have been observed in various sports (17,34,44), and it is not clear whether it is appropriate to make generalizations regarding sports injuries from male to female athletes. Several studies have simultaneously captured injury data for males and females participating in the same team sports. Within individual studies the same injury definition and exposure denominator have been used. It is therefore feasible to make direct comparisons of the injury patterns between male and female players.

A search of the Medline database, 1966 through July 1998, was conducted to retrieve English language journal articles on injuries to participants of team sports. The search strategy comprised the descriptor "athletic injuries" combined with the descriptors "male" and "female", which both had to be present. The abstracts of references retrieved in the search were reviewed manually to eliminate non-team sporting activities and to confirm that injury data for males and females were collected simultaneously.

1.3.1 Literature Review

The summaries of the journal articles included in the review are presented in chronological order. Table 1.2 presents an overview of the literature.

Information on injuries sustained while playing intramural touch football was collected at the University of California, Davis during the 1969 fall season (14). The researchers found that the female injury rate was 32.6/1000 player-games while the male injury rate was 19.9/1000 player-games. Female players had a higher rate of sprain/strain than males, however there was no difference between males and females in the rate of serious injury per player-game.

A study of injuries among high school basketball players in Oklahoma City found that females were injured four times as often as males: 717 injuries/1000 participants versus 157/1000 participants (23). The ankle was the most common

injury site for both males and females. Seventy-four percent of injury to females was classified as minor compared with 50 percent for males.

Whiteside reviewed two years of data from the National Athletic Injury/Illness Reporting System (NAIRS) to compare injury patterns for males and females for three varsity sports: basketball, gymnastics, and softball/baseball (42). Females were reported to have higher injury rates than males in basketball and gymnastics. There were no differences in the injury rates for baseball/softball. Numerous differences in anatomical distribution of injury between males and females were noted. In particular, females suffered more serious ankle and knee injury than males.

Researchers at Pennsylvania State University retrospectively examined fracture rates in several varsity sports (41). Female gymnasts, lacrosse players, and volleyball players were found to have higher rates of fractures than their male counterparts. For basketball, swimming, and track and field, female athletes reported lower rates of fractures.

Two professional basketball teams, one male and one female, were followed for two consecutive seasons (44). Female players sustained 60 percent more injuries than the males, with injury rates of 51/1000 athlete exposures and 32/1000 athlete exposures, respectively. Knee and thigh injury occurred more frequently among the female players. There were significantly more sprains/strains among female players, while males sustained more muscle cramps. The authors recommended a greater emphasis on women's strengthening programs.

Data were collected on injuries sustained during an international youth (9 to 19 years) soccer tournament in Denmark (30). Four hundred and ten teams played 945 matches in the course of five days. Females were injured twice as often as males: 30 injuries/1000 player-hours compared with 16/1000 player-hours. There were no significant differences in the anatomical distribution or severity of injury between males and females.

Colliander et al. conducted a retrospective survey of injuries to Swedish elite basketball players (10). The injury rate for females was 2.9/1000 athlete exposures compare with 2.5 for males. Ankle sprains were the most common injury for both

males and females, however females tended to require more time off from basketball as a result of their ankle injuries.

Injury data were collected for youth (under 18 years) competing in an international outdoor soccer tournament in Norway (19). A total of 1348 teams played 3001 matches over a six day period. The injury rate for females was 17.6/1000 player-hours compared with 9.9/1000 player-hours for males. Females sustained more sprains than the males, but fewer lacerations. The authors suggested that inferior playing technique among the females may have been a factor related to injury.

A study of varsity athletes at the University of Western Ontario over the 1984-85 season revealed that the injury rates for females were greater in volleyball, soccer, gymnastics, and rowing (22). Overall, females were found to have a greater number of overuse injuries than males.

A prospective study was undertaken at four high schools in Buffalo, NY (40). Among the 16 to 18 year old students participating in contact sports, the injury rate/1000 exposures was 6.8 for females and 9.4 for males. No differences were noted in severity or anatomy of injury between males and females.

Eight matched male and female varsity teams were studied prospectively for one academic year (16). With the exception of gymnastics, no gender differences for injury rates were observed for the any of the sports. Among gymnasts, females sustained four times the injuries of males. For each of the sports, the types and sites of injury were similar for males and females.

The results of two years of injury surveillance of basketball in 196 high schools were reported by Zillmer et al. (45). The rate for major injuries that resulted in time loss of 22 days or more was 1.17/1000 athlete exposures for females compared with 0.72/1000 athlete exposures for males. Fourteen percent of injuries suffered by females were to the knee, compared with eight percent for males. Knee injuries to females were significantly more serious than those suffered by males.

In a prospective study conducted in Ohio, injury rates were the same for males and females participating in indoor soccer (ages ranging from 7 to 50 years) (18).

Further analysis revealed that females had twice the rate of serious injuries when compared with males and, in particular, sustained three times as many serious knee injuries as males.

Emergency department data in Kingston, Ontario were examined for ice hockey injuries for males and females (36). The female injury rate per 1000 participant hours was 11.9 while the rate for males was 5.9. Females suffered a higher proportion of knee and finger injury than their male counterparts.

An examination of five years of data from the National College Athletic Association Injury Surveillance System (NCAA ISS) revealed that knee injury rates in both soccer and basketball were higher for females than males (2). Further examination showed that rates for anterior cruciate damage were much higher for females, and more females required corrective surgery to repair the torn ligaments.

Putukian et al. reported the injury frequency for indoor soccer participants at an international recreational tournament held in 1993 (25). A total of 69 teams played 171 games over three days. The authors found that the injury rates for males and females were not significantly different (57.9 injuries/1000 participant hours for males and 47.4 for females). However, males suffered more severe injury than females.

Male and female teams from the same Rugby Union Football Club in England were followed for two seasons (17). Females had an injury rate of 900 injuries/1000 games compared with 1700/1000 games for males. Injury to the lower limb was more common in females and, in particular, females suffered proportionately more knee injury. Females sustained more concussions than males, but suffered no head lacerations. Foul play contributed to injury twice as often among males compared with females.

Following the 1993-94 season, information on injuries to elite volleyball players in Denmark was collected (1). The injury rate was the same for male and female players. Females had a higher rate of serious shoulder injury than males.

Injuries occurring among 457 Swedish floorball players were analyzed prospectively during the 1993-94 season (43). The overall rates of injury for males

and females were similar, however male players had proportionately more severe ankle injuries. Males also suffered significantly more overuse injuries.

1.3.2 Summary of the Literature

In investigations that concurrently examined injuries among males and females participating in team sports, no clear picture emerged regarding the rate or severity of injuries for female athletes compared with their male counterparts. Within some sports, gender differences were observed regarding anatomical distribution of injury. A number of studies reported that females sustained a larger proportion of lower extremity injuries, in particular, to the knee. This review of the literature suggests that it is problematic to generalize the male sport injury experience to the female sport population.

Table 1.2. Patterns of injury for female and male participants in team sports: summary of the literature

Study	Sport/Population	Rate of injury[†]	Anatomy[‡]	Diagnosis[‡]	Severity[§]
Kraus (1971)	Touch football / Varsity	Female: 33/1000 games Male: 20/1000 games		Sprain/strain: Female ↑	No difference
Moretz (1978)	Basketball / High school	Female: 717/1000 participants Male: 157/1000 participants			Female ↓
Whiteside (1980)	Basketball Gymnastics Baseball / High school	Female ↑ Female ↑ No difference	Ankle: Female ↑ Knee: Female ↑		Female↑(ankle/knee)
Whiteside (1981)	Gymnastics Lacrosse Volleyball Basketball Track & Field / Varsity	Female ↑ Female ↑ Female ↑ Female ↓ Female ↓			
Zelisko (1982)	Basketball / Professional	Female: 51/1000 AE* Male: 32/1000 AE*	Knee: Female ↑ Thigh: Female ↑	Sprain/strain: Female ↑ Muscle cramp: Female ↓	
Schmidt-Olsen (1985)	Soccer / Youth (9 - 19 years)	Female: 30/1000 player hours Male: 16/1000 player hours	No difference		No difference
Colliander (1986)	Basketball / Elite	Female: 2.9/1000 AE* Male: 2.5/1000 AE*			Female ↑ (ankle)
Maehlum (1986)	Soccer / Youth	Female: 18/1000 player hours Male: 10/1000 player hours		Sprain: Female ↑ Laceration: Female ↓	
Meeuwisse (1988)	Volleyball Soccer Rowing / Varsity	Female ↑ Female ↑ Female ↑		Overuse injury: Female ↑	

* injuries/1000 athlete exposures

[†] ↓ = lower rate; ↑ = higher rate

[‡] ↓ = less common; ↑ = more common

[§] ↓ = less severe; ↑ = more severe

Table 1.2. Patterns of injury for female and male participants in team sports: summary of the literature (continued)

Study	Sport/Population	Rate of injury[†]	Anatomy[‡]	Diagnosis[‡]	Severity[§]
Whieldon (1990)	Various contact & collision sports / High school	Female: 7/1000 AE* Male: 10/1000 AE*	No difference		No difference
Lanese (1990)	8 sports / Varsity	Gymnastics: Female ↑ No difference for the rest	No difference	No difference	
Zillmer (1992)	Basketball / High school	Female: 1.2/1000 AE* Male: 0.7/1000 AE*	Knee: Female ↑		Female ↑ (knee)
Lindenfeld (1994)	Soccer, indoor / Recreational	No difference	Knee: Female ↑		Female ↑
Voaklander (1994)	Ice hockey / All levels	Female: 12/1000 AE* Male: 6/1000 AE*	Knee: Female ↑ Finger: Female ↑		
Arendt (1995)	Soccer Basketball / Varsity		Knee: Female ↑ Knee: Female ↑		Female ↑ (knee)
Putukian (1996)	Soccer, indoor / Recreational	Female: 58/1000 hours Male: 47/1000 hours			Female ↓
Lewis (1996)	Rugby / Recreational	Female: 900/1000 games Male: 1700/1000 games	Knee: Female ↑ Concussion: Female ↑ Laceration: Female ↓		
Aagaard (1996)	Volleyball / Elite	No difference			Female ↑ (shoulder)
Wikstrom (1997)	Floorball / Recreational	No difference	Ankle: Female ↓	Overuse injury: Female ↓	

* injuries/1000 athlete exposures

[†] ↓ = lower rate; ↑ = higher rate

[‡] ↓ = less common; ↑ = more common

[§] ↓ = less severe; ↑ = more severe

1.4 Risk Factors Associated with Ice Hockey Injuries

Few researchers have investigated risk factors associated with injury among ice hockey players, and these studies have all been restricted to male hockey players. In a comparison of injury rates between Peewee hockey players in body checking and non-body checking leagues, Regnier et al. found body checking to be associated with injury (26). Age has been linked to injury, with a distinctive trend towards higher injury rates as players get older (31,33). This age effect appears to plateau as players reach adulthood. Hostile and aggressive behaviors have also been implicated in the occurrence and nature of injuries among hockey players (8,32).

In a prospective study of high school hockey players, Smith et al. observed a higher rate of injury among players who experienced preseason fatigue, were on the ice more during games versus practices, were involved in collisions, and were in the high playing time group (31).

Voaklander et al. reported that there were unique sets of risk factors associated with distinct types of injuries among male recreational hockey players (38). The chance of receiving an injury through player contact was found to be proportional to the number of other fitness activities in which a player participated, and inversely related to player weight. Sprain/strain injuries were proportional to self-appraised skill level, previous injury history, and age. Facial injuries were related to the interaction between shooting side preference and player position. Left shooting defense players who did not wear facial protection were at highest risk.

To date, no research has examined personal risk factors associated with injury among female ice hockey players.

1.5 Summary

There are several reasons why injury research with female recreational ice hockey players is important. Participation in ice hockey by females of all ages is increasing and information is needed to determine the level of risk for this sporting

population. The few studies that have specifically examined injuries to female hockey players are limited in scope or methodology. Almost all that is known about ice hockey injury has been obtained from studies of male hockey players, however it is not clear whether generalizations to female hockey players can be made. The literature suggests that the injury pattern in team sports for female athletes differs from that of males. Risk factor models from the study presented in this thesis will be useful in identifying individual attributes that are associated with injury among of female hockey players. Based on this research, equipment, training, or rule modifications may be identified that could reduce the incidence and severity of injury.

The following chapters describe the pattern of injury for female ice hockey players, and identify personal risk factors that contribute to injury.

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Chapter 2

Epidemiology of Women's Recreational Ice Hockey Injuries

2.1 Introduction

Women in North America have been playing organized ice hockey for over 100 years, however in the past decade there has been rapid growth in number of females who participate in this sport. In Canada, between 1987 and 1997, the number of registered female players increased by 250% (2). In the United States, the numbers increased by 260% between 1990 and 1995 (2). In 1996-97 there were approximately 50,000 registered female ice hockey players in Canada and the United States. With the inclusion of women's ice hockey in the 1998 Winter Olympic Games and the concomitant publicity surrounding its inauguration as an Olympic sport, it has been suggested that over 220,000 women and girls in North America will be playing ice hockey by the year 2000 (2).

Ice hockey is a contact/collision sport that can be hazardous to its participants. Most research on hockey injuries has been conducted on male hockey players competing at minor (6,7,27), high school (13,25), collegiate (3,12,19,22), elite (18,21) and recreational (14,16,28,29) levels. It is not clear from the literature whether it is appropriate to generalize injury data from males to females. While it is generally accepted that injuries to athletes are sport-specific and not gender-specific (4), studies of team sports in which injuries to males and females have been examined simultaneously suggest that substantial differences may exist in the frequency and nature of injuries suffered by females (1,10,17,20,30).

Few studies have reported on injuries among female ice hockey players. A Finnish study reviewed injuries sustained by all ice hockey players registered with the national ice hockey association in 1990 and 1991 (16). The authors reported an injury rate of 67 injuries/1000 person-years of exposure for females compared with 105 injuries/1000 person-years of exposure for males. Information on anatomic location and types of injuries by gender was not provided. A Canadian study

collected injury data from emergency department records over one year in Kingston, Ontario (28). The injury rate for women was 11.9 injuries/1000 participant-hours, and for men was 5.9 injuries/1000 participant-hours. In this study, the lower extremity was the most common injury site for both women (38%) and men (25%). Contusion was the most common diagnosis for women (51%) and men (40%). Most injuries were caused by collisions: 22 percent for women and 25 percent for men. Researchers in Minnesota collected injury data at tournament games for girls aged eight to 14 years and for boys aged 11 to 14 years (8). The injury rate for the girls was 50.5 injuries/1000 player hours, and 106.4 injuries/1000 player hours for boys. One hundred percent of injuries for girls (n=4) were contusions caused by falling or being hit by a puck or stick. Sixty-five percent of injuries for boys (n=20) were contusions. Most injuries to the boys resulted from collisions.

The objective of the present study was to examine the incidence and nature of injuries sustained by female recreational ice hockey players. The results will be compared with those of an earlier study of similar design that examined the incidence and nature of injuries suffered by male recreational ice hockey players (29).

2.2 Methods

Study Participants. Participants for this research were recruited from the two women's ice hockey leagues operating within the Greater Edmonton area in Alberta, Canada during the 1997-98 hockey season. All 33 teams from these leagues were included in the study to maximize sample size. The leagues represented approximately 90 percent of the women's recreational ice hockey players in the Greater Edmonton area. Co-educational hockey teams and loose affiliations of individual teams that share ice time were not considered for this study. One league divided the teams into three tiers according to the skill level of players, and there were no age restrictions for players within these three tiers. A fourth tier comprised midget teams in which players were 18 years of age or younger. The second league had only one tier and there were no age restrictions. In the present study, midget teams were considered as a separate group (Midget). All other teams were grouped

together and were designated as adult women's recreational teams (AWRT). Women's ice hockey rules are similar to standard ice hockey with the major exception that no intentional body contact is permitted. All players are required to wear the standard array of protective equipment for ice hockey, including full facial protection.

Informed consent was obtained from each study participant or from a parent/guardian for players who were under 18 years of age. The study was approved by the Health Ethics Review Board, Faculty of Medicine and Oral Health Sciences at the University of Alberta, and was endorsed by the executives of the women's hockey leagues.

Injury assessment. Players were recruited in the dressing room immediately following each team's first game of the 1997-98 hockey season. Injury and game attendance data were collected by trained telephone interviewers at the end of each calendar month for the duration of the hockey season, including playoffs. Diagnostic information for individuals who sought medical treatment was solicited from the attending health professional or institution. For the purposes of this study an injury was defined as: any acute injury sustained while playing women's ice hockey during any game or practice that resulted in an individual missing the remainder of a game/practice, a subsequent game/practice, and/or required an individual to consult a health professional.

Statistical analysis. Data were analyzed using SPSS statistical software (26). Differences between the AWRT, Midget, and non-participating populations were compared using chi-square and student's *t* test statistics. Incidence rates were calculated per player and per player-exposure. The player-exposure rate was calculated using the following equation: rate = number of injuries/Σ(reported game or practice attendance for each player). Frequency tables were generated to illustrate the diagnostic, anatomic, and mechanistic distribution of injury. Differences between the AWRT and Midget patterns of injury were tested using the chi-square statistic. The injury sample size allowed for the detection of a medium effect for AWRT and Midget comparisons (9). Differences in the number of days

missed from hockey as a result of injury between AWRT and Midget were tested using the Mann-Whitney U test. The significance level for bivariate statistical procedures was established as $p \leq 0.05$.

2.3 Results

Four hundred and twenty-three players from 33 teams were approached to participate in this study. Of these, 105 (25%) refused to participate, although 65 of these completed a demographic questionnaire. Four players (1%) were lost to follow-up before any injury or participation data could be collected. The final sample consisted of 314 participants, or 74 percent of those initially asked to participate. As the hockey season progressed, four players moved from Edmonton, four players quit hockey, three players became pregnant and quit hockey, and eight players had phones disconnected for which new numbers could not be found. Partial data for these players were included in the results. The final results are based on 295 (94%) of the original sample.

Demographics. The demographic characteristics of the study population are presented in Table 2.1. In general, the participants were young, healthy, and physically active. The aggregate mean age for study participants was 23.9 ± 8.2 years. The mean age for AWRT players was 27.0 ± 7.1 years, with ages ranging from 14 to 47 years. The mean weight for AWRT players was 64.7 ± 9.9 kg, ranging from 47.7 kg to 95.3 kg. Their mean height was 1.66 ± 0.06 m, ranging from 1.50 m to 1.83 m. For Midget players, the mean age was 14.7 ± 1.6 years, with ages ranging from 11 to 18 years. The mean weight for Midget players was 56.0 ± 11.1 kg, ranging from 35.4 kg to 86.3 kg. Their mean height was 1.63 ± 0.08 m, ranging from 1.37 m to 1.80 m.

Table 2.1. Participant demographics

Variable	AWRT (n=236) mean ± SD / %	Midget (n= 78) mean ± SD / %	Non-participants (n=69) mean ± SD / %
Age (years)*	27.0 ± 7.1	14.7 ± 1.6	22.0 ± 7.8
Weight (kg)*†	64.7 ± 9.9	56.0 ± 11.1	59.3 ± 9.0
Height (m)*	1.66 ± 0.06	1.63 ± 0.08	1.64 ± 0.06
BMI*	23.4 ± 11.3	20.9 ± 3.2	22.1 ± 2.7
Married*	22.6%	0.0%	10.1%
Smoker	13.6%	11.5%	18.8%
Alcohol use*			
Less than once/week	37.8%	85.7%	48.5%
1 - 3 times/week	36.5%	9.1%	29.4%
> 3 times/week	25.8%	5.2%	22.1%
Occupation*			
Student	33.6%	97.4%	61.8%
Homemaker	5.2%	0.0%	1.5%
Clerical/Service/Sales	22.8%	2.6%	17.6%
Production/Trades	12.1%	0.0%	2.9%
Professional/Manager	26.3%	0.0%	16.2%
Injured in past year	40.0%	42.3%	44.1%
Participates in other fitness activities	83.3%	82.1%	79.4%

*$p \leq 0.001$; AWRT and Midget compared.
†$p = 0.03$; non-participants and study participants compared.

Injury Rate. One hundred and two players reported a total of 125 injuries during the 1997-98 hockey season. The aggregate injury rate was 398 injuries/1000 players, or 7.5 injuries/1000 player-exposures. Seventy-six players from the AWRT reported 93 injuries during the study period for an injury rate of 394/1000 players, or 7.8 injuries/1000 player-exposures. Twenty-six Midget players reported 32 injuries for an injury rate of 410 injuries/1000 players, or 6.7 injuries/1000 player-exposures. Of the 102 injured players, 83 suffered one injury, 15 suffered two injuries, and four suffered three injuries.

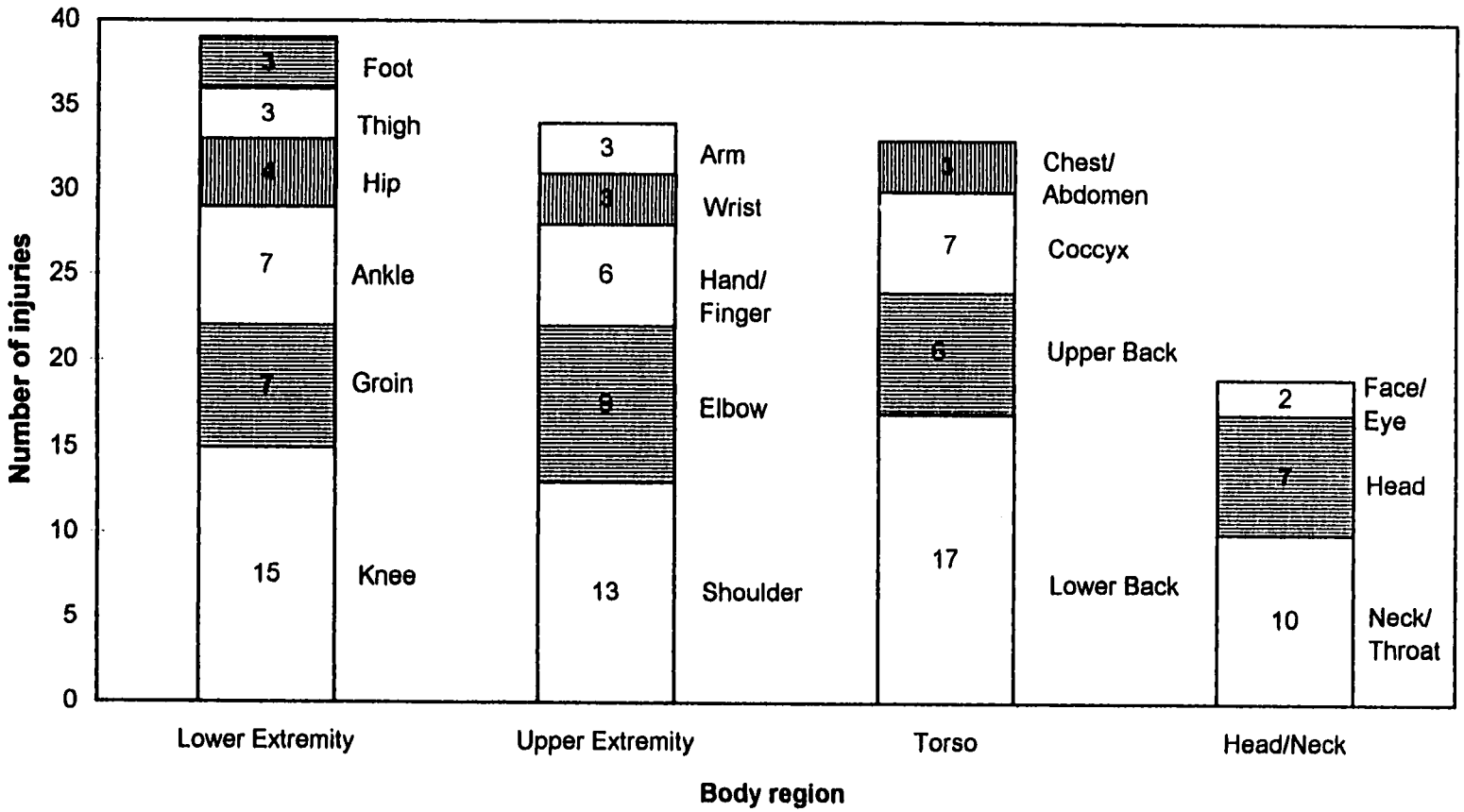
Pattern of injury. Overall, the lower extremity was the injury site most often reported (31%) (Table 2.2). No significant differences were detected in the anatomic distribution of injury between AWRT and Midget players. For AWRT players, the anatomic region most often injured was the upper extremity (29%), and for Midget players, it was the lower extremity (41%). For the aggregate sample, the most frequently injured sites were the lower back (14%), knee (12%), and shoulder (10%) (Fig. 2.1).

Table 2.2. Anatomic distribution of injury

Anatomic Site	AWRT	Midget	Total
Lower extremity	26 (28%)	13 (41%)	39 (31%)
Upper extremity	27 (29%)	7 (22%)	34 (27%)
Torso	23 (25%)	10 (31%)	33 (26%)
Head / neck / face	17 (18%)	2 (6%)	19 (15%)
Total	93 (100%)	32 (100%)	125 (99%)*

*Does not total 100% due to rounding.

Figure 2.1. Anatomical distribution of injuries by specific body site.



Sprain/strain was the injury diagnosis most often reported for all players (52%) (Table 2.3). The predominant injury diagnosis for AWRT players was sprain/strain (57%), while for Midget players it was contusion (50%). The differences in the diagnostic distribution of injury between AWRT and Midget players were statistically significant ($p = 0.02$).

Table 2.3. Diagnostic distribution of injury*

Diagnosis	AWRT	Midget	Total
Sprain/strain	53 (57%)	12 (38%)	65 (52%)
Contusion	22 (24%)	16 (50%)	38 (30%)
Concussion	6 (7%)	1 (3%)	7 (6%)
Fracture	2 (2%)	1 (3%)	3 (2%)
Dislocation	1 (1%)		1 (1%)
Other	9 (10%)	2 (6%)	11 (9%)
Total	93 (100%)	32 (100%)	125 (100%)

*For statistical comparison, the dislocation, fracture, and concussion categories were grouped.

Overall, the dominant injury mechanism was player contact, either as a result of a collision with another player or a body check (40%) (Table 2.4). No significant differences were detected in the mechanistic distribution of injury between AWRT and Midget players.

Table 2.4. Mechanism of injury*

Mechanism	AWRT	Midget	Total
Body check	22 (24%)	5 (16%)	27 (22%)
Collision with player	17 (18%)	6 (19%)	23 (18%)
Collision with boards/goal	18 (19%)	7 (22%)	25 (20%)
Stick contact	12 (13%)	8 (25%)	20 (16%)
No contact	10 (11%)	2 (6%)	12 (10%)
Falls	8 (9%)	1 (3%)	9 (7%)
Puck contact	6 (6%)	3 (9%)	9 (7%)
Total	93 (100%)	32 (100%)	125 (100%)

*For statistical comparison, the falls category was grouped with collisions, and puck contact was grouped with stick contact.

Injury events. Overall, 66 percent of injuries occurred during league games (11.9 injuries/1000 player-exposures), five percent during play-off games (6.8 injuries/1000 player-exposures), 17 percent during tournament games (8.4 injuries/1000 player-exposures), six percent during exhibition games (4.0 injuries/1000 player-exposures), and seven percent during practices (2.0 injuries/1000 player-exposures). Seventeen percent of game injuries occurred during the first period, 36 percent during the second period, 44 percent during the third period, and three percent occurred during the pre-game warm-up. Penalties were assessed in 16 percent of injury instances.

Outcomes. The response rate for diagnostic confirmation by health professionals/hospitals was 80 percent. The diagnosis reported by players was in agreement with the health professional abstract 81 percent of the time. Thirty-two percent of injured players sought treatment from community physicians, 10 percent from physiotherapists, 10 percent from chiropractors, and 13 percent from hospital emergency departments. The remaining 36 percent did not seek medical attention for their injuries. Table 2.5 presents the diagnostic distribution of injuries treated at different venues.

Table 2.5. Where players sought treatment

Institution of initial treatment (response rate)	Fracture/ Dislocation	Sprain/ strain	Contusion	Concussion	Other	Total
No treatment (N/A)		21 (33%)	18 (46%)	3 (43%)	3 (27%)	45 (36%)
Physician (78%)	3 (60%)	19 (30%)	14 (36%)	1 (14%)	3 (27%)	40 (32%)
Emergency dept. (75%)	2 (40%)	5 (9%)	5 (13%)	3 (43%)	1 (9%)	16 (13%)
Physiotherapist (73%)		9 (14%)	2 (5%)		1 (9%)	12 (10%)
Chiropractor (100%)		9 (14%)			3 (27%)	12 (10%)
Total	5 (100%)	63 (99%)*	39 (100%)	7 (100%)	11 (99%)*	125 (101%)*

*Does not total 100% due to rounding.

One player was hospitalized as a result of injury (meniscal tear). Eighty-two percent of injuries resulted in an absence from hockey of seven or fewer days, 14 percent

required an absence of eight to 28 days, and three percent required an absence of more than 28 days. Table 2.6 illustrates time lost from hockey for AWRT and Midget players. Overall, 15 percent of injuries resulted in time lost from work or school. A total of 139 days were missed from work or school as a result of injury.

Table 2.6. Injury severity as a function of time lost from hockey

Time lost	AWRT	Midget	Total
≤ 7 days missed	76 (82%)	27 (84%)	103 (82%)
8 - 28 days missed	15 (16%)	3 (9%)	18 (14%)
> 28 days missed	2 (2%)	2 (6%)	4 (3%)

2.4 Discussion

Although considerable research has examined male ice hockey injuries at various levels of play, few studies have included female players. Comparison of injury data with previous investigations is difficult due to differences in injury definition and denominator selection. In the present study, comparisons are limited to leagues in which full facial protection is mandatory and to studies of recreational ice hockey players.

The injury definition and study design used in the present research were identical to those used in a study of men's recreational ice hockey injuries, in which 431 players were followed during a hockey season to examine the frequency and nature of injury (29). Since the same definition and exposure denominator were used, specific comparisons between the women's league and the men's recreational league (MRL) have been made.

The observed injury rate of 7.5 injuries/1000 player-exposures for the women's league was less than the 12.2 injuries/1000 player-exposures reported for the MRL (29). It was also lower than the injury rates reported for male collegiate hockey players (12,19,22). There are potentially many reasons for this observation, including the absence of intentional body checking, mandatory facial protection, differences in the nature of the game associated with body mass, speed, and impact force, gender differences in behaviors (2,8), and gender-specific mechanical differences (4).

In the women's league, 40 percent of injuries resulted from player contact. This was the same as the MRL (29), where body checking is also prohibited, but lower than in leagues where body checking is permitted (7,13,14,22). In the women's league, there was wide variation in the weight of players, with a range of 59.9 kg. It is expected that larger players could exert an impact force much greater than that of smaller players, with differences perhaps as great as 70 percent (5,23). If body checking was allowed in women's ice hockey leagues, higher rates of injuries would be anticipated (23,24).

The anatomic and diagnostic distributions of injury observed in the women's league were consistent with previous research, including the MRL (3,13,16,19,25,28,29). It was expected that the knee would be a major injury site among the women's league players, as research suggests that female athletes are susceptible to knee injuries (15). While the knee was the most common site of lower extremity injuries (39%), knee injuries represented only 12 percent of all injuries. This is somewhat lower than reported in other hockey studies, in which knee injuries ranged from 15 percent (25) to 60 percent (28). The lower back was the most common injury site overall (14%). Injuries to the lower back are not common among ice hockey players (11), although they have been reported in other studies (13,20,24). Eighty-two percent of lower back injuries were diagnosed as sprain/strain, suggesting that muscular strain may be a factor (11). A Canadian study of emergency department admissions (28) found finger injuries among female ice hockey players to be high (approximately 25%), however this was not found to be the case in the present study. The head/neck/facial area among women's league players sustained 15 percent of all injuries, which is similar to proportions reported in leagues in which players wear full facial protection (6,7,13,19,22,25,27). In the MRL, where facial protection is not required, the proportion was 30 percent (29).

In terms of injury severity as a function of time lost from hockey play, the women's league players sustained less severe injuries than the MRL. Eighty-two percent of injuries required seven or fewer day away from hockey for females compared with 66 percent for males (29). The percentage of injuries that resulted in work/school time being lost was similar for females and males, 15 percent and 16 percent respectively. Females sought treatment from a health professional for 64 percent of injuries compared

with 80 percent for males. In particular, 36 percent of MRL players visited an emergency department compared with 13 percent of female players. This could be a reflection of the nature of injuries sustained by males, in particular the number of facial lacerations.

It is noteworthy that over 51 percent of injuries in the women's league were treated by community physicians or other health professionals, and 36 percent were self-treated. In similar studies, the proportion of injuries either treated by health professionals in the community or self-treated ranged from 64 percent (6,29) to 81 percent (7). This suggests that injury data collected solely from emergency departments results in an underestimation of sports-related injuries among recreational athletes. Furthermore, it reflects the need to examine records from multiple health care providers in order to determine the full extent of injury sustained while playing hockey.

In the present study, penalties were assessed in 16 percent of incidents that resulted in injuries. This is lower than the 31 percent reported for the MRL (29). Other studies reported levels from 24 percent (22) to 66 percent (7). The lower proportion of penalties could be attributed to a sense of fair play that has been reported to be inherent in women's ice hockey (2,8). Women hockey players are competitive and play aggressively, but intimidation, dominance, and strength are less important factors than in men's hockey (2).

Study limitations. Several potential limitations of this study need to be discussed. First, not all female ice hockey players participated in the study. However, because study participants did not differ significantly from non-participants in baseline demographic measures (Table 2.1), we feel the sample is representative of the population of female ice hockey players in the Edmonton area. Generalization to female recreational ice hockey players who are affiliated with the hockey associations in Canada and the United States should be possible.

Second, self-report bias may be a factor in this study. Injury data collected for players who did not contact health professionals (36%) have not been validated. This may have resulted in misclassification of injury sites and diagnoses. It is possible that self-report bias may have affected the quality of the mechanism of injury data, and also inflated or deflated injury rates and injury severity. An attempt was made to control for

self-report bias through frequent contact with study participants and the use of a standardized questionnaire. However, it was not possible to measure the effectiveness of this technique. Finally, some differences were noted in the diagnostic confirmations from the health professionals regarding diagnosis for those players who were treated for their injuries.

Notwithstanding the above concerns, this study represents the largest prospective study of female ice hockey players in a defined geographic area. The information reported quantifies the incidence and nature of injuries sustained by female recreational ice hockey players. The injury rate observed was found to be lower than rates reported for men's recreational and collegiate hockey players. Injury severity, as measured by lost playing time, was less than that reported in male hockey leagues. These observations are potentially due to the absence of intentional body checking, mandatory full facial protection, anatomical and mechanical differences, and attitude and behavioral differences. Because many of the other mechanisms of injury remain the same, the diagnostic and anatomic distribution of injury appears similar to other levels of hockey where full facial protection is mandatory. One exception to this is the lower back, which was the most common injury site overall among female hockey players. The incidence of lower back injuries among female hockey players should be further investigated to determine if it is a spurious finding or if it is related to anatomical function or level of conditioning. Female recreational ice hockey players are at risk for injuries and further research is required to identify areas for injury prevention.

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Chapter 3

Personal Risk Factors Associated with Injury Among Female Recreational Ice Hockey Players

3.1 Introduction

Women's ice hockey is a rapidly growing sport in North America. In Canada and the United States, the number of registered female players increased by over 250 percent between 1988 and 1996 (2). It is projected that approximately 175,000 girls and women will be playing this sport by the year 2000 (2). Little research has been published on the injury experience among female ice hockey players (4,6,19).

Hockey is a contact/collision sport and players are at risk for injury. Risk of injury has typically been identified in the literature by factors extrinsic to the hockey player. Few studies have examined intrinsic characteristics that may be associated with injury among hockey players. Risk factors that have been identified for male hockey players include: age (15,17,20), weight (20), player position (8,14,20), shooting side preference (20), the interaction between player position and shooting side (20), history of previous injury (8,20), facial protection (15), self-appraised skill level (20), preseason fatigue (15), and exposure level (15). To date, no published study has examined personal risk factors associated with injury among female ice hockey players. It is not clear from the literature whether risk factor information can be generalized from male to female athletes, although in studies that simultaneously examined risk factors for male and female athletes in the same sport, some gender differences have been identified (10,13,18).

The data analyzed in this paper expand upon previous work that examined the incidence and nature of injury among female recreational ice hockey players in Edmonton, Canada (6). In general, the rules for men's and women's ice hockey are the same, however some rule modifications have been instituted to enhance safety. Body checking is not permitted and full facial protection is mandatory for all female players.

The primary objective of this paper was to identify personal risk factors associated with injury among female recreational ice hockey players. In addition, the previously documented relationship between injury occurrence and the interaction of playing position and shooting side preference was examined (20).

3.2 Methods

Study design and participants. This was a prospective study designed to examine the nature of injury among a cohort of female recreational ice hockey players. Participants for this research were recruited from the two women's ice hockey leagues operating in the greater Edmonton area in Alberta, Canada. The details of the study sample have been published elsewhere (6). In summary, baseline measurements, including risk factor data, were collected at the beginning of the 1997-98 hockey season during recruitment of study participants. Information was obtained on age, height, weight, alcohol and tobacco use, occupation, fitness level, hockey skill level, shooting side preference, playing position, and previous injury history.

During the hockey season, participants were telephoned at the end of each calendar month by trained telephone interviewers. Information collected included the number of games played in the previous month, how many team practices were attended, whether any injuries had been sustained, and the nature, severity, and circumstances of the injuries (if applicable). For each injury requiring medical treatment, diagnostic and treatment confirmation was obtained from the attending health professional or institution.

Dependent variable. The dependent variable was the occurrence of an injury during the study season. For this study, an injury was defined as: any acute injury sustained while playing women's ice hockey that resulted in a player missing the remainder of the game/practice, a subsequent game/practice, and/or required an individual to consult a health professional.

Independent variables. The independent variables were selected on the basis of their biological plausibility and previous association with ice hockey injury as

determined by literature review. Age, height, weight, and body mass index (BMI) were treated as continuous variables. All other independent variables were either dichotomous or categorical. The "high exposure" variable was based on total game and practice exposure over the season. This variable was dichotomized at the median of 50 games/practices, with the reference group being players whose game/practice exposure was at or below the median. The decision to dichotomize the exposure time variable was based on previous research on subject-related risk factors associated with sports injuries (18). The "hockey experience" variable was dichotomized similarly and the reference group was players at or below the median of five years playing hockey.

Statistical analysis. All data analyses were performed using SPSS statistical software (16). A bivariate logistic analysis was performed on all independent variables with injury as the dependent variable. Independent variables whose significance was $p \leq 0.10$ in the bivariate analysis were entered into a multiple logistic regression model using a stepwise procedure. The significance level for acceptance in the multivariate model was $p \leq 0.05$. Variables entered into the stepwise procedure were tested for all possible first order statistical interactions. In addition, the interaction of player position and shooting side preference was tested for significance at this stage (20). The analyses of independent variables are reported as odds ratios (OR) with 95 percent confidence intervals (95% CI).

Separate logistic analyses were also performed on all independent variables with "body contact injuries" and "sprain/strain injuries" as the dependent variables (20).

Sample size. At a significance level of 0.05 (two-tailed), the sample size produced a power of 80 percent to detect a medium difference in proportions between dichotomous independent variables (5). A medium difference represents an approximate raw difference in proportions of 0.20 to 0.25 (5).

3.2 Results

Descriptive analysis. Four hundred and twenty-three players from 33 teams were asked to participate in the project. Of these, 105 (25%) refused to participate, however 65 (62%) provided baseline information. Four (1%) players were lost to follow-up before any injury or participation data could be collected. The final study sample consisted of 314 participants, or 74 percent of those initially asked to participate. As the season progressed, 19 players quit hockey or were lost to follow-up. The results of the study are based on 295 (94%) participants from the original sample. Table 3.1 summarizes the demographic characteristics of the study sample. Overall, the participants were a young, healthy and physically active group of females. The median age was 23 years, with ages ranging from 11 to 47 years.

A total of 125 injuries were reported during the course of the hockey season. The injury rate was 7.5 injuries/1000 player-exposures. The most common diagnosis was sprain/strain (52%), and the most common site of injury was the lower extremity (31%). Player contact, either through collision with another player or a body check, resulted in 40 percent of injury.

Risk factors. Table 3.2 summarizes the results of the bivariate analysis for each risk factor. Factors that were found to independently contribute to injury ($p \leq 0.05$) included: sports injury in the past year, participation in strength training activities, player position, hockey experience, and high exposure level. The only interaction term that was identified as significant was the interaction between player position and shooting side preference (Table 3.2). Specifically, a player who reported playing right defense while carrying the blade of the hockey stick on the left side of her body was found to be at higher risk of injury.

Table 3.1. Participant demographics

Variable	Participants (n=314) mean ± SD / %	Non-participants (n=69) mean ± SD / %
Age (years)	23.9 ± 8.2	22.0 ± 7.8
Weight (kg)*	62.4 ± 10.5	59.3 ± 9.0
Height (m)	1.66 ± 0.07	1.64 ± 0.06
BMI (kg/m^2)	22.8 ± 3.5	22.1 ± 2.7
Married	22.8%	10.1%
Smoker	13.1%	18.8%
Alcohol Use		
Less than once/week	49.7%	48.5%
1 - 3 times/week	29.7%	29.4%
> 3 times/week	20.6%	22.1%
Occupation		
Student	49.7%	61.8%
Homemaker	3.9%	1.5%
Clerical/Service/Sales	17.7%	17.6%
Production/Trades	9.0%	2.9%
Professional/Manager	19.7%	16.2%
Injured in past year	40.6%	44.1%
Participates in other fitness activities	83.0%	79.4%
Participates in strength training activities	20.8%	26.4%
Self-appraised skill level		
Above average	34.3%	33.3%
Average	59.7%	52.2%
Below average	6.1%	14.5%
Hockey experience > 5 years	40.4%	43.5%
Ringette experience	43.9%	39.1%

*$p = 0.02$; study participants and non-participants compared

Table 3.2. Risk factors associated with injury: bivariate logistic regression

Factor	Unadjusted Odds Ratio	95% Confidence Interval	p
Age (years)	0.99	0.97,1.02	0.696
Weight (kg)	0.99	0.98,1.02	0.907
Height (m)	0.98	0.95,1.01	0.189
BMI (kg/m^2)	1.01	0.95,1.08	0.728
Alcohol use			
< Once/Week	1.00		
1-3 Times/Week	0.87	0.61,1.22	0.414
>3 Times/Week	0.96	0.66,1.38	0.817
Smoker	1.11	0.81,1,52	0.525
Injured in past year	2.20	1.40,3.45	**0.001**
Participates in other fitness activities	1.28	0.70,2.36	0.427
Participates in strength training activities	1.82	1.08,3.07	**0.024**
Self-appraised skill level			
Above average	1.00		
Average	1.22	0.81,1.83	0.334
Below average	0.63	0.32,1.25	0.189
Position			
Goal	1.00		
Right defense	1.68	0.93,3.00	**0.081**
Left defense	0.85	0.44,1.63	0.624
Right wing	0.87	0.52,1.43	0.572
Left wing	1.68	1.03,2.75	**0.039**
Center	0.93	0.54,1.59	0.783
Utility*	1.12	0.66,1.91	0.667
Shoots left	0.92	0.73,1.14	0.440
Position by shooting side interaction			
Goal and all players shooting right	1.00		
Right defense and shoots left	2.81	1.27,6.23	**0.011**
Left defense and shoots left	0.66	0.29,1.51	0.324
Right wing and shoots left	0.65	0.30,1.38	0.263
Left wing and shoots left	1.26	0.54,2.96	0.591
Center and shoots left	0.71	0.39,1.28	0.254
Utility* and shoots left	0.64	0.35,1.16	0.139
High exposure (> 50 games/practices)	1.31	1.05,1.64	**0.016**
Hockey experience > 5 years	1.72	1.10,2.70	**0.018**
Practices during season	1.22	0.98,1.53	**0.080**
Left handed	1.04	0.72,1.50	0.822
Married	0.86	0.65,1.12	0.267
Ringette experience	1.17	0.75,1,83	0.481
Injured at work in past year	1.58	0.65,3.84	0.311

*Utility players are those who reported playing a variety of positions (n=53).

The stepwise multiple logistic regression analysis resulted in a final model that included injury in the past year, high hockey experience, and high exposure level (Table 3.3). No interaction terms were found to be significant. The separate analyses for body contact and sprain/strain injuries did not provide additional information on risk factors associated with injury.

Table 3.3. Risk factors associated with injury: multiple logistic regression

Factor	Odds Ratio	95% Confidence Interval	p
Injured in past year	1.55	1.22,1.96	0.000
Hockey experience > 5 years	1.44	1.13,1.82	0.003
High exposure (> 50 games/practices)	1.37	1.08,1.73	0.008

3.4 Discussion

Despite numerous studies relating to ice hockey injuries, few involved female players and few investigated intrinsic risk factors associated with injury in ice hockey. In a study of 431 male recreational hockey players, researchers used bivariate and stepwise logistic regression analysis to identify risk factors associated with general injury, as well as for the specific categories of sprain/strain, body contact, and facial injuries (20). For a general injury, risk factors included injury in the past year (OR = 1.54), and the interaction between player position and shooting side preference. Left shooting, right defensemen were at greater risk of injury than any other position (OR = 7.24). For sprain/strain injury, the significant risk factors were prior injury (OR = 1.81), age (OR = 1.07), and self-appraised skill level. Players who rated themselves as above average were 42 to 55 percent more likely to be injured than those who rated themselves as average or below average. Risk factors associated with body contact injury included weight (OR = 0.96), and number of fitness activities (OR = 1.39). For facial injury, the only risk factor was the player position/shooting side interaction. Left shooting defense players were at greater risk of injury than other positions (OR = 9.52 for the right defensemen, OR = 5.20 for the left defensemen).

Other researchers used multiple logistic regression analysis to examine physical and psychosocial risk factors among a cohort of 86 male high school hockey players (15). When all variables were considered, low vigor ($p = 0.025$) and high fatigue ($p = 0.007$) significantly predicted season injury. When psychosocial variables were considered alone, preseason fatigue was significantly associated with injury ($p = 0.009$). Preseason injury barely missed significance when physical variables were considered alone ($p = 0.055$). The researchers also found that greater individual playing time was associated with season injury, although they did not include this variable in their logistic regression analysis.

There were some similarities in the personal risk factors observed in the present study and those reported in previous research. Each will be discussed separately as follows:

High exposure. Players in the high exposure group (more than 50 games/practices during the season) were 37 percent (95% CI: 8%,73%) more likely to be injured than those in the low exposure group. It is intuitive that the more time a player spends participating in a sport, the more opportunities there are for injury. Similar observations have been recorded in other sports (1,11,18). Unfortunately, there is no practical and acceptable intervention that would follow to prevent injury based on this risk factor (18). Nonetheless, research into potential risk factors and the occurrence of sports injuries should consider controlling for level of exposure of participants.

Hockey experience. Players with more than five years of hockey experience were 44 percent (95% CI: 13%, 82%) more likely to be injured than those with less experience. There are several potential reasons for this. This may be related to age, since the mean age for the more experienced players was 27.2 (± 8.1) years compared with 21.6 (± 7.4) years for the less experienced players. Level of play may also be a consideration. Fifty-nine percent of players who played on teams at the most competitive tier had more than five years of hockey experience. This compares with 34 percent of players who played on teams in the remaining tiers. As with exposure

level, there is no reasonable intervention that can be recommended to prevent injury based on this risk factor.

Previous injury. Players who reported a sports injury within the previous 12 months were 55 percent (95% CI: 22%, 96%) more likely to sustain an injury than those who did not report a prior injury. Fourteen percent of the previously reported injuries were in the same location as those sustained in the present study season. Furthermore, 14 percent of players who suffered a sprain/strain in the previous 12 months also sustained a sprain/strain injury during the hockey season under review. History of previous injury has been shown to be a risk factor in other sports injury studies. Among male recreational ice hockey players, those who reported a prior injury had an 81 percent greater chance of sustaining a subsequent sprain/strain, and a 54 percent greater chance of sustaining a general injury (20). In a study of soccer players, researchers found that 42 percent of injured players had sustained an injury of the same type and location during the preceding year (9). In a prospective study of 139 young adults in the Netherlands, the final logistic regression model included previous injury as an important predictor of sports injury (OR = 9.4) (18).

Several explanations have been proposed for the risk of reinjury, including inadequate rehabilitation, underestimation of the severity of the primary injury, premature return to sports activity, and persistent instability (7,12). Recreational athletes who sustain an injury should be encouraged to seek appropriate treatment and rehabilitative attention, and discouraged from returning to competitive play until full healing has occurred. Early recognition of symptoms and subsequent change in training level, and complete rehabilitation following injury may reduce the chance of reinjury. However, further research into specific risk factors associated with reinjury should be pursued so as to better guide athletes at all levels of play.

Other risk factors. Although the interaction between player position and shooting side preference was not significant in the final model, it was found to be significant in the bivariate analysis (Table 3.2). In particular, left shooting, right defense players were at a significantly higher risk of injury than any other position (OR = 2.81). A similar finding was documented in a study of male recreational

hockey players (20). In that study, however, the injuries to left shooting, right defensemen were associated with facial injuries and facial protection. In the present study, the interaction between player position and shooting side was not significant when controlled for exposure level, however it is an interesting observation that may warrant further research.

It was thought that player weight would be predictive of injury given the wide variation in weight among the study participants (3). The mean weight was 62.6 kg, with a range of 60 kg. However, none of the anthropometric factors such as weight, height, or BMI were found to be significant predictors of injury.

Psychosocial factors were not considered in the present study, however they have been found to be predictive of injury in other investigations. In a study of high school hockey players, preseason injury was not found to be a significant risk factor. However, researchers reported relationships between previous injury and such variables as confidence, stress, and preseason depression (15). The authors speculated that these factors may indirectly moderate injury occurrence, and suggested that further study into the interplay between psychosocial variables and physical risk factors was warranted (15).

Study limitations. Potential limitations of this study need to be discussed. First, not all female ice hockey players participated in the study. However, because participants did not differ significantly from non-participants in baseline demographic measures (Table 3.1), we feel the sample is representative of the population of female ice hockey players in the Edmonton area. Second, this analysis of risk factors associated with injury is limited to data collected over one hockey season in a defined geographic area. It may not be appropriate to generalize to other hockey populations, and further research is encouraged. Finally, self-report bias may be a factor in the assessment of previous injury. At baseline, all participants were asked whether or not they had sustained a sports injury in the previous 12 months. Details about the nature and location of previous injuries were collected, however this information was not validated. This may have resulted in misclassification of injury sites and diagnoses, and also inflated or deflated the reinjury rates.

Notwithstanding the above concerns, this study represents the first published research to quantify personal risk factors associated with injury among female recreational ice hockey players. Risk factors that were found to be significantly related to the occurrence of injury included: injury in the past year (OR = 1.55), more than five years of hockey experience (OR = 1.44), and high exposure level (OR = 1.37). The importance of controlling for level of exposure when investigating risk factors for sports injury was also highlighted.

Recreational hockey players should be encouraged to seek professional treatment and rehabilitation advice following injury. Prompt and appropriate attention to injury may reduce the incidence of reinjury. However, research into specific risk factors associated with reinjury is required.

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Chapter 4

Overview and Future Directions

4.1 Overview

The preceding chapters reported the results of a prospective study that examined injuries among female recreational ice hockey players in Edmonton, Alberta over the 1997-98 hockey season. The incidence and nature of injury for female hockey players were described, and personal risk factors associated with hockey injury were identified.

Chapter One reviewed previous research in the areas of ice hockey injury, patterns of injury for male and female participants in team sports, and risk factors associated with ice hockey injury. While the literature on ice hockey injury spanned thirty years and included different data sources and study designs, several trends in the pattern of injury were observed. Most notably, sprain/strain and contusion were the most common diagnoses for hockey injury (3,8,11,12,15), and player contact was the most common mechanism of injury (4,7,12,15).

Many risk factors that contribute to hockey injury have been reported, including age (12,15), weight (15), player position (15), and history of previous injury (15). However, few prospective studies have examined intrinsic characteristics that may predispose individual hockey players to injury. Furthermore, none have included female hockey players. The literature on male and female athletes identified gender differences in the nature of and risk factors for sports injuries (1,9,10,14,16), and supported the need for targeted injury research among female ice hockey players.

Chapter Two quantified the incidence, nature (anatomy, diagnosis, and mechanism), and severity of injury for female ice hockey players in the Greater Edmonton area. This was a prospective study that followed 314 players through the entire 1997-98 hockey season to collect exposure and injury data. During the course of the season, only 19 players were lost-to-follow-up, therefore the results of this study were based on data from 295 participants, or 94 percent of the intial study

group. The study design was adapted from previous research with male recreational hockey players (15). Results from the present study confirmed that this study design is well suited for use among the recreational sports population. The importance of examining records from multiple health care providers in investigations of injury among recreational athletes was demonstrated in the present study. Female hockey players who were injured during the season either self-treated or sought treatment from a variety of health professionals in the community. Relying on emergency department or physician records for injury data may result in an underestimation of the incidence of sports injury among recreational athletes.

Injury information was reported for two levels of female players: those who were 18 years of age or younger and played on Midget teams, and those who played on adult women's recreational teams (AWRT) in which there were no age restrictions. There were no statistically or clinically significant differences in the nature of injury between the two groups, however the injury rate for Midget players was 6.7/1000 player-exposures, and for AWRT players, it was 7.8/1000 player-exposures. This is consistent with previous research that reported a trend toward higher injury rates as players get older (12,13).

The anatomic, diagnostic, and mechanistic distribution of injury observed among the female players was similar to that in previous research among male hockey players. One notable difference was the high incidence of lower back injuries among female hockey players. The lower back was the most prevalent injury site in the present study, however hockey injuries to this body region have not commonly been reported (6). Further research is required to confirm this finding.

The aggregated injury rate for female hockey players was lower than that reported for male recreational and varsity hockey players. This may be due, in part, to mandatory facial protection, the absence of intentional body checking, differences in attitude and behavior, and anatomic and mechanical differences.

Chapter Three identified risk factors associated with injury among female recreational hockey players. Using the data set from the original cohort of study participants, bivariate and multiple logistic analyses were used to develop an injury

risk model. Risk factors found to be significantly related to the occurrence of injury were high player exposure level (more than 50 games/practices per season), more than five years of hockey experience, and history of a sports injury in the previous 12 months. The first two factors do not lend themselves well to injury prevention strategies. However, the importance of controlling for player exposure level was evident in the development of the injury risk model, and this variable should be incorporated into future risk analyses for sports injury. With regard to previous injury, recreational athletes who sustain sports injuries must be encouraged to seek appropriate treatment and rehabilitation services, and discouraged from returning to competitive play before proper healing has taken place. This finding also highlights the importance of additional research into the circumstances of reinjury among athletes.

The injury risk model derived from this study is based on data collected over one hockey season in a defined geographic area. It is not clear if the model can be generalized to other hockey populations. The current model is best viewed as an initial step in the search for risk factors that contribute to injury among female hockey players.

This research represents the largest study of injury among female ice hockey players to date. The prospective study design, the large sample size, and high rate of follow-up have provided valid observations about the injury experience among female ice hockey players. The results of this study have contributed to the body of knowledge in the research on ice hockey injury.

4.2 Future Directions

Additional research into the pattern of injury among female ice hockey players is warranted. Specifically, further examination of injury by level of participation and by age group should be considered. There should be an investigation into the incidence and nature of lower back injuries among female ice hockey players to determine if this is an anomaly of the present study, or if it is related to anatomical function or level of conditioning. Future analyses of individual

risk factors should incorporate psychological variables. In particular, efforts should be made to explore the relationship between injury incidence and severity and the reported sense of fair play and less aggressive attitude among female ice hockey players (2,5).

A follow-up study to the present research is currently underway. The objectives of the study are to examine long-term consequences of injury among participants who were injured during the study season, and to explore whether injury is a potential barrier to continued participation in ice hockey. Specific research efforts should focus on the issue of reinjury among recreational athletes, in particular to identify risk factors associated with reinjury.

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INFORMATION SHEET

Title of Project: The Epidemiology of Women's Recreational Ice Hockey Injuries

Principle Investigator: Don Voaklander, Ph.D.
Co-investigators: Donna Dryden, M.L.S.
Louis Francescutti, M.D., Ph.D.
John Spence, M.A.

Background: There has not been a comprehensive study of women's ice hockey injuries. The results of this project will be used to help make recreational hockey a safer and more enjoyable experience for participants.

Purpose: You are being asked to participate in a research study. The purpose of this study is to examine the frequency and nature of women's ice hockey injuries.

Procedures: Participation in this project will require about 15 minutes of your time as you fill out a short questionnaire. In addition, during the 1997-98 season (including playoffs), you will be contacted by telephone at the end of each calendar month and asked a brief series of questions about any injuries you may have suffered while playing hockey in the previous month. If you have suffered any injury that required medical treatment, we will ask at that time that you allow the attending health professional to fill in a form detailing the diagnosis of the injury you have suffered and how it was managed. At six months post-injury you will be contacted to determine what, if any, impact the injury has made on your life.

Possible Benefits: There may not be direct benefits to you for being in this study. However, it is expected that once the study is complete, the results will be given to hockey officials and leaders so they may take action deemed necessary.

Possible Risks: There are no risks involved in this study.

Confidentiality: Personal records relating to this study will be kept confidential. Any report coming out of this research will not give your name. Only the study team listed above will have access to your records.

You are free to withdraw from the research study at any time and your continuing hockey participation will not be affected.

Please contact Dr. Don Voaklander at (403) 492-5099 if you have any questions or concerns.

ICE HOCKEY QUESTIONNAIRE

1. What is your age?

   _____Years

2. What is your height?

   _____ Feet _____Inches or _____Centimeters

3. What is your weight?

   _____Pounds or _____Kilograms

4. What is your marital status?

   ☐ Not married
   ☐ Married/Common law
   ☐ Divorced/Separated
   ☐ Widowed

5. What is your smoking status?

   ☐ Cigarette smoker; 1 or more packs a day
   ☐ Cigarette smoker; less than 1 pack a day
   ☐ Cigars/Pipe
   ☐ Non-smoker

6. In an average week, how many alcoholic beverages do you drink?

   ___ None ___ Glasses of wine ___ Bottles of beer ___ 1 oz. drinks distilled liquor

7. What is your present occupation? (eg. lawyer, carpenter, homemaker, student)

   _____

8. Rate you hockey skills compared to the players you compete against. (Be honest)

   ☐ Excellent skill
   ☐ Above average skill
   ☐ Average skill
   ☐ Below average skill
   ☐ Poor skill

9. Rate you hockey skills compared to the players on your own team. (Be honest)

   ☐ Excellent skill
   ☐ Above average skill
   ☐ Average skill
   ☐ Below average skill
   ☐ Poor skill

10. How many years of experience do you have playing **ice hockey**?

    _____Years

11. How many years of experience do you have playing **ringette**?

    _____Years

12. In the past 12 months, have you suffered an injury as a result of doing sports or exercise that has limited your ability to participate in sports, exercise, or work?

    ☐ Yes
    ☐ No

13. If you answered **YES** to Question #12, please list the activity(s) that resulted in an injury in the past 12 months and the nature of the injury.

    Activity_____Type of injury_____

    Activity_____Type of injury_____

    Activity_____Type of injury_____

14. In the past 12 months, have you suffered an injury as a result of work activities that has limited your ability to participate in sports, exercise, or work?

    ☐ Yes
    ☐ No

15. If you answered **YES** to Question #14, please list the activity(s) that resulted in an injury in the past 12 months and the nature of the injury.

    Activity_____Type of injury_____

    Activity_____Type of injury_____

    Activity_____Type of injury_____

16. Other than hockey, do you currently participate in any physical activity, program (either on your own or in a formal class) or sport designed to improve or maintain your physical fitness?

☐ Yes
☐ No

17. If you answered **YES** to Question #16, please list the activity(s) you participate in.

_____

18. What ice hockey position do you most often play?

☐ Right wing
☐ Left defense
☐ Goaltender
☐ Left wing
☐ Right defense
☐ Center

19. Do you shoot with a left or right hockey stick?

☐ Left
☐ Right

20. Are you right or left handed?

☐ Left
☐ Right

21. Do you wear a knee brace?

☐ No
☐ Yes, and it is custom made
☐ Yes, and it is off the shelf

22. Do you normally wear glasses or contact lenses?

☐ Yes
☐ No

23. If you answered **YES** to question #22, do you wear your glasses or contact lenses while playing hockey?

☐ Yes
☐ No
☐ Does not apply

24. Other than shooting and passing the puck around, does your pre-game warm-up include:

- ☐ Vigorous skating
- ☐ Vigorous skating and stretching
- ☐ Stretching
- ☐ Neither skating or stretching

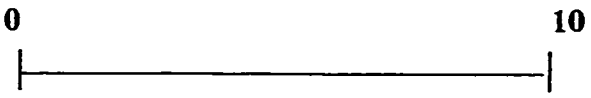
25. How many pre-season exhibition games have you played this season?

_____games(s)

26. What is the **main reason** you play hockey?

- ☐ Friendship with teammates
- ☐ Personal fitness
- ☐ Team achievement (winning)
- ☐ Excitement
- ☐ Personal achievement (skill development)

27. Please mark on the following line how important ice hockey is to you as a recreational activity, with 0 being not very important to 10 being extremely important.



CONSENT FORM (To be completed by research participant)

Title of Project: The Epidemiology of Women's Recreational Ice Hockey Injuries

Principle Investigator: Don Voaklander, Ph.D.
Co-investigators: Donna Dryden, M.L.S.
Louis Francescutti, M.D., Ph.D.
John Spence, M.A.

Please circle **YES** or **NO** in response to each of the following questions.

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached information sheet?	Yes	No
Do you understand that there are no benefits or risks involved in taking part in this study?	Yes	No
Has the issue of confidentiality been described to you, and do you understand who will have access to the information you provide?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
I agree to take part in this study:	Yes	No

Signature of Participant_____ Date_____

(Printed Name)_____Telephone Number_____

What is the name of your team_____

Signature of Witness_____

Signature of Investigator or Designee_____

****If you are under the age of 18 years**, please print the name and mailing address of your parent or guardian. A separate consent form will be mailed to them.

Name of Parent or Guardian: _____

Mailing address: _____

October 1997

Dear Parent or Guardian:

At the first game of the 1997-98 hockey season, your daughter/ward was asked to participate in a research study on the epidemiology of women's recreational ice hockey injuries. The study is being conducted by the Department of Public Health Sciences at the University of Alberta, and permission to contact the players was granted by the Northern Alberta Women's Hockey League. All players with the League have been invited to participate. The attached Information Sheet summarizes the purpose and format of the research study.

Your daughter/ward competed the attached questionnaire, and signed a consent form agreeing to participate in the study. However, because she is under the age of 18 years, we require your consent before we can include her as a study participant.

Please complete the enclosed Consent Form, and return it to the Public Health Sciences Department in the enclosed stamped, self-addressed envelope. If you have any questions about this study, please do not hesitate to contact Dr. Don Voaklander at (403) 492-5099.

Don Voaklander, Ph.D.

CONSENT FORM (To be completed by a parent or guardian for participants under the age of 18 years)

Title of Project: The Epidemiology of Women's Recreational Ice Hockey Injuries

Principle Investigator: Don Voaklander, Ph.D.
Co-investigators: Donna Dryden, M.L.S.
Louis Francescutti, M.D., Ph.D., M.P.H.
John Spence, M.A.

Please circle **YES** or **NO** in response to each of the following questions.

Do you understand that your daughter/ward has been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached information sheet?	Yes	No
Do you understand that there are no benefits or risks involved in taking part in this study?	Yes	No
Has the issue of confidentiality been described to you, and do you understand who will have access to the information your daughter/ward provides?	Yes	No
Have you had an opportunity to ask questions and discuss this study?	Yes	No
I agree that my daughter/ward may take part in this study:	Yes	No

Signature of Parent or Guardian _____ Date_____

(Printed Name)_____Telephone Number_____

Name of daughter/ward_____

Signature of Witness_____

Signature of Investigator or Designee_____

TELEPHONE DATA CONTACT SHEET - MONTHLY INJURY TALLY

SUBJECT NAME: _____

TELEPHONE NUMBER: _____

DATE: _____

NOTES:

Hello, is Ms._____ at home?

Hello, Ms. _____, this is _____ calling from the University of Alberta. I am calling you because you have volunteered to participate in a project examining hockey injuries. Do you have a few minutes to answer some questions concerning any injuries you may have suffered in the month of _____? The interview will only take about 5 minutes and your answers will be confidential. Feel free to ask any questions at any time. OK?

1. How many league games did you miss in the month of _____?
2. How many team practices did you attend in the month of _____?
3. How many tournament games did you play in the month of _____?
4. How many exhibition games did you play in the month of _____?

In March and April:

5. How many playoff games have you played in the month of _____?

6. Have you had an injury from hockey that has prevented you from completing a game, caused you to miss a game, or required you to seek medical treatment in the month of _____? (medical treatment could include a visit to a doctor, physical therapist, chiropractor, or other health professional) ☐ YES ☐ NO

If yes to question #6, go to the next page.

If no, thank Ms. _____ for her cooperation.

7. Did you have to see a doctor or any other health care professional concerning your injury?
8. **If yes, to question #7**: Where did you go to seek treatment and who did you see?

Name of Institution _____ Date_____

Name of Health Professional _____

9. What type of injury did you receive? (Circle appropriate items on list below)

BODY PART			**CONDITION**
Head	Forearm	Groin	Abrasion
Face	Wrist	Thigh	Concussion
Eye	Hand	Knee	Contusion (bruise)
Jaw/Chin	Thumb	Shin	Laceration
Teeth/Mouth	Finger	Calf	Strain
Nose	Chest	Ankle	Sprain
Throat	Upper Back	Foot	Dislocation
Neck	Lower Back	Heel	Nerve Damage
Shoulder	Abdomen	Toes	
Upper Arm	Genitalia	Spinal Cord	
Elbow	Hip		

10. During which of the following did the injury occur?

- ☐ League game
- ☐ Tournament game
- ☐ Exhibition game
- ☐ Play-off game
- ☐ Practice

11. During which period of play did the injury occur?

- ☐ 1st period
- ☐ 2nd period
- ☐ 3rd period
- ☐ Overtime
- ☐ Pre-game warm-up

12. What position were you playing when you were injured?

☐ Right wing	☐ Left defense
☐ Right defense	☐ Left wing
☐ Goaltender	☐ Center

13. How long were you prevented from participating in hockey as a result of this injury?

_____ days

14. How long were you prevented from working or going to school as a result of this injury?

_____ days

15. How long were you prevented from participating in other sports or fitness activities as a result of this injury?

_____ days

16. What activity was involved when you were injured? (Circle appropriate items)

Fighting

Stick Checking (no penalty)

Illegal Stick Checking (penalty called)

- Hooking
- Spearing
- Slashing
- High sticking
- Cross checking
- Butt-ending

Body Checking (no penalty)

- Unintended Collision
  - With Person
  - With Goal
  - With Stick
  - With Boards
  - Fall

Illegal Body Checking (penalty called)

- Boarding
- Tripping
- Roughing
- Charging
- Elbowing
- Interference
- Kicking

No Contact

Thank Ms. _____ for her cooperation.

«Date»

«Title» «FirstName» «LastName»
«Company»
«Address1»
«Address2»
«City», «State»
«PostalCode»

Dear «Title» «LastName»:

«patient1» is presently a subject in a research project examining the types of injuries that occur in recreational ice hockey. The project is being administered by the Department of Public Health Sciences at the University of Alberta.

«patient1» recently visited your office/institution on or about « date »
for consultation/treatment concerning an injury she received while participating in ice hockey. It is necessary for the purposes of this research project that an abstract form be filled out concerning the diagnostic specifics of this hockey injury.

With this in mind, I have enclosed an abstract form for you to fill in and a photocopy of the consent form that «patient1» has signed. Any information you provide will be confidential and will be used only as group data in research. If there is any administrative charge for performing this task, please enclose an invoice made out to the Recreational Hockey Injury Study and you will be reimbursed. If you have any questions or comments, do not hesitate to call Don Voaklander at 492-5099.

The study entitled: THE EPIDEMIOLOGY OF WOMEN'S RECREATIONAL ICE HOCKEY INJURIES has been reviewed and approved by a duly constituted ethics committee within the Faculty of Medicine and Oral Health Sciences at the University of Alberta.

Sincerely yours,

Don Voaklander Ph.D.

WOMEN'S RECREATIONAL ICE HOCKEY INJURY STUDY
CASE ABSTRACT FORM

Department of Public Health Sciences
University of Alberta
13th Floor, Clinical Sciences Building
Edmonton, Alberta
T6G 2H9

Name of Patient		**Date Treated**	

DIAGNOSIS (Please print and check the appropriate BODY PART, CONDITION)

Dx: _____

BODY PART

- ☐ Head*
- ☐ Face*
- ☐ Eye/Orbit*
- ☐ Jaw/Chin*
- ☐ Teeth/ Mouth*
- ☐ Nose*
- ☐ Throat
- ☐ Neck*
- ☐ Shoulder*
- ☐ Clavicle*
- ☐ Upper Arm*
- ☐ Elbow
- ☐ Forearm
- ☐ Wrist
- ☐ Hand
- ☐ Thumb
- ☐ Finger
- ☐ Chest
- ☐ Upper Back
- ☐ Lower Back
- ☐ Coccyx/ Sacrum
- ☐ Spinal Cord*
- ☐ Abdomen
- ☐ Gonads
- ☐ Genitalia
- ☐ Hip
- ☐ Groin
- ☐ Thigh
- ☐ Meniscus
- ☐ Knee*
- ☐ Patella
- ☐ Shin
- ☐ Calf
- ☐ Ankle
- ☐ Foot
- ☐ Heel
- ☐ Toes

CONDITION

- ☐ Abrasion
- ☐ Contusion
- ☐ Laceration
- ☐ Strain
- ☐ Sprain
- ☐ Dislocation
- ☐ Fracture
- ☐ Neurotrauma
- ☐ Other (please list)

PRINCIPAL MANAGEMENT OF INJURY

- ☐ Surgery
- ☐ Superficial debridement, minor suturing, dental work, etc.
- ☐ Immobilization (cast, splint, etc.)
- ☐ Therapeutic modalities (heat, ultrasound, etc.)
- ☐ Prescription medication therapy
- ☐ Proprietary management (aspirin, butterfly bandage, etc)
- ☐ Rest

WAS A REFERRAL MADE?

- ☐ NO
- ☐ YES

To what health service:

HOSPITALIZED

- ☐ NO
- ☐ YES

OTHER INFORMATION:

*** For these injuries, please answer on reverse side for detailed diagnosis**

HEAD / SCALP

- ☐ Scalp laceration
- ☐ Cerebral concussion
- ☐ Craniocerebral hematoma, epidural
- ☐ Craniocerebral hematoma, subdural
- ☐ Intracerebral hemorrhage
- ☐ Skull Fx

EYE / ORBIT

- ☐ Retinal detachment
- ☐ Iris contusion
- ☐ Periorbital hematoma
- ☐ Eye, globe contusion
- ☐ Corneal laceration
- ☐ Corneal opacity
- ☐ Orbital blowout Fx

FACE / EYE / EYEBROW

- ☐ Forehead laceration
- ☐ Eyebrow laceration
- ☐ Cheek laceration
- ☐ Eyelid laceration
- ☐ Zygoma Fx

JAW / CHIN

- ☐ Chin laceration
- ☐ Temporomandibular sprain
- ☐ Mandible Fx
- ☐ Maxilla Fx

TEETH / MOUTH

- ☐ Mouth laceration
- ☐ Tooth, luxated
- ☐ Tooth Fx

CLAVICLE

- ☐ Acromioclavicle sprain
- ☐ Sternoclavicular sprain
- ☐ Clavicle Fx

NECK

- ☐ Tracheal contusion
- ☐ Neck laceration
- ☐ Brachial plexus stretch injury
- ☐ Cervical spine sprain/strain
- ☐ Spine dislocation, cervical
- ☐ Spine Fx-dislocation
- ☐ Disk rupture, cervical

SHOULDER

- ☐ Shoulder contusion
- ☐ Axillary nerve compression
- ☐ Capsule sprain (lesion)
- ☐ Gleno-humeral dislocation
- ☐ Gleno-humeral subluxation
- ☐ Shoulder strain
- ☐ Rotator cuff strain
- ☐ Scapula Fx
- ☐ Humerus Fx

KNEE

- ☐ Anterior cruciate strain
- ☐ Posterior cruciate strain
- ☐ Lateral collateral strain
- ☐ Medial collateral strain
- ☐ Meniscal tear
- ☐ Patellar dislocation
- ☐ Patellar Fx

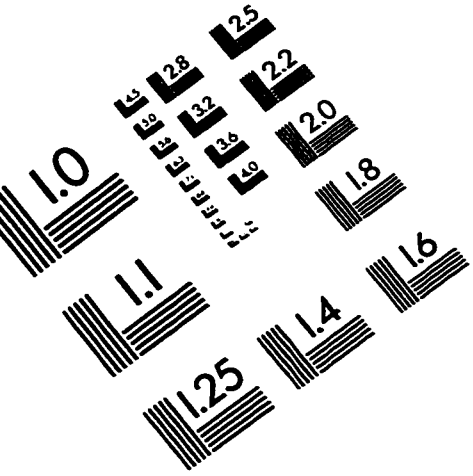
SPINAL CORD

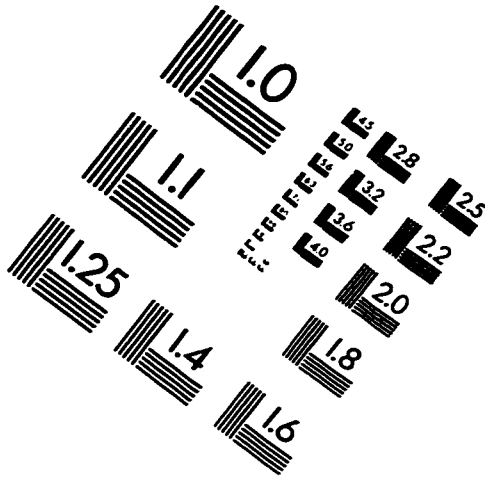
- ☐ Spinal cord contusion
- ☐ Spinal cord trauma (para)
- ☐ Spinal cord trauma (quad)
- ☐ Spinal cord trauma (death)

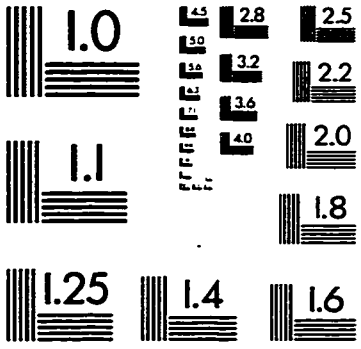
NOSE

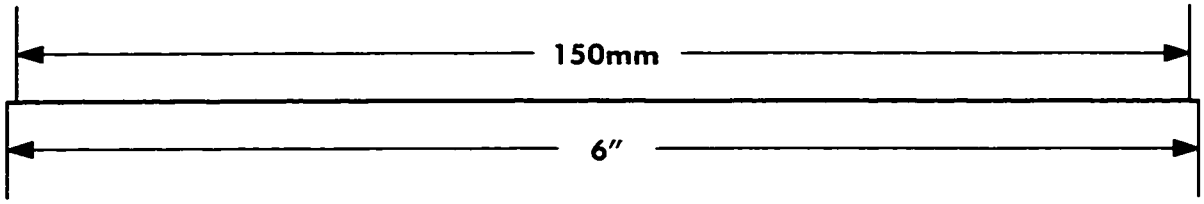
- ☐ Nose contusion
- ☐ Nose laceration
- ☐ Nose Fx

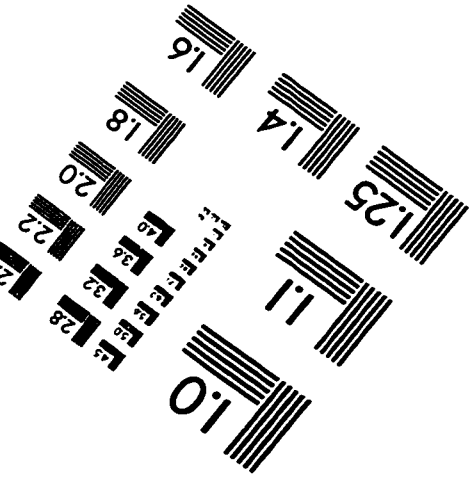
IMAGE EVALUATION
TEST TARGET (QA-3)

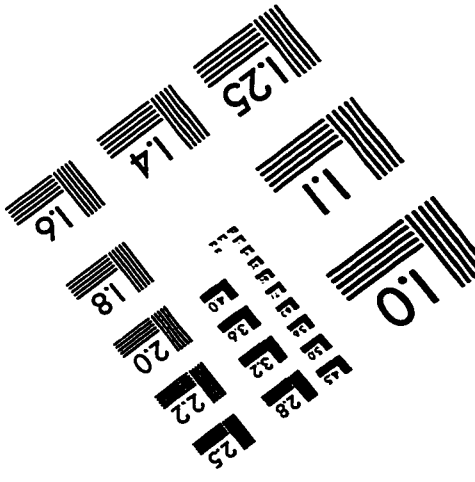












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